

MOD-2 FAILURE MODE AND EFFECTS ANALYSIS

Robert Lynette and Robert Poore Boeing Engineering and Construction Co.

July 1979

Prepared for NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Lewis Research Center Under Contract DEN 3-2

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U.S. DEPARTMENT OF ENERGY Energy Technology Distributed Solar Technology Division



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Cleveland, Ohio 44135
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TABLE OF CONTENTS

ITEM	PAGE	
Introduction .	ii	
Summary of Results	ii	-
Summary of Revisions	iii	R
Failure Severity Code	iv	-
Summary of Major MOD-2 Failure Modes & Effects	v	
Appendix A, Failure Mode & Effects Analysis - Detailed Worksheets	1	
Appendix B, System Schematics	262	
Appendix C, Memo K-6265-SS-487, dated 18 October, 1978, MOD-2 Failure Mode and Effects Analysis	270	
Appendix D Cable Run and Slip Ring Analysis	273	- R

INTRODUCTION

The failure mode and effects analyses (FMEA) were performed during preliminary and detail design in order to identify all MOD-2 failure modes and to ensure that the resultant effects are: (1) acceptable from a safety standpoint and (2) fail safe or, if not fail safe, represent least cost solutions (i.e., result in the lowest cost of electricity).

R

The FMEA's were completed by the cognizant designers and reviewed by system engineers and a reliability specialist. In general, fail safe design is employed wherever cost effective and a safe life design is employed for single thread structural items such as the rotor. The failure severity code used in the analysis is described in Table 1.

Completion of the FMEA's by the designers as an in-line part of the design process resulted in numerous design changes to either prevent serious failure modes or reduce their impact. The FMEA's contained herein reflect the detail design configuration. All major changes incorporated subsequent to the BDR will be evaluated relative to personnel safety and cost of electricity.

R R

Whenever applicable, failure frequency data has been included in the analyses. This data was used to quantify the probability of occurrences and hence the impact on the cost of electricity.

SUMMARY OF RESULTS

Over 860 failure modes were analyzed and numerous corrective actions were implemented to preclude costly failures. Special attention was directed at all potentially catastrophic failure modes; the results of this effort are summarized in Table 2.

R

Wherever practical, redundancy is used to preclude catastrophic failures. Safe life design is employed for items whose failure could cause serious damage, but could not be made redundant (e.g., blade fatigue cracks). The ability to control each rotor pitch control surface independent of the other precludes several potentially serious failure modes such as control linkage binding or bearing failures (the MOD-2 design provide for an orderly shutdown with just one control tip operative). The most probable, potentially catastrophic failure mode is the rapid progression of a fatigue crack in the blade. The MOD-2 design has incorporated a crack detection system which will cause an orderly WTS shutdown prior to suffering significant rotor damage.

R

The detailed FMEA sheets are contained in Appendix A, and relevant electrical/hydraulic schematics are included in Appendix B. Appendix C contains the results of a staff analysis of WTS emergency shutdowns. Appendix D contains an FMEA of the cable runs and both slip rings.

Summary of Revisions (Initial Analysis at PDR; this revision at DDR)

The purposes for this revision are: (1) to update the FMEA based on changes to the MOD-2 configuration that have occurred since the preliminary-design review (PDR), (2) to add a new section that contains an analysis of the possible effect of electrical failures that have a potential for causing numerous secondary failures (e.g., a wire shorts and causes other wires in the same bundle to short to ground or to other wires) and (3) to add a new section that contains an analysis of the possible effects of contact-to-contact shorts of adjacent slip rings in the two slip ring assemblies. The latter two sections could not be completed at the PDR since cable runs and slip ring assignments had not yet been established.

The major configuration changes covered by this revision are:

- 1. Addition of ice detection and crack detection systems.
- 2. Changes in the gearbox lubrication system to take advantage of the pump redundancy.
- 3. Deletion of the delta pressure sensors in the yaw hydraulics system.
- 4. Changes in the yaw drag brake caliper to make the drag proportional to hydraulic pressure rather than depending upon a mechanical spring.

The following pages have been added:

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11i - New page
Pages 273 through 295 Appendix D (new section)
```

The following pages have been revised:

```
1, 11, v ( was page iv)
1, 2, 29, 46, 69.1, 72, 82, 98, 129, 148, 169, 262, 263, 266a, 267 & 268
```

TABLE 1, SAFETY AND FAILURE SEVERITY CATEGORY GUIDE

		IMPACT		
HAZARD CATEGORY	FUNCTION	REPAIR COST	TIME TO REPAIR	PERSONNEL INJURY
Minimal	a None (1)	nd a Under \$1000	 and a Under 2 Days	nd None
Marginal	None an Critical (2)	d ar Under \$1,000	nd an Under 2 Days	d First Aid
Critical	Loss of control (3)	or c Up to \$10,000	or o Up to 10 Days	r Hospital
Catastrophic	Loss of System (4)	over 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	or Over o 10 Days	r Fatal or Permanent Disable

Impact values include the dollar and human cost of an unplanned event (a realized hazard).

Hospitalization is a severity category; includes wound stitches, extensive burn treatment, broken bone setting and equivalents.

<u>Permanent Disablement</u> includes loss of limb, sight or other majority body function.

*With the exception of flying objects emanating from the WTS, personnel injury can only occur during period of preventative and corrective maintenance.

- (1) Minor items that can be repaired with convenient.
- (2) No loss of generating capability, but repair must be accomplished within 2 weeks to avoid shutdown.
- (3) Causes WTS shutdown.
- (4) Destruction of major element such as rotor or gear box.

TABLE 1, SAFETY AND FAILURE CATEGORY GUIDE

Table 2, Summary of Major Failures and Effects - MOD-2-107

Failure	Effect	Corrective action
Structural failures		
Structural failures Rotor Ice forms and is thrown off Blade fatigue cracks Spar buckling Fatigue crack at control tip spindle end thread or at tip-blade interface Inboard joint-rotor to hub bolt or flange weld failure Broken teeter trunnion or flange cracks Buckling inboard sections or hub	Could injure public — remote possibility Loss of part of rotor and possible secondary damage if allowed to progress	Ice detection system added Crack detection system shuts down WTS prior to incurring serious damage Safe life design Fatigue tests Inspection schedule Mid-blade assembly buckling test
compression skins Drive	-	-
Broken low speed shaft Broken quill shaft bulkhead joint	Loss of load	Emergency shutdown effected prior to reaching damaging overspeed Safe life design
Teeter shaft or flange cracks	Possible extensive rotor damage	Strain gage correlation Safe life design
Failure of structure or foundation	Extensive damage	Safe life design
Control system failures		
Signal to one tip incorrectly drives control surface to zero pitch Control linkage to one tip jams	Emergency shutdown triggered by differential of tip position signals	None required, analysis verifies that one tip operative can safely stop rotor
Control system signal to both pitch actuators incorrectly drives control surfaces to zero pitch	Emergency shutdown triggered by generator output power sensor	None required — shutdown occurs prior to damaging overspeed
Power output sensor fails, calling for power increase when system is already at full power output	Damaging overspeed possible if load drops off prior to initiating shutdown	System changed to command shutdown prior to load dropping off Also, backup power sensor signal sent to controller ,
Electrical power failures		
 Synchronizer provides signal to close bus tie contactor too soon or too late (WTS not proper phase relationship or voltage to mate with bus) 	High current transient causing high torque load on the generator that could cause mechanical damage to generator or drive train	Synchronizer is fully redundant and fail safe
Loss of commercial power while WTS is at rated power	Rotor speed increases	None required — shutdown occurs prior to damaging overspeed

APPENDIX A

MOD-2 FAILURE MODES AND EFFECTS ANALYSIS - DETAILED WORKSHEETS

TABLE OF CONTENTS

Control Number	<u>I tem</u>	Page
4.0	Rotor Subassembly	
4.1	Rotor Blade	
4.1.1	Shell Structure	1
4.1.2	Spars	2
4.1.3	Inbrd. Joint	3
4.1.4	Pivot Spindle	4
4.2	Hub	5
4.3	Pitch Change Mechanism	
4.3.1	Hydraulics	
4.3.1.1	Actuators	8
4.3.1.2	Reservoir	9
4.3.1.3	Accumulators	10
4.3.1.4	Valves	
4.3.1.4.1	Start-Stop Valves	11
4.3.1.4.2	System Relief Valve	12
4.3.1.4.3	Teeter Brake Valve	13
4.3.1.4.5	Servo Valve	14
4.3.1.4.5	Shuttle Valve	15
4.3.1.5	Fittings & Hoses	16
4.3.1.6	Filters	17
4.3.1.7 & 8	Motor - Pump Assembly	18
4.3.1.9	Sensing Devices (See controls)	
4.3.1.10	Electrical Cables	
4.3.1.10.1	Control Cable to Tip No. 1 Actuator	19
4.3.1.10.2	Control Cable to Tip No. 2 Actuator	20
4.3.1.10.3	Tip No. 1 Bonding Strap	21
4.3.1.10.4	Tip No. 2 Bonding Strap	22
4.3.1.10	Cables and Connectors (See controls)	
4.3.1.11	Emergency Feather Device (See controls)	
4.3.2	Feather Lock Mechanism	23
4.3.3	Fasteners, Rod Ends	24

5.0	Drive Train Subassembly	
5.1	Low Speed Shaft and Bearings	
5.1.1	Shaft (Part of low speed shaft & bearings)	25
5.1.2	Radial Bearing	26
5.1.3	Teeter Bearing	⁻ 27
5.1.4	Radial Thrust Bearing	28
5.1.5	Teeter Stop	29
5.1.6	Electrical Distribution Equipment	
5.1.6.1	Slip Rings	30
5.1.6.2	Slip Ring Junction Box	31
5.1.6.3	Electrical Cables	
5.1.6.3.1	Power Cable to Hydraulic System	32
5.1.6.3.2	Control Cable to Hydraulic System	33
5.1.6.3.3	Rotor Actuator Control Cable	34
5.1.6.3.4	Flex Cable Across Teeter Bearing	35
5.1.6.3.5,	Teeter Bearing Bonding Strap ,	36
5.1.6.4	Rotor Junction Box	37
5.2	Quill Shaft and Couplings	
5.2.1	Quill Shaft	38
5.2.2	Quill Shaft Coupling	39
5.3.1	Gearbox Mounting Installation	40
5.3.2	Gears and Shafts	41
5.3.3	Gear Box Bearings	42
5.4	High Speed Shafts and Couplings	
5.4.1	High_Speed Shaft	43
5.4.1	High Speed Shaft Couplings	44
5.5	Rotor Brake	45
5.6	Lubrication System	
5.6.1	Gearbox Lubrication	46
5.6.2	Rotor Bearing Lubrication	47
5.6.3	Generator Lubrication	48
5.7	Generator	49
6.0	Nacelle Subassembly	
6.1	. Nacelle Structure	

6.1.1	Primary Truss Structure	50
6.1.2	Secondary Support Structure	51
6.1.3	Yaw Bearing Support Structure	52
6.1.4	Forward Bearing Support	53
6.1.5	Aft Bearing Support	54
6.1.6	Enclosure	55
6.3	Yaw Drive System	
6.3.1	Brake Disc	56
6.3.2	Bearing, Gear, Pinions	57
6.3.3	Gear Box	58
6.3.4	Hydraulic Motor	59
6.3.5	Hydraulic Pump and Motor	60
6.3.6	Hydraulic System Components	
6.3.6.1	Reservoir	61
6.3.6.2	Heat Exchanger	62
6.3.6.3	- Accumulators	63
6.3.6.4	Relief Valve	64
6.3.6.5	Solenoid Valves	. 65
6.3.6.6	Motor Control Valve	66
6.3.6.7	Fittings, Tubes, Hoses - Yaw System	67
6.3.6.8	Fittings, Tubes, Hoses - Yaw Brake	68
6.3.6.9	Fittings, Tubes, Hoses - Rotor Brake	69
6.3.6.10, 11	High Pressure and Low Pressure Filters	- 69.1
6.3.6.12	Check Valves	69.2
6.3.6.13	Needle Valve	69.3
6.3.7	Weather Shield	70
6 3.8	Miscellaneous Fasteners	71 -
6.3.9	Brake Calipers	72.
6.3.10	Yaw Sensors (See Controls)	
6.5	Environmental Control System	
6.5.1	Cooling Equipment	73
6.5.2	Heating Equipment	74
6.6.1.1	High Voltage Power Cable to GAU	74.1
6.6	Electrical Cables	
6.6.1	High Voltage Power Cables	75

6.6.2	Accessory Power Cables	
6.6.2.1	Main 480 Volt Feeders	76
6.6.2.2	AC Power Cable to the Control System	77
6.6.2.3	DC (Uninterruptable) Power to the C.S.	78
6.6.2.4	Power Cable to Yaw Drive System	79
6.6.2.5	Power Cable to Pitch Control System	80
6.6.2.6	Power Cable to Gear Box Oil Heaters	81
6.6.2.7	Power Cable to Lubrication System	82
6.6.2.8	Power Cable to Environmental Control System	83
6.6.2.9	Power Cable to Electrical Facilities Eqpt.	84
6.6.2.10	Uninterruptable Power Feeders	85
6.6.3	Control and Instrumentation Cables	
6.6.3.1	Generator Control Cable	86
6.6.3.2	Control Cable to the Generator Acc. Unit	87
6.6.3.3	Control Cable to Rotor	88
6.6.3.4	Control Cable	89
6.6.3.5	Control Cable to Tower	90
6.6.3.6	Control Cable to Gear Box	91
6.6.3.7	Control Cable to Lub. System	92
6.6.3.8	Control Cable to Yaw Drive System	92.1
6.6.4	Slip Ring Brush Assembly (Drive Train)	93
6.8	Generator Assessorv Unit	
6.8.1	Generator Circuit Breaker	94
6.8.2	Generator Excitation Controls	
6.8.2.1	Voltage Regulator	95
6.8.2.2	Power Factor Controller	96
6.8.2.3	Field Current Relay	97
6.8.3.	Generator Protective Relays	
6.8.3.1	Over Voltage Relay	98
6.8.3.2	Under Frequency Relay	99
6.8.3.3	Over Current Relay	100
6.8.3.4	Reverse Power Relay	101
6.8.3.5	Ground Current Relay	102
6.8.3.6	Differential Protection Relay	103

6.8.3.7	Generator Winding Overtemperature Relay	103.1
6.8.3.8	Generator Bearing Overtemperature Relay	103.2
6.8.3.9	Loss of Excitation Relay	103.3
6.8.3.10	Power Factor Relay	103.4
6.8.3.11	Generator Bearing Undertemperature Relay	103.5
6.8.4	Generator Instrumentation Transformers	
6.8.4.1	Potential Transformers	104
6.8.4.2	Current Transformers	105
6.8.5	Generator Instrumentation Transducers	
6.8.5.1	Voltage Transducer	106
6.8.5.2	Current Transducer	107
6.8.5.3	Real Power Transducer	108
6.8.5.4	Reactive Power Transducer	109
6.8.5.5	Generator Temperature Transducer	109.1
6.8.6	Accessory Power Transformer	110
6.8.7	Accessory Power Circuit Breaker Panels	
6.8.7.1	480 Volt Circuit Breaker Panel	111
6.8.7.2	115/230 Volt Circuit Breaker Panel	112
6.8.8	GAU Internal Wiring	
6.8.8.1	4.16 KV Buses	114
6.8.8.2	480 Volt Circuits	115
6.8.8.3	115/230 Volt Circuits	116
6.8.8.4	D.C. Circuits	117
6.8.8.5	Control Circuits	. 118
6.9	Electrical Facilities	
6.9.1	Lighting Equipment	119
6.9.2	Convenience Outlets	120
6.9.3	Aircraft Warning Lights	121
7.0	Tower Subassembly	
7.1	Tower	
7.1.1	Tower Structure	122
7.1.2	Nacelle Access Device	123
7.1.3	Ladder	124
7.1.4	Tower Foundation	125

7.2	Electrical Cables	125
7.2.1	High Voltage Cables	
7.2.1.1	Tower HV Cable	126
7.2.1.2	Tower to BTBU HV Cable	127
7.2.1.3	BTBU to Transformer HV Cable	128
7.2.1.4	Aerial HV Cable	129
7.2.2	Accessory Power Cables	
7.2.2.1	Accessory Power Feeder to the Tower Jct. Box	130
7.2.2.2	Accessory Power Feeder to the Nacelle	131
7.2.2.3	Accessory Power Cable to the Tower Cont. Unit	132
7.2.2.4	Acc. Power Cable to the Lift System	133
7.2.2.5	Acc. Pwr. Feeder to Twr. Elec. Facility	134
7.2.2.6	Acc. Pwr. Cable to Pwr. Output Transformer	135
7.2.2.7	Uninterruptable Pwr. Fdr. to Twr. Junction Box	136
7.2.2.8	UPS Cable to Tower Control Unit	⁻ 137
7.2.2.9	UPS Feeder to Nacelle	138
7.2.3	Control Cables	
7.2.3.1	Control Cable to Nacelle	139
7.2.3.2	Control Cable to BTB Unit	140
7.3	Cable Transition Mechanism	141
7.4	Lightning Protection System	
7.4.1	Electrical Path Across Yaw Bearing	142
7.4.2	Generator Lightning Arrestors	143
7.4.3	Transformer Lightning Arrestors	144
7.4.4	Earth Grid	145
7.4.5	Connection to Earth Grid	146
7.6	Electrical Equipment	
7.6.1	Bus Tie Breaker Unit	
7.6.1.1	BTBU Enclosure	147
7.6.1.2	Bus Tie Contactor (BTC)	148
7.6.1.3	Bus Tie Controls	
7.6.1.3.1	Synchronizer .	149
7.6.1.3.2	Differential Protection Relay	150
7.6.1.4	Bus Tie Instrumentation	<u>-</u> -

7.6.1.4.1	Generator Voltmeter	151
7.6.1.4.2	Utility Voltmeter	152
7.6.1.4.3	Generator Ammeter	153
7.6.1.4.4	Line Ammeter	154
7.6.1.4.5	Generator KW Meter	155
7.6.1.4.6	Generator PF Meter	156
7.6.1.4.7	Generator KWH Meter	157
7.6.1.4.8	Line KWH Meter	158
7.6.1.4.9	Potential Transformer	159
7.6.1.4.10	Current Transformer	160
7.6.1.4.11	Generator Total Running Hours	161
7.6.1.4.12	BTC Operating Cycles	162
7.6.1.5	Accessory Power Transformers	
7.6.1.5.1	4.16 KV to 480 Volt Transformer	167
7.6.1.5.2	480 Volt to 115/230 Volt Transformer	168
, -		
7.6.1.6	Uninterruptable Power Supply	
7.6.1.6.1	Battery	169
7.6.1.6.2	Battery Charger	170
7.6.1.6.3	Battery Heater	171
7.6.1.7	BTBU Internal Wiring	
7.6.1.7.1	High Voltage Input Bus	172
7.6.1.7.2	High Voltage Output Bus	173
7.6.1.7.3	480 Volt Acces. Power Circuit Breaker Panel	174
7.6.1.7.4	<pre>115/230 Volt Acces. Power Circuit Breaker Panel</pre>	175
7.6.1.7.5	Uninterruptable Power Circuit	176
7.6.1.7.6	Control Circuit	177
7.6.2	Power Output Transformer	178
7.6.3	Fused Manual Disconnect Switch	179
7.7	Control Subsystem	179.1
7.7.1	Power Failure Restart Circuit	180
7.7.2	CPU, PROM and Data Bus	181

7.7.3	Interrupt Logic	182
7.7.4	Deleted	183
7.7.5	Serial I/O Circuits	184
7.7.6	Fail Safe System	185
7.7.7	RPM Signal	186
7.7.8	No. 1 Vibration Signal	187
7.7.9	No. 2 Vibration Signal	188
7.7.10	Bearing Overtemperature #1	189
7.7.11	Bearing Overtemperature #2	190
7.7.12	Deleted	191
7.7.13	Teeter Brake Unlock System	192
7.7.14	Emergency Accumulator Command Signal	193
7.7.15	Pitch Hyd. Pump On Command Signal	194
7.7.16	Pitch Hyd. Pump Off Signal	195
7.7.17	No. 1 Pitch Servo Command Signal	196
7.7.18	No. 2 Pitch Servo Command Signal	197
7.7.19	No. I Blade Pitch Position Signal	198
7.7.20	No. 2 Blade Pitch Position Signal	199
7.7.21	Blade Locked #1 Signal	200
7.7.22	Pitch Hyd. Filter Clogged Signal	201
7.7.23	Blade Lock #2 Signal	202
7.7.24	Pitch Hyd. Oil Temp. High Signal	203
7.7.25	Pitch Hyd. Oil Pressure Low Signal	204
7.7.26	Pitch Accumulators Precharge Low	205
7.7.27	Pitch Hyd Oil Level Low Signal	206
7.7.28	Gear Box Oil Temperature High Signal	207
7.7.29	Gear Box Oil Pressure Low Signal	208
7.7.30	Gear Box Oil Level Low Signal	209
7.7.31	Gear Box Oil Temp. Low	210
7.7.32	Gear Box Oil Flow Low Signal	211
7.7.33	Deleted	212
7.7.34	Gear Box Oil Pump On Command Signal	213
7.7.35	Gear Box Oil Pump Off Command	214
7.7.36	Rotor Brake Command Signal	215
7.7.37	Deleted	216
7.7.38	Rotor Brake Unlocked Signal	217

- 7.7.39	Generator Field Enable Signal	218
7.7.40	Generator Output Signal	219
7.7.41	Utility Power Status Signal	220
7.7.42	Bus Tie Contactor Open Signal	221
7.7.43	Sync. Enable Signal	222
7.7.44	Bus Tie Disconnect Command Signal	223
7.7.45	Remote RS 232 Signal	224
7.7.46	Local RS 232 Signal	225
7.7.47	Ground Intrusion Signal	226
7.7.48	Deleted .	227
7.7.49	NCU Temp. Low Signal	228
7.7.50 ·	Yaw Accumulator Precharge Low Signal	229
7.7.51	Yaw Oil Level Low Signal ,	230
7.7.52	Yaw Oil Pressure Low Signal	231
7.7.53	Deleted	-232
7.7.54	Deleted	233
7.7.55	Yaw Oil Temp. High Signal	234
7.7.56	Yaw Oil Pump On Signal	235
7.7.57	Yaw Oil Pump Off Signal	236
7.7.58	Yaw Left Command Signal	237
7.7.59	Yaw Right Command Signal	238
7.7.60	Deleted	239
7.7.61	Fail Safe Yaw Hyd. Pump Off Command	240
7.7.62	NCU Temperature Low Signal	241
7.7.63	No. 1 Wind Speed Signal	242
7.7.64	No. 2 Wind Speed Signal	243
7.7.65	No. 1 Direction Signal	244
7.7.66	No. 2 Direction Signal	245
7.7.67	Fail Safe Generator Bearing Overtemp.	246
7.7.68	Fail Safe Enable Signal	247
7.7.69	Fail Safe Emergency Acc. Pressure Low Signal	248
7.7.70	Fail Safe Pitch Accum. Signal	249
7.7.71	Fail Safe Pitch Hyd. Pump Off Command	250
7.7.72	Fail Safe Bearing Temp. #1 & #2 Signal	251
7.7.73	Fail Safe Vibration #1 & #2 Signal	252
7.7.74	Fail Safe Gearbox Oil Pressure Signal	253

7.7.75	Fail Safe Gearbox Temp. High Signal	254
7.7.76	Deleted	255
7.7.77	Fail Safe Rotor Brake Command Signal	256
7.7.78	Fail Safe Overspeed	257
7.7.79	Test Van Ready Signal	258

SUBSYSŢE	М		COMPONE				PAGE		
	ROTO	IR		SHELL ST	RUCTURE		FMEAN	0 4	4.1.1
FUNCTION	OF COMPO	NENT							
CARRY :	SHEAR AN	D BENDING LOA	NDS TO BLADE AT	TACHMENT AT	HUB	_			
						_			
FAILURE	APPEN REF	FECTS IN TENSI	ON SKIN WELD.	CAUSES LOS	S OF POPTIO	N OF		PLIC	
				CAUSES EUS	S OF FORTIO			ATIN	G MODES
		CRACK IS UNDE					ALL		
M	AY <u>CAUSE</u>	CHANGE IN BL	ADE STIFFNESS	AND IN TURN	INCREASE				
	IBRATION								
2. IC	E ACCUM	ULATIONS COUL	D SEPARATE FRO	M ROTOR AND	STRIKE PEO	PLE	G		
OF	ANIMAL	S IF DETECTIO	N SYSTEM FAILS						
					 -				
F	AILURE FRE	QUENCY			FAILURE S	EVERIT	ГҮ		
	FAILURE	COMPONENT	MEAN TIME			[Γ	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CR	ITICAL	CAT.	ASTROPHIC IV
	 	2 10 FER ROOK						<u> </u>	
l	Cannot	be accurate	y calculated				<u>X</u>	<u> </u>	<u>x*</u>
·									
FAILURE	DETECTION	METHODS				_			
1 CRAC	CK DETEC	TION SYSTEM.							
					· · · · · · · · · · · · · · · · · · ·				
2. ICE	DETECTO	ORS ON BLADES.							
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)						
1 17 10	DUC 2500	TO AVOID TH'	IS FAILURE MODE	RV USE OF	A CDACK DET	ECTIO	M CVCTE		
			· · · · · · · · · · · · · · · · · · ·	. 01 032 01	A CRACK DET	LUTTO	1 31316	.1'1 •	
		INTO SYSTEM)							
SAFE L	IFE DES	IGN OF THIS CO	OMPONENT IS IN	TENDED TO AV	OID THIS FA	ILURE	MODE.		
		····							
* IF	NOT DETE	ECTED							
2. ICE	DETECTOR	RS ON BOTH BLA	ADES PROVIDE RE	DUNDANCY.	DETECTION C	IRCUI	r is fa	IL S	SAFE
(I.E	, OPEN	OR SHORTED WI	RE/CONNECTION	RESULTS IN	WTS SHUTDOW	N).			
			<u>-</u>						
			······································						
						-			
			 						
				NAME J. N	IOBLE			DATE	0/ 13/ /
OPERATING			_				R	ev.	10/25/7
В	SHUTDOWN TRANSITIO WARM-UP	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHI	ITION T	O FEATHE	R	3/8/79

SUBSYSTE	М		C	COMPONEN	IT			PAGE	2 ,
	ROTO	}	<u></u>	SPARS	S		FMEA NO 4.1.2		
	OF COLIPO		ADC TO D	N ADE AS	TTACIDATAT AT				
CARRY	SHEAR		DADS 10 B	SLAUE A	TTACHMENT AT	HUB.			
								-	<u>.</u>
			·						
FAILURE N	ODES& EF	FECTS PACK ACROSS SE	PAR.						PPLICABLE RATING MODES
		ERSTRESSING OF		STRUCTUE	RF'	<u>-</u>		ALI	· ·
		OF SPARS BY H				SES			,
		ERSTRESSING OF					_	ALL	-
3	0313 011		-		,				,
<u> </u>	1					-			
			-						
4			-	·					-
F.	AILURE FRI	OUENCY	T			FAIL URE S	SEVERIT	Υ	, _
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE	MEAN BETWEEN	FAILURE	MINIMAL	MARGINAL II	CR	ITICAL III	CÀTASTROPHIC IV
	_					-		-	χ*
	Ca	not be accura	tery car	iculater "	1		X .		
2	-		 -				├ ^		
	DETECTION	LACTHODS	<u> </u>	1	-	L	<u> </u>		J
FAILURE	DETECTION	IMETHODS	-		•		•		
1 Crack	<pre>C Detect</pre>	ion System							
a Not	da mactiv	observable		_		-			-
2 1102 (irectly	UDSET VADTE							
3 Chang	ge in bl	ade stiffness	may be d	detecte	d by an acco	elerometer a	s incr	eased	vibration
DISCUSSIC	N AND COF	RECTIVE ACTION (IF APPLICAE	BLE)					
		·		•			 -		
THESE	FAILUR	E MODES WOULD	NOT IMME	EDIATEL'	Y AFFECT WTS	S OPERATION.	BUT C	OULD L	EAD TO
CATAS	STROPHIC	FAILURE OF TI	HE BLADE	SHELL	STRUCTURE	IN A FAIRLY	SHORT	TIME.	
IT 19	POSSIB	<u>LE TO AVOID M</u>	OUE I BY	USE OF	A CRACK DE	TECTION SYST	EM. ()	(NCORPO	RATED).
		SIGN OF THIS (-					MODES	
	İ	T.	-						
*	IF NOT	DETECTED							•
									
		,							
									
									·
					NAME	J. NOBLE			DATE 8/15/78
OPERATIN	G MODES						<u> </u>	D	ev. 10/25/78
	SHUTDOW	·N	D TE	RANSITION	N TO STANDBY	G OPER	ATE	, r	3/8/79
В		ON TO WARM UP	E ST	TANDBY	TO OPERATE	H - TRAN I - FEATH	SITION	TO FEAT	

SUBSYSTE	М		COMPONE	NT			PAGE 3	3		
ROTOR				INBD JOINT				FMEA NO 4.1.3		
FUNCTION	OF COMPO	NE NT								
ATTACH	ES_ROTOR	BI ADE TO HUB								
										
			·-·			····				
FAILURE A	LPFAIEU	FECTS IRE DUE TO COR	ROSION, FATIGU	Ε,	OR INTERNAL	}		PLICABLE RATING MODES		
			CAUSES SEVERE A				F.	G, H		
			E TRAIN, NACEL							
			TO INCLUSION,		DOCTON OD OV		3			
						I.	<u>!</u> '			
			BLADE CAUSES SE		IRIC <u>LUADI</u> NG	UN_	F.	G, H		
TE	ETER BEA	RING, DRIVE T	RAIN, NACELLE	& TOWER.						
							_			
				1		l				
F.	AILURE FRE			L	FAILURE S	EVERIT	Υ	r 		
FAILURE	FAILURE MODE	COMPONENT FAILURE RATE	MEAN TIME BETWEEN FAILURE		MARGINAL		TICAL:	CATASTROPHIC		
MODE NO	FREQ %	× 10 ⁶ PER HOUR	(YEARS)	1	11		111	IV		
1		Cannot be a	ccurately calc	lated		- /	χ .	у*		
2		" "	II	II II		1	X	X *		
				-			,			
FAILURE	DETECTION	L		<u>. </u>	L					
					•			-		
1 VIS	UAL INSP	'ECTION (BOLTS	MISSING - CRA	<u>CKS IN WELD)</u>						
₂ CHA	NGE IN N	ATURAL FREQUE	NCY (OR STIFFN	ESS) OF ROTO	R ASSY.					
з INC	REASE IN	VIBRATION _								
		RECTIVE ACTION (I								
<u>1. IN</u>	SPECTION	I OF FLANGE WE	LD & CONSERVAT	IVE LOCAL DE	SIGN					
2. US	E OF MAN	IY, SMALL DIAM	ETER HIGH QUAL	ITY BOLTS GI	VES REDUNDAN	T LOAD) PATH			
3. AP	PLICATIO	N AND MAINTEN	ANCE OF GOOD C	ORROSION PRO	TECTION SYST	EM_(IN	NSIDĒ 8	OUTSIDE)		
SH	OULD PRE	VENT ANY FAIL	URE CAUSED BY	CORROSION (A	LSO FAY SURF	ACE_SE	ALAÑT)			
			SHOULD PRECLUD	•			1			
			SE COMPONENTS							
			STABLISH FATIG			IGUE 1	AILUKE			
			STADETSH TATE	OL ALLOWABLE						
*	IF NUI	DETECTED								
										
			· · · · · · · · · · · · · · · · · · ·	NAME A	l Falco			DATE 8/16/78		
OPERATIN	G MODES							ev. 10/25/78		
В	SHUTDOWN TRANSITIC WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY N TO OPERATE	G-OPERA H-TRANS I FEATHE	ITION TO	O FEATH	ER		

SUBSYSTE	М		COMPONE	TV			iE 4 ~	
	TOR		PI'	VOT SPINDLE	FME	FMEA NO 4.1.4		
	OF COMPO					_	•	
PR	OVIDE CO	<u>ONTROL AXIS AN</u>	ID STRUCTURAL R	ESTRAINT FO	R CONTROL TIP	·		
·					-			
FAILURE N	MODES & EF	FECTS DACK AT INRO	END THREAD. T	TD WOULD EV	II OEE CAUCTI	uc C	APPLICABLE DPERATING MODE	
					FF ALL CAUSTI	113	ALL į	
							· · · · ·	
	=		ADE INTERFACE.		FALL OFF CAL	JSING	ALL	
								
<u>3 0V</u>	ERSPEED	CAUSES BENDIN	IG OF SPINDLE.	DISPLACED	HINGELINE WOU	JLD	ALL	
CA	NUSE IMB	ALANCE & SHUTE	OMN		····		ALL	
4					ı			
		-	,					
F.	AILURE FRI	EQUENCY		l	FAIL URE S	EVERITY		
	FAILURE	COMPONENT	MEAN TIME		<u> </u>	<u> </u>		
FAILURE MODE NO	MODE	FAILURE RATE	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL,	CRITICĂ		
		X 10 - PER HOUR						
1		Cannot be	accurately ca	 culated			- X	
2		н н	11				X ·	
3		si n	11	11		, ,		
	DETECTION	I METHODS		L		- 		
		_						
1 08	SERVABLE				· · · · · · · · · · · · · · · · · · ·			
2 08	SERVABLI	=	-			•		
		-				=		
3				,				
DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLE)				•	
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				. .	•			
CAEE LT	EE DECIO	ON OF THIS COM	DONENT IC INTE	NDED TO AUG	. Tuese e			
SAIE LI	LE DEST	SIN_OE_IUTO_COM	PONENT IS INTE	NUED TO AVU	IN IHFSF FAIT			
							<u> </u>	
REDUNDA	NCY COUL	<u>.D BE ACHIEVED</u>	BY AN ADDITION	NAL CLAMP O	R SIMILAR DEV	ICE AROUN	4D SPINDLE	
AND PUT	INBOARD	OF THE OUTBO	ARD BEARING.					
						·		
				-			•	
		-			1 1001 -	·	1	
				NAME (). NOBLE		DATE 8/15/	
OPERATIN	G MODES						Rev. 10/25/	
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATH	SITION TO FE	ATHER	

SUBSYSTEM HUB	COMPONE	ит НИВ			PAGE (
		unR			FMEAN	4.2
FUNCTION OF COMPONENT		·NC				
ATTACHES ROTOR BLADE TO TEET	IEK REAKT	.NG				
FAILURE MODES & EFFECTS 1 LIGHTNING STRIKE - LOCALIZED	DAINT D	AMAGE FAY S	FΔI			PLICABLE
			LAL		OPER	ALL
PROTECTED BY CONSIDERABLE ME						ALL
2 HAIL - OVERALL PAINT DAMAGE	<u>- MOST S</u>	SEVERE ON LE	ADING EDGE			•
						ALL
3 SNIPER - LOCALIZED PAINT DAM	MAGE					
					}	ALL
4 INTERNAL MOISTURE BUILDUP -	ACCELERA	ATES CORROSI	ON			
LARGE AMOUNT COULD FREEZE AF	ND CAUSE	UNBAL ANCE				ALL
FAILURE FREQUENCY			FAILURES	EVERIT	Y	
TENNING ME	AN TIME			1		
FAILURE MODE FAILURE RATE BETWEE	EN FAILURE	MINIMAL	MARGINAL		ITICAL III	CATASTROPHIC IV
1 Frequency is site depende		X				
2 <u>Frequency is site depende</u> 3 Frequency is site depende	ent	X X		 		
4 Frequency is site depende					X	· · · · · · · · · · · · · · · · · · ·
		<u> </u>		L		
FAILURE DETECTION METHODS						
1, 2 and 3: VISUAL FOR PAINT DAM	AGE & RES	SULTING CORR	OSION			
4 INTERNAL MOISTURE DE						
DE TECTED ABYEBEARING	VCB DETER	ARGE ENBUSHU	TBOWNUNESA T	ROBLE	MIIM	ILL BE
FAILURE CAUSE AND CORRECTIVE ACTION (IF AP						
4 MOISTURE BUILDUP IS	S MINIM	MIZED BY PRO	VIDING VENTS	<u> </u>	UTBD.	END AND
ALLOWING CENTRIFUGAL	FORCE TO	FORCE THE	WATER OUT.		CORROS	ION
CONTROL SYSTEM WILL	MTNTM17	CORROSION.				
SONTINGE STORETT MAKE	1121121122					
1,2,3 NORMAL MAINTENANCE P.	A TAUT TAUG (ALT ANY MA TOP		05 DUE	TO.
MORPHE PROTECTION OF THE		SHUULU PREVE	NI ANY MAJUI	K DAMA	GE DUE	10
LOCALIZED PAINT REMO	VAL.					
1,2 WTS INSPECTION FOLLO	WING EXT	REME WEATHER	CONDITIONS			
						
		NAME AL	FALCO		Ţ	DATE 8/6/78
OPERATING MODES						v. 10/25/78
1	TRANSITION	N TO STANDBY	G OPERA	TF	INC.	10/20/70
B TRANSITION TO WARM-UP E	STANDBY	N TO OPERATE	H TRANS	ITION T	O FEATHE	R
C WARM UP F	TANSTITO	- TO OI ENATE	FEAIR	- ^ `		

SUBSYSTE			COMPONE			P	AGE 6	٠, ,	
Н	IUB			HUB	F	FMEANO 4.2			
	OF COMPO								
A	TTACHES	ROTOR BLADE T	O TEETER BEARI	NG	···	 _			
FAILURE N	MODES & EF	FECTS	FAILURE FROM F	ATTGUE CRACK	C PROPAGATION	, ,		PP LICAB	
								, G, (H	
			ORMATIONS AND						
_			<u>OF STA 60: HUB</u> LOSS OF BLADE				ſ	F,G,H	
						1			
A <u>51</u>	IMME IRIC	LOADING ON TE	ETER BEARING, 1	NA CELLE, DRI	VE TRAIN & 1	OWER.			
	· ************************************								
		<u> </u>						•	
	-				-	•			
F	AILURE FRE	QUENCY			FAILURES	EVERITY		•	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II	CRITI			TROPHIC IV
	1				-			X	
		CANNOT BE A	CCURATELY CALC	PLATED	 			 -	
2	<u> </u>			 	ļ ·			X	
					<u> </u>			<u> </u>	
FAILURE	DETECTION	METHODS							
1 0 1/10					=				
' <u>, 2 VIS</u>	SUAL_INSF	PECITON							
CHA	ANGE IN F	REQUENCY OF R	OTOR ASSY.		•			~	
					•				
INC	CREASE IN	N VIBRATION	-		-				
DISCUSSIO	N AND COR	RECTIVE ACTION (F APPLICABLE)		3				
,2 SAFE	LIFE DES	SIGN IS INTEND	ED TO AVOID FA	TIGUE FAILUR	RES				
		`							
									<u> </u>
	<u></u>								
•			-		•			**	
									
									
				-					
			~	NAME AL	_ FALCO			DATE \$	3/ 6/78
OPERATIN	G MODES							·	0/25/78
	SHUTDOW	, N	D TRANSITIO	N TO STANDBY	G OPERA	TE	'\	IL	11 23/18
В		ON TO WARM-UP	E STANDBY	N TO OPERATE		OT NOITI	FEATH	IER	

SUBSYSTE	м HUB			COMPONENT HUB					PAGE 7		
				HUB FMEANO 4.2							
	OF COMPO	NENT ROTOR BLADE TO	TEETE	R RFARII	VG.						
	17.01.20			.,				_			
	- • .					 _	····				
FAILURE N	AODES & EF	FECTS						A	PPLIC	ABLE	
 			N CKENC	DUE TO	011501 010 /	CHERT CHOIL	705	OPER	RATIN	NG MODES	
<u> </u>		OF COMPRESSIO			<u>-</u>			A, F	, G		
l —		ICANE LOADS)					SHUT-	İ			
DC	WN INIT	IATED BY VIBR	ATION D	ETECTIO	N SYSTEM AFT	TER STARTUP.					
					····]			
		_							-		
F	AILURE FRE	QUENCY				FAILURE S	EVERIT	Y			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN	N TIME N FAILURE ARS)	MINIMAL I	MARGINAL	CR	ITICAL III	CAT	TASTROPHIC IV	
1	CANNO	T BE ACCURATE	Y CALC	ULATED]				Х	
2					-						
3							<u> </u>		_		
	l		<u> </u>		<u>L</u>	<u> </u>			L		
FAILURE	DETECTION	METHODS									
1	VIBRATI	ON PICK-UP MO	UNTED O	N LOW SI	PEED SHAFT F	RONT BEARING	3.				
2											
3											
4					· -						
FAILURE		CORRECTIVE ACTI									
	ESTABLI	SHMENT OF CON	SERVATI	VE ENVI	RONMENTAL OF	PERATING RANG	SE TO	MINIM	IZE	RISK OF	
	THIS FA	ILURE MODE.									
1											
		-									
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					<u>-</u>						
ł		<u>, </u>									
l											
					NAME	AL FALCO			DATE	8/16/78	
OPERATIN	G MODES							Re	٧.	10/25/78	
	SHUTDOW TRANSITION WARM UP	N ON TO WARM-UP	E S	TANDBY	N TO STANCSY	G OPERA H TRANS I FEATHE	ITION T	O FEATHI	ER		

SUBSYSTE		ANGE MECHANIS	SM COMPONE	NT CTUATORS		PAGE	8 10 4.3.1.1
	OF COMPO		PITCH PORTION	OF THE WIN	D TURBINE RO		,
							-
							
1	MODES & EF	INTERNAL	LEAK -, REDUCE	S RATE OF M	OTION, ACTUA		RATING MODES
		ER LOAD, HEATS					F, G, H
2 EXT	ERNAL LE	AK DISSIPATES	S SYSTEM FLUID				F, G,-H
 3 JAM	MED - UN	NABLE TO CONTR	ROL BLADE PITCH	ON ONE BLA	DE ONLY		, , , ,
							F, G, H
4 ROD	-END SEF	PARATION - UNA	ABLE TO CONTROL	BLADE PITC	H, ONE BLADE		- 0
ONL F	Y AILURE FRE	EQUENCY	-		FAILURE S	EVERITY	F, G, H
FAILURE	FAILURE	FAILURE RATE	MEAN TIME BETWEEN FAILURE	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
MODE NO	FREQ %	× 10 ⁻⁶ PER HOUR	(YEARS)	1	- 11	III	IV
1,2	.95	70 70	1.7		X	· X*	
4	.01	70	164	,		Х	
FAILURE	DETECTION	I METHODS			<u>. </u>		
1 POO	R SPEED	CONTROL, OVE	RHEAT WARNING,	MANUAL TEST			
2 VIS	UAL, LO	W FLUID QUANT	ITY ALARM				
	DBACK S	IGNALS FROM 2	BLADES DISAGRE	EE, UNABLE I	O FEATHER OF	UNFEATHER	ONE .
4 FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)			· · ·	
SYS	TEM WILL	L SHUT DOWN.	· · · · · · · · · · · · · · · · · · ·				
1.			TO ALLOW MAIN				
			DISABLING FEEL ACTUATOR CAN E				FERENCES
3.4			RED WILL STOP 1				N ITSFLF
		LINE TO THE W					
					<u> </u>		
*	IF UNDE	TECTED DURING	INSPECTIONS.	···			
			· <u> </u>				
				NAME D.	W. KING		DATE 8/9/78
В	- SHUTDOW	IN ON TO WARM UP	D TRANSITION E STANDBY F - TRANSITION	N TO STANDBY	G-OPERA H TRANS	TE SITION TO FEATI	ev. 10/25/78 HER
	TANIN UP		i - inangillu	O OI ERATE	FEAIR		

SUBSYSTE		SE MEGUANICA		COMPONE	OMPONENT					2.1.0	
		GE MECHANISM			RESERVOIR		FMEAN	0 4	.3.1.2		
	OF COMPO	SUPPLY OF HYE	DRAULIC	FLUID F	OR THE PITC	H CONTROL HY	'DRAUL	IC SYS	TEM.		
-	_										
FAILUBE N	FLE JAM	FECTS TUMBLES		▶					PLICA	ABLE G MODES	
<u>-</u>								F,G	,Н,	& I	
		FAILS - AIR	SLOWLY	ENTERS	HYDRAULIC S	YSTEM, &/OR	OIL	_			
-		BREATHER						۲,	i,H,	& I	
		EL GAUGE FAILS CATION - 🖒		DUCES EM	IPTY INDICAT	ION PRODUC	ES	E C	и	9 T	
	SPREADS OIL IN AREA OF LOW SPEED SHAFT F,G,H,&I										
FAILURE FREQUENCY FAILURE SEVERITY											
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN	N TIME N FAILURE (ARS)	MINIMAL I	MARGINAL II		ITICAL III	CAT	ASTROPHIC IV	
1	10	10	110					Χ			
2,4	100	20	5.					Χ			
3	100	7	1.	/				χ			
<u> </u>	DETECTION	METHODS			<u></u> _		<u></u> .				
		ALARM & VISUAL	DETEC	TION OF	OTI TH DDEA	THED WITE CH	IT DOW	INIC			
		M PRESSURE &/(I DOM				
	S SHUTS	····		THE DICEIO	11121 1113 3110						
4	2 2UU[3	DOWN.			· · · · · · · · · · · · · · · · · · ·						
		CORRECTIVE ACTION			 :-						
1	_ `_	EVEL INDICATOR			ERMITTENT LO	W LEVEL ALAF	RM, AI	R ENTE	RS P	UMP .	
I	NLET, O	IL ESCAPES FRO	OM BREA	THER.							
		ATOR INCORREC	-								
t	NSATISF	ACTORY, THE O	IL TEMP	ERATURE	OR PRESSURE	DETECTION S	SYSTEM 	WILL	SHUT	THE	
hh	TS DOWN	•									
	EVELOPM	ENTAL TESTS TO	D BE CO	NDUCTED	TO VERIFY R	ESERVOIR PER	RFORMA	NCE.			
			• • • •								
	·										
				 							
					NAME D	W VINC		1,	DATE	7/20/0	
OPERATING	MODES					. W KING				7/20/8 10/25/78	
A	SHUTDOW	N DN TO WARM UP	E S	TANDBY	I TO STANDBY	G OPERA H TRANS I FEATHE	ITION T			.0, 20, 10	

SUBSYSTE PIT	M CH CHANG	GE MECHANISM		COMPONE	ACCUMUL	ATORS			PAGE THE AND	10 o '4.3.1.3
	OF COMPO	NENT RAULIC ENERGY	FOR FEA	THFRING	~		í			- ·
2. ST	ORE ENER	RGY FOR SHORT	TERM PE	AK DEMA	NDS DURI	NG NOR	MAL OPERA	TION		
									-	
1	ODES & EF	GAS LE					SPRING RA	\TE_		PLICABLE RATING MODES
OF	SYSTEM F	REDUCED, EVENT	TUAL LOS	S OF AC	CUMULATO	R CAPA	BILITY.		F, G	, H, & I
2 GAS	LEAKS E	EXTERNALLY - L	.0SS_0F	ACCUMUL	ATOR CAP	ABILIT	Υ		Ğ, H	, & I
3 0IL	LEAKS E	EXTERNALLY - (DISSIPAT	TES OIL	FROM SYS	TEM			A E	, G, H, & I
									А, г	, ы, п, а і
4					····		·			
F.	AILURE FRE	QUENCY			 -		FAILURE S	EVERIT	Y	:
<u> </u>	FAILURE	FAILURE RATE		TIME				<u> </u>		
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR		I FAILURE ' ARS)	MINIMA	L ^	ARGINAL		TICAL	CATASTROPHIC IV
1	30	42	9				X	X IF	UNDET	CTFB
2	20	42	14					X		
3	30	42	9	·			Χ	X IF	UNDET	ECTED
4			L					<u></u>		ا ا
FAILURE	DETECTION	I METHODS								
1 LOW	ACCUMULA	ATOR GAS PRES	SURE WHI	EN HYDRA	AULICS DE	-PRESS	URIZED-DI	SABLE	S STAR	T-UP ARTLITY
² GAS	PRESSURE	NOT EQUAL TO	HYDRAL	ILIC PRE	SSURE; S	SYSTEM	SHUTS DO	WN		
3 L0S	OF HYD	RAULIC PRESSU	RE AND	VISUAL :	INSPECTIO	N				
4										
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APP	LICABLE)					+	
									<u> </u>	<u> </u>
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	<u> </u>			·			-			·····
		· -	<u> </u>		NAME	D. W.	KING			DATE 7/21/8
OPERATIN	G MODES				<u> </u>				Re	ev. 10/25/78
	SHUTDOW				N TO STANDE	BY	G OPERA			- 1
	WARM UP	ON TO WARM UP		TANDBY RANSITIO	N TO OPERA	ΓE	I FEATHI		- LAIN	- 11

SUBSYSTE PIT		SE MECHANISM	COM	MPONE	TART-STOP	VALVE	<u> </u>	PAGE FME A	11 /	1.3.1.4.1
	OF COMPO							FMEA	NO	
APPLIE	S HYDRAU	JLIC PRESSURE	TO SERVO V	ALVES	S FOR NORM	AL OP	ERATION			
										
FAHLIBEA	ODES& EF	FECTE	-						4004.16	4015
· 1 EII	HER VAL	E FAILS TO OF	PEN - UNABL	E TO	START TUR	BINE.	-		APP LIC	NG MODES
									<u></u> F	
2 EIT	HER VAL	E FAILS TO CL	OSE - TURE	BINE !	SHUTS DOWN	NORM	ALLY		Н	
										
3_B01	H VALVES	S FAIL TO CLOS	SE D			 -			Н	
							· · · · ·			
4			<u> </u>							
F,	AILURE FRE	QUENCY	<u> </u>		,		FAIL URE S	SEVERITY		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIN BETWEEN FAI (YEARS	ILURE	MINIMAL 1	м	ARGINAL 11	CRITICAL 111	CAT	TASTROPHIC IV
1	90	41	3.1					Y		
2	10	41	278					X		
3	100	.003	.5 x 1	06				Х		_
FAILURE	DETECTION	METHODS								
1 UNA	BLE TO S	START TURBINE-	ALL OTHER	SYSTI	EMS OK.		`			
•										
2 PER	CIUDIC C	HECK FOR VALVE	UPERATION	٧.		-				
3 UNA	BLE TO	IMPLEMENT NORM	MAL_SHUTDON	√N, BI	UT NO PROB	LEM.	,	· · · · · · · · · · · · · · · · · · ·		
DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLE	:)						
₹ TI		ES PROVIDED TO	TNODEASE	DEL TA	ARTI TTV					
- In	IO VALVI		THURLASE	KELI	MDILIII.					
					· · · · · · · · · · · · · · · · · · ·					· ········
						-				
								·		
										
•								<u> </u>		
							<u> </u>			
	·									
								·		
					NAME	D. W.	KING		DATE	7/21/78
OPERATING	G MODES							·		10/25/78
8 -	SHUTDOWI TRANSITIO WARM-UP	N DN TO WARM-UP	E STAN	IDBY	TO STANDBY		G-OPERA H-TRANS	SITION TO FEAT	HER	

SUBSYSTE	М		COMPONE	COMPONENT				PAGE 12		
PITCH C	HANGE ME	CHANISM	SYSTE	M RELIEF VAL	VE		FMEA NO 4.3.1.4.2			
FUNCTION OF COMPONENT										
REL	IEVES PR	ESSURE IN ÈVE	NT PUMP COMPEN	SATOR FAILS				, 		
		<u>.</u>								
FAILURE A	ODES&EF	FECTS NALLY - UNABL	E TO MAINTAIN	SYSTEM PRESS	URE, HEATS' F	LUID		PPLICABLE RATING MODES		
			_					E,F,G,H		
2 LE	AKS EXTE	RNALLY - DISS	IPATES SYSTEM	FLUID, MAKES	A MESS	-				
							E,	F,G,H		
3 FA	ILS TO O	PEN - SYSTEM	MAY BE OVER PR	ESSUREIZED I	F PUMP COMPE	NSATO	R			
AL	SO FAILS						E	F.G		
4										
F.	AILURE FRE	QUENCY			FAIL URE S	EVERIT	Υ			
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FALLURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL IÍ		TICAL III	CATASTROPHIC IV		
1	40	17	66.6	,	ХХ.	χ	IF U	NDETECTED		
2	40	17	66.6		X			1		
3	20	17	33.3		x D	Х	IF U	NDETECTED		
	DETECTION	METHODS		<u> </u>				1		
1 LOW	PRESSURI	E ALARM, OR Q	ERHEAT ALARM					1		
2 LOW	FLUID QU	ANTITY ALARM								
			T DENOU TEST	CONCTITUTE						
3 NO D	F LEC LION	METHOD EXCEP	T BENCH TEST -	CONSTITUTES	DOUBLE FAIL	URE.		··· ·····		
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)							
								_		
_ D PI	ROBABILI	TY OF DOUBLE I	AILURE IS NEGL	IGIBLE						
	·									
										
·		·				<u> </u>				
			-		·					
										
				NAME [O. W. KING			DATE 8/9/78		
OPERATIN	G MODES			 	· · · · · · · · · · · · · · · · · · ·		Re	ev. 10/25/78		
В	SHUTDOWN TRANSITIO WARM UP	N DN TO WARM UP	E STANDBY	N TO STANDBY	G - OPERA H - TRANS I - FEATH	T NOITIE				
L								<u> </u>		

SUBSYSTE PITO		MECHANISM	COMPONEI TEE	NT TER BRAKE V	PAGE FME A N	13 10 4.3.1.4.3		
FUNCTION	OF COMPO	NENT					1.0.1.1.0	
CONT	ROLS_HYE	RAULIC PRESSU	RE TO RELEASE	TEETER BRAKI				
								
				• t			-	
FAILURE N	ODES&EF	FECTS PEN-TEETER BR	AKE SLIPS, BRA	KE LINING &	PLATE WEARS.	A OPE	PPLICABLE RATING MODES	
						1	G	
2 F.A	US TO	LOSE-TEETER B	RAKE RELEASES	TOO FARLY OF	N START-UP			
<u></u>					, <u> </u>		F	
3								
<u> </u>								
4								
F.	AILURE FRE	OUENCY			FAIL URE S	EVERITY		
	FAILURE	COMPONENT	MEAN TIME				T	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC	
	90	21	6.2		-			
2	10	21	55.6		X X		 	
	10	21	55.0	<u> </u>			 	
	<u> </u>						<u> </u>	
FAILURE	DETECTION	METHODS						
1 BRA	KE SQUE	AKS DURING NOR	MAL OPERATION,	VISUAL INS	PECTION	<u>.</u>		
_ MAN	IUAL INSI	DECTION						
2 MAN	IOAL INSI	LCTION.						
3							•	
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)					
		HYDRAULIC PRE	SSURE SWITCH AD	DED TO INDI	CATE			
		BRAKE RELEASE	STATUS.					
								
					·			
								
			-					
	·-···							
						·	<u> </u>	
				NAME D	. W. KING		DATE	
CPERATIN	G MODES				_		Rev. 10/25/7	
В		N ON TO WARM UP	D TRANSITION E STANDBY			ITION TO FEATH	IER	
С	WARM UP		F - TRANSITION	N TO OPERATE	I FEATHE	R		

SUBSYSTE	М		COMPONEN				PAGE	14	
ITCH CHA	ANGE MEC	HANISM		SERVO VALV	E	,	FMEAN	0 4.	3.1.4.4
-	OF COMPO			 -			· .		
CONT	ROLS PIT	CH CHANGE ACT	UATOR						
							•		
					٢				
	ODES&EF		MMANDS - ONE BL	ADE TIP MOV	ES TO LIMIT	0F		PP LICA	BLE MODES
MC	OTION.						F	G H	
<u>2</u> If	NTERNAL	LEAKAGE - HEA	TS FLUID, REDUC	ES RATE OF	PITCH CHANGE		F	G H	•
3 J/	AMS - ON	E BLADE TIP W	ILL NOT MOVE				F	,G,H	
. F	KTERNAI	LEAKAGE - DEP	LETES SUPPLY IF	NOT DETECT	FD.		<u> </u>		
4 -/		EL/IIVIGE DEF	22120 001121 11				F,	G,H ⁻	
·	AILURE FRE	OUENCY	······		FAILURE S	EVEDIT			
	FAILURE	COMPONENT	MEAN TIME		FAILURES			ī	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE	MINIMAL I	MARGINAL II	CR	ITICAL III	CATA	STROPHI IV
1	9	74	17.1			_ X	-		
2,4	90	74	1.7	-	X, (4)	Х	(2)		
2	ו	74	154			,		T^{-}	
2 OVERI	HEAT WAR	NING				•			
3 SAME	AS 1 AB	OVE.	4. FLUID LEVE	L SENSOR.					
Siscussio	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				,		
		··							-
	FC	OR 1, 2, 3, 4	EMERGENCY STOP	IS INITIATE	D WHICH BY-F	PASSES	SERVO	VALV	Ε
			•			-	•		
	-					_			
									
					······································				<u> </u>
						 -			
				- 	. VINO		7		0/0/70
		 		NAME D. W	. KING				8/9/78
PERATING			_				F	kev.	10/25/7
В-	SHUTDOWI TRANSITION WARM UP	N DN TO WARM-UP	E STANDBY	TO STANDBY TO OPERATE	G OPERA H TRANS I FEATH	SITION	TO FEATH	IER -	-

SUBSYSTE	М		COMPONE	TV			3€ 15	
	CH CHANGE MECHANISM SHUTTLE VALVE							4.3.1.4.5
DISABL	OF COMPO	NENT) VALVE & APPL	IES BLADE FEAT	HERING PRESS	SURE UPON LOS	S OF NOR	MAL HY	DRAULIC
SYSTEM	PRESSUE	RE.			-	1		
			RESSURIZED - U	NABLE TO CO	NTROL ONE BLA	ADE. '		CABLE NG MODES
TIP	, BYPASS	SES FLUID	<u></u> -				F,G H	
2 FAI	LS TO SE	HUTTLE WHEN DE	-PRESSURIZED-	UNABLE TO FI	EATHER ONE			
BLA	DE TIP				•		H,I	
3 LEA	KS	·		- 			F,G,H,	
4								
<u></u>								-
FA	AILURE FRE	QUENCY			FAIL URE S	EVERITY		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL 11	CRITICA	L CA	TASTROPHIC IV
1	10	27	41.7			Х		
2	10	27	41.7		Х			
3	90	27	4.6		X			
LOW 2 NO P	PRESSURI	E ALARM, OVERT CHANGE IN FEA	DE TIP ON START FEMP ALARM ATHERING ACCUMU		EATHER" COMM/	AND. SLOW	FEATH	ERING
3 INSP	ECTION D	DURING PREVENT	ATIVE MAINTENAM	NCE PERIODS.			_	
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)	- · <u>-</u>				
			<u> </u>					
1,2. SHL	ITDOWN C	AN BE ACCOMPL	ISHED BY FEATHE	RING ONE BLA	ADE.			
								
		· · · · · · · · · · · · · · · · · · ·	·					
		- <u> </u>						
					····			
			<u>-</u>				- -	
				NAME	D. W. K11		DAT	E 8/9/78
OPERATING	MODES	······································				<u>'J</u>		10/25/78
A B	SHUTDOWN	y . DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION	I TO STANDBY	G OPERA H - TRANS I FEATHI	ITION TO FE		,

SUBSYSTE		ALCHVNI CW		COMPONENT FITTINGS & HOSES				PAGE 16		
PITCH CHANGING MECHANISM FITTINGS & HOSES FUNCTION OF COMPONENT						FMEAN	0 4.3.1.5			
			RAULIC FLUID TO)						
			ATHER LATCHES							
-										
FAILURE M	ODES& EF	FECTS LLY FAILS - L	OSS OF PRESSUR	E: OIL WOULD	SPILL INTO			PPLICABLE RATING MODES		
RAC	EWAY AND	O/OR BLADE SEC	TIONS.				F	,G <u>,</u> H		
2 HYD	RAULIC	FLUID LEAKS -	OIL WOULD-LEAK	INTO RACEWA	Y: POSSIBLE	OIL				
COA	IING ON	ELECTRICAL CO	MPONENTS.		· · · · · · · · · · · · · · · · · · ·		F	,G,H		
<u>3 L I N</u>	ES_CLOG	- LOSS OF PRE	SSURE					_		
							F	,G,H		
4										
						<u> </u>				
. F/	FAILURE FRE		MEAN TIME		FAIL URE S	EVERIT	Υ	-		
FAILURE MODE NO	MODE FREQ %	COMPONENT FAILURE RATE × 10 ¹⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I_	- MARGINAL	CR	TICAL III	CATASTROPHIC IV		
1	20	29	20				X			
_2	75	29	5.3		X		*			
3	5	29	80.			,	X			
}		SURE, LOW OIL	QUANTITY. SYS	TEM_WOULD_GO	O INTO EMERG	ENCY S	STOP.	·····		
3 SLOW	FEATHER	ING RESPONSE F	PICKED UP BY MI	CRO PROCESSO	OR.			- 1		
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)							
l			MATIC STOP (FEA		•					
1250-	1260 ST/	ATION, COMPART	MENT W/ELECTRI S SHOULD BE RE	CAL & MECHA!	NICAL COMPON	ENTS A	MAY BE	COATED WITH		
ALSO	BE AVOI	DED, (DRAINS).								
1			ACEWAY AREA: EL					STANT.		
3 <u>. THIS</u>	FAILURE	MODE IS NOT A	ERY LIKELY SIN	CE THE SYSTI	EM HAS TWO F	ILTERS	S			
	CDITI	CAL IT LEVEL (AD DESCUES CEN	CODC INITIA	TE CHUTDOWN					
-	* CRITICAL IF LEVEL OR PRESSURE SENSORS INITIATE SHUTDOWN PRIOR TO LEAK DETECTION BY MAINTENANCE PERSONNEL.									
	LKIOK	TO LLAK DETEC	STON DI NATIVE	INTIOL FERSON	111LL •					
·										
						-				
				NAME JOS	E A. BURRUEL		_ -	DATE 7/26/78		
OPERATING	G MODES						R	ev. 10/25/78		
В	SHUTDOW TRANSITIO WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I-FEATH	SITION	TO FEATE	łĘR		

SUBSYSTE		CHANTEN	СОМРО			PAGE	PAGE 17				
PITCH CHANGE MECHANISM FILTERS						FMEAN	4.3.1.6				
FUNCTION OF COMPONENT											
REMOVES SOLID PARTICLES FROM HYDRAULIC FLUID.											
FAILURE	ODES & EF	FECTS					PPLICABLE				
1_EA	1 FAILS TO REMOVE PARTICLES - OPERATING N										
1.5/	AKS FYTE	PNALLY - DISS	IPATES SYSTEM				7, 0 11				
	2 LEAKS EXTERNALLY - DISSIPATES SYSTEM FLUID MAKES A MESS F. G H										
		PRESSURE DROP	- D				., .				
·		TER CLOGGING					F, G, H				
4											
F.	AILURE FRI	EQUENCY			FAIL URE S	EVERITY					
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILUI (YEARS)	RE MINIMAL	MARGINAL 11	CRITICAL	CATASTROPHIC IV				
1	FIL	TER CLOGGED, S	EE #3		X	χ*					
2	100	14	8.3			Х					
_3	CAN	NOT BE ACCURAT	ELY ESTIMATE	D	X	χ*					
FAILURE	DETECTION	METHODS									
1 PERI	ODIC FLU	IID SAMPLING &	FILTER ELEME	ENT REPLACEMEN	IT						
LOW	FLUID QU	ANTITY ALARM	VISUAL INSPE	CTION							
2 2011											
3 DIFF	ERENTIAL	PRESSURE SWI	TCHES. WTS	WILL STOP IF I	EXCESSIVE PRE	SSURE DROP	IS INDICATED.				
DISCUSSIO	N AND COR	RECTIVE ACTION (I	FAPPLICABLE)	CALISE MALEUNCT	TON OF VALVE	c					
					<u> </u>						
_ 🗗 -	INTERNAL	BYPASS VALVE REDUCE PITCH	OPENS PRODUC	ING SAME EFFE	CT AS FAILUR	E MODE NO.	l;				
	INI ALSO	REDUCE FILER	CHANGE RATES	WHICH WOOLD	DE DETECTED	DI INC MITCH	JPRUCESSUR.				
*	T UNDET	ECTED BY MAIN	TENANCE DEDSO	NNE1							
	IF UNDET	ECTED BY MAIN	ENANCE PERSO	MILL							
 -											
ļ ——											
	·					· · · · · · · · · · · · · · · · · · ·					
				NAME D.	W. KING	· 	DATE 8/9/78				
OPERATING	MODES				··· Mariu	Re	ev. 10/25/78				
A 8	SHUTDOW	N DN TO WARM UP	E STANDBY	ION TO STANDBY ION TO OPERATE	G-OPERA H TRANS I FEATHE	TE ITION TO FEATH	•				

SUBSYSTE	M		COMPONEN	T		_ F	PAGE]	8
PITCH		ECHANISM	<u> </u>	MOTOR-PL	JMP ASSY.		FMEAD	4.3.1.788
			OPERATION OF F	ITCH CHANGE	MECHANISM			
	·				·	- T		
FAILURE M	PHYDRAU	LIC OR NO PRE	SSURE - PRODUCE	S LOW PRESS	SURE ALARM	_		PPLICABLE RATING MODES
	S SHUTDO						F	,G,H
=			DUCES PITCH CHA	INGE RATES,	MOMENTARY LO	DW W		
			SHUTDOWN		TO FLUTD	JTC	 	F,G ,H
	UTDOWN	HYDRAULIC PRE	SSURE - OVERHEA	TIS HYDRAUL	IC FLUID	W12		E C II
	AKS - E	/TEDNAI			-			F,G,H
4 LE	, E	TERNAL				_	_	F G H
F.	VILURE FRE	QUENCY			FAILURE S	EVERITY	 -	<u> </u>
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRIT		CATASTROPHIC . IV
1	50	38	61	-		Х	,	
2	20	38	15.2			Х		
3	100	17	6.7			Х		
4	OETECTION 30 PRESSURE	METHODS 38 E ALARM _ WTS	10.0 SHUTDOWN	<i>5-</i>	X	χ*	•	
₂ LOW	PRESSURE	E ALARM - WTS	SHUTDOWN		-			•
3 OVER	HEAT ALA	ARM - WTS	SHUTDOWN					- -
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)					-
* IF	UNDETE	CTED		. ——	i			-
			·					
					-			
			<u> </u>				Ĺ	
								
					······································			·
		•	-			-		
			·- ·		•			
					M. WINO			2475240470
OPERATING	MODES	<u> </u>		NAME D.	W. KING		F	DATE8/9/78 Rev. 10/25/78
A B	SHUTDOW	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H · TRAN I FEATH	SITION TO		-

SUBSYSTE	М			NT CONTROL			PAGE 19	4 2 2 22
ROTOR -			TO TIP	NO 1 ACTUAT	OR		FISE A NO	4.3.1.10
PROVIDE		FOR THE FLOW	OF COMMANDS AND		L DATA FROM	THE TEE	TER BEA	RING
FLEXIBL	E CABLE	ASSEMBLY TO T	HE TIP NO. 1 AC	TUATOR		·····		
					·······			
FAILURE,	ire in c	able is open	circuited: No	path for a	specific com	nand		LICABLE
0	r data t	o or from Tip	No. 1 actuator	. lip is no	ot controlla	ole.	F,	G,H
f	alse dat	a may be tran	rt circuited: smitted, lip No	False comma . I does no	nds may resu t position	lt or	F,	G,H
•		namtially and	or high r unded / Loss-of	esistance.	mand function	on to	•	
			does not positi			JII-LU-	F,	G,H
4′								
3					_			
F	AILURE FRE	OUENCY			FAIL URE	SEVERITY		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		ICAL C	CATASTF12HI
. 1	20	.04	14 x 10 ³			Х		
2	10	.04	28 x 10 ³			X		
3	70	. 04	4 x 10 ³			Х		
	S SHUTS		IFFERENTIAL IN	THE TWO PIT	СН		·	
<u>Conse</u>	<u>rvatīve</u>	RECTIVE ACTION (I Mechanical_de these failur	sign of cable w	ıll_reduce_				
Fails	afe shut	<u>down is inıti</u>	ated if tip con	trol signal:	are not exe	ecuted.		
				 -				
	1				· · · · · · · · · · · · · · · · · · ·			
							<u> </u>	
								
			····					
								
				NAME	G. TRUSK /	H. Roti	n DA	т <u>е</u> 8/17/78
PERATIN	G MODES					110 01	·	ev. 10/3/
8	SHUTDOW! TRANSITIO WARM UP	N ON TO WARM-UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHI	OT NOITE	Re	v. 10/25/

SUBSYSTE ROTOR -		1		NT CONTROL CA 2 ACTUATOR	IBLE TO		PAGE 20	// < / 100 2			
FUNCTION		NE NT	111110				TMEANU)			
PROVIDE	Д РАТН	FOR 'THE FLOW O	OF COMMANDS AND	OPERATIONAL	_ DATA FROM T	HE TE	ETER BE	ĀRING			
FLEXIBLE	E CABLE	ASSEMBLY TO T	HE TIP NO. 2 AC	TUATOR							
	-										
FAILURE M	Wire	e in cable is a	open circuited:				OPE R	PLICABLE - ATING MIDES			
		or data to or	from tip No. 2	actuator, t	tip is not co	ntrol	F ,	,G,H			
	able. Cable is	nartially sh	ort circuited:	False comma	andś may resu	lt_	F	,G,H			
	or false	e data may be	transmitted, ti	p No. 2 does	s not positio	n	'	,0,11			
3	properly Cable 1s	nartially or	or high ounded/_Loss_o	resistance.	ommand functi	on					
			position prope		<u> ИШИЛИ</u>	<u> </u>	F,	,G,H ⁻			
4-	In 1,2,	and 3 WTS may	y shut down.								
	FAILURE FREQUENCY FAILURE SEVERITY										
FAILURE COMPONENT MEAN TIME											
FAILURE MODE NO	JRE MODE FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL						TICAL	CATASTR_PHIC			
MODE NO		x 10 PER HOUR			<u> </u>	- ·		10			
1	20	.04	14 x 10 ³			X					
2	10	.04	28 x 10 ³			X	,				
3	70	.04	4 x 10 ³			X					
FAILURE I	DETECTION	METHODS				-					
1 - 3 T	ip No. 2	data_display	ed on CRT termi	nal indicate	es that comma	nds a	re not				
	xecuted.				-			,			
WTS	shuts o	down due to di	fferential of p	oitch positio	on signals.		,				
		RRECTIVE ACTION (I									
1-3 C	onservat	tive mechanica	l design of cab	<u>le will</u> redu	ce						
00	ccurrenc	ce of these fa	ilures.			,					
F	aılsafe	shutdown init	iated if tip co	ntrol signal	ls are not ex	ecute	d.				
			(<u> </u>	-					
					 						
			1			,					
<u> </u>		-									
								· ,			
								· · · · · · · · · · · · · · · · · · ·			
				NAME G.	TRUSK / H.	Roth		ATE 8/17/78			
PERATING				•				ev. 10/5/78			
В	SHUTDOW TRANSITION WARM UP	IN ON TO WARM UP	E STANDBY	N TO STANDBY N TO OPÉRATE	G OPERAT H TRANSI I-FEATHE	ITION TO	O FEATHE	v. 10/25/78 R			

SUBSYSTE	M		COMPONEN	NT		PAGE	- •
-ROTOR -	EPS	DATE NIT	TIP NO	. 1 BONDING	STRAP	FMEA	NO 4.3.1.10.
			OW OF LIGHTNING	G CURRENT FI	ROM THE VARIA	BLE PITCH T	TIP OF THE
			PORTION OF THE				
FAILURE 1	nding st	rap is open c	ircuited.				APPLICABLE ERATING MILES
			No				ALL
2 BO	nding st	rap has high	resistance due 1	to fraying.			ALL
3 Bo	nding st	rap has high	resistance due 1	to poor bond			ALL
4							
F	AILURE FRE	EQUENCY			FAIL URE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTF_2HIC
1	20	.2	2.8 x 10 ³				*1
2	40	.2	1.4 x 10 ³				*1
3	40	.2	1.4 x 10 ³		}	•	*1
		dic inspection					
Discussion 1 - 3	When ligh cur or high possibly overhea used to	rrent will fol resistance pa y flow through ting, pitting	FAPPLICABLE) es the variable How the path of ath replaces the the tip pitch or welding of p failure mode.	least resi low resist bearing or arts. Redu	stance to gro ance bond pat hydraulic lir ndant bonding	ound. If and the currents causing straps wi	n infinite ent_will local ll be
	*1 Phy:	<u>sica</u> l <u>d</u> ama <u>ge c</u> ten metal. Pi	could be fatal a robability of si	t a manned te being ma	site due to f inned in a thi	alling par under storm	ts, or and also
	hav	ing failure of	f both straps is	negligible	. 0&M manua	l will spec	ify that
	no	one is allowed	d in nacelle dur	ing lightni	ng storms.		
							
				NAME G	. TRUSK / H.	Roth	DATE 8/17/78
OPERATIN	G MODES			<u> </u>			REV. 10/5/78
В	SHUTDOWI TRANSITIO WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERAT H TRANSI I FEATHE	TION TO FEATH	IER

SUBSYSTE	М -		COMPONE		<u> </u>	<u>-</u> -	PAGE 22		
ROTOR -			TIP NO	. 2 BONDING	STRAP		_	vo 4.3.1.10.4	
	OF COMPO		OF LIGHTNING CU	RRENT FROM	THE VARIARIE	סודרט	TID O	NE THE DOTOR	
								I INC KUTUK	
IO THE	FIXED PI	ITCH PORTION O	F THE BLAVE.			···		<u>`</u>	
FAILURE N	MODES & EF	FECTS strap is ope	n carcuated	s				APPLICABLE	
<u></u>	Dona mg	301 up 13 ope	ii cii cai cca.				OPE	ALL	
	Pondina	stran has his	ah masistansa di	uo to fravir				ALL	
2	Bonuing	Strap has hi	gh resistance d	ue to Trayii	<u>ıy.</u>	-		ALL	
3	Bonding	strap has hi	gh resistance s	ue to poor l	ond connecti	on.	-	ÄLL	
						}			
4									
				 ,					
F,	AILURE FRE	- 			FAIL URE S	EVERITY	/		
FAILURE MODE NO	FAILURE MODE FREQ. %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL II	CATASTF19HIC	
1	20	.2	2.8 x 10 ³]*	
2	40	.2	1.4 x 10 ³	-				1*	
3	40	.2	1.4 x 10 ³]*	
FAILURE	DETECTION	METHODS			4				
1 - 3	Period	ic inspection.	,			_			
	7 61 700	ic Tuabcecion			 	.			
2				- 	•				
_						-			
3		<u> </u>	 -						
DISCUSSIO		RECTIVE ACTION (I	FAPPLICABLE) strikes the var	lahlo nitch	tin of tho\m	otom t	hà na		
	extreme	ly high curre	nt will follow	the path of	least resist	ance t	o gro	und. If	
	-an-infi	nite or high	resistance path	replaces th	ne low resist	ance b	ond p	ath the	
			y flow through g, pitting, or			_n <u>yara</u>	U.I.I.C_	Lines	
									
			raps will <u>be us</u> ize strap fatig			ure mo	ide, s	traps will	
				·					
	* See	page 21 for	safety note.						
				- 				-	
									
				·			·1		
				NAME G	. TRUSK / H.	Roth	i	DATE 8/17/78	
JPERATINI			.		_		R	ev. 10/5/78	
8	TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA' H TRANSI I FFATHE	TION TO	FEATH	IER _	

SUBSYSTE	М		COMPONE	NT		PAGE	23
ROTOR			FEATHER	LOCK MECHA	NISM	FMEAN	0 4.3.2
	OF COMPO		EATHERED POSITI	ON			-
10 1101	O DETIDE	11. 11. 11.	- TOUR TOUR				
		···- ·- · · · · · · · · · · · · · · · ·				· · · · · · · · · · · · · · · · · · ·	
FAILURE N	MODES & EF	FECTS FAILS TO LOCK					PPLICABLE RATING MODES
: :::::		INIES TO LOOK					.D.E.E.H.I
2 ME	CHANTEM	EATLE TO UNIO	ער			Aeber	<u> </u>
<u> </u>	MANTON	FAILS TO UNLO			······	 F,G	
						— 	
3							
<u> </u>				-			
4			······································	······································			
F.	AILURE FRE	OUENCY			FAILURE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTROPHIC IV
1	10	2.3	500		_	Х	-
2	90	2.3	55.6	1	`	X	
	-						
FAILURE	DETECTION	METHODS	<u></u>			<u></u>	· · · · · · · · · · · · · · · · · · ·
1	0001710N	INDICATOR CH	OWS MOVEMENT A	אף פודכם ומי	CTATHS INF	NICATEC UNU O	CKED
<u> </u>	2021 L10N	TINDICATOR SU	JWS MOVEMENT M	ND FILEN LUC	V SIVIOS INI	JICATES UNLO	CKED.
2 TIP I	DOES NOT	RESPOND TO CO	OMMAND - START-	UP NOT POSS	IBLE.		
3						ē	
	N AND COR	RECTIVE ACTION (I	F APPLICABLE)		 ·		
<u>1. s</u>	INCE ONL	Y ONE TIP IS	REQUIRED TO STO	P WTS, A FA	ILURE TO LOC	K WILL NOT F	REVENT
A.	WTS SH	UTDOWN .					<u> </u>
			<u> </u>		, ,		
2. F/	AILING T	O UNLOCK IS A	FAIL-SAFE FEAT	URE. WTS W	ILL BE INSPE	CTED_FOR FAI	LURE CAUSE.
		v					
				· -			
							
l ———				NAME M	A. HOYT		DATE 8/15/78
OPERATING	G MODES	· · · · · · · · · · · · · · · · · · ·		<u></u>	. <u> </u>	<u> </u>	
В	SHUTDOWI TRANSITIC WARM UP	N ON TO WARM UP	E STANDBY	TO STANDBY	G OPERA H-TRANS I FEATHE	ITION TO FEATH	ER

SUBSYSTE	M		PAGE 24						
ROTOR	•		IDS		FMEA NO 4.3.2				
FUNCTION	OF COMPO	NENT					<u> </u>		
ATTAC	HEMENT C	F ACTUATOR TO	BLADE AND TIP.		1				
									_
FAILURE M	ODES & EF	FECTS			· · · · · · · · · · · · · · · · · · ·		Π	PPLICABLE	
1 ROD	END BE	ARINGS WEAR EX	CESSIVELY.					RATING MOD	ES
		·						G	
, ROD	END BRI	EAKS		-					
<u></u> -					-	-		G	
			· · · · · · · · · · · · · · · · · · ·				_		
3			 		-				
							ļ		
4									
]	,	
F	AILURE FRE	EQUENCY ,	_		FAILURE S	EVERIT	ΓY		
	FAILURE COMPONENT MEAN TIME								
FAILURE MODE NO	MODE FREQ %	FALLURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		ITICAL III	CATASTRO _IV	PHIC
					 			<u> </u>	
<u> </u>	98	6.8	17		X			ļ	
2	2	6.8	833				X	<u> </u>	
								- 1	
AILURE	DETECTION	METHODS						 	
TNC	DECTION	TID DOCITION	! INDICATOR					·	
1 1113	PECTION	, TIP POSITION	INDICATOR.						
INS	PECTION	, TIP POSITION	N INDICATOR.						
2									-
3									
DISCUSSIO	N AND COR	RECTIVE ACTION (F APPLICABLE)			•			
1. EX	CESSIVE	WEAR WILL BE	INDICATED BY T	IP POSITIO	N MOVEMENT AT	A FI)	(ED COM	ΙΜΔΝΟ	_
	(0200112		,		TIOTEMENT M				
_2SI	NCE TIP	S ARE CONTROLL	LED_INDEPENDEN	TLY, FAILU	RE OF ONE TIP	ROD E	ND WIL	.L_NOT	
PF	REVENT A	N EMERGENCY SE	HUT DOWN BY THE	OTHER TIP					
	·	.,		-VIII-II-II-I			-		
								•	-
						- · · · -			
									
		•							
	-							_	
									
				NAME	MAURIE HOYT			DATE 0/10	-/70
				NAME	MAURIE HUIT			DATE 8/15	<u>,, ,, , , , , , , , , , , , , , , , , </u>
PERATIN					<u>.</u>				
	TRANSITION	N ON TO WARM UP	D-TRANSITION E STANDBY		G OPERA H - TRANS		TO FEATH	IER .	
	WARM UP		F TRANSITION	TO OPERATE	I - FEATH	R		-	

					<u>-</u>							
COMPONENT (PART OF LOW SPEED SHAFT & PAGE 25 DRIVE TRAIN SHAFT BEARINGS) FMEANO 5.1.1												
FUNCTION	OF COMPO		OR TO THE QUILL			MOMEN.						
WEIGHT		MQUL TROTT NOT	on to the quie									
												
FAILURE M	ODES&EF	FECTS ER SHAFT OR S	HAFT FLANGE JO	INT - ROTOR	COULD FALL C)FF		PPLICABLE RATING MODES				
	- · — — — — — — — — — — — — — — — — — —							<u> </u>				
2 BRO	KEN QUIL	L SHAFT BULKH	EAD JOINT - WOU	JLD ALLOW RO	TOR TO FREE	HEEL		G				
3 DEF	ORMED SH	IAFT STRUCTURE	- COULD CAUSE	IMBALANCE A	ND BEARING							
F	AILURE						G					
4	4											
F	FAILURE FREQUENCY FAILURE SEVERITY											
FAILURE MODE NO	IODE NO FREQ % × 10 6 PER HOUR (YEARS) ! !! !! !!!											
1	5	1.1	2000					Х				
2	5	1.1	2000	· · · · · · · · · · · · · · · · · · ·								
3	90	1.1	111		<u> </u>			Х				
İ	DETECTION		- OF OFNEDATOR	OAD INTE	TEC /FLECTD	. CAL \	CMCDOC	NOV CHUTDOWN				
AS U	TILITY	TRIES TO DRIVE										
2 LOSS	OF GENE	ERATOR RESULTS	S IN ACTIONS ABO SUBSEQUENT APP	OVE (1) PLUS	S OVERSPEED (F ROTOR BRAKE	OF ROT	OR TRI	GGERS				
			MPERATURE SENSI				EMEDG	MADOTHES				
DISCUSSIO	N AND COR	RECTIVE ACTION (LU AT DEART	COS MOULD IN		LITEING	- SHOTDOMY.				
	E LIFE		TION DEVICES NO	T DDACTICAL		-						
			DURE PREVENTS			SS OF	DESIGN	I IMITS				
			DONE TREVERTS	NOTOK OVERSI	LLD IN LAOL.		DESTON	LIMITS.				
3NOA 	IE_REQUII	KEU. ————										
												
												
- 												
<u></u>		_,		NAME ROL	F LUTH			DATE 8/7/8				
OPERATING	G MODE S											
В	SHUTDOWN TRANSITIO WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATH	SITION T	O FEATH	ER				

SUBSYSTEM COMPONENT								PAGE 2	6 - 1
DRIVE TRAIN RADIAL BEARING (FLUID) FMEA NO 5.1.2									
TO SUPPO	RT LOW S	PEED SHAFT BY	DECREA:	SING RUN	NING FRICTI	ONS AND TO R	REACT	ROTOR	MOMENT
(FROM O	VERTURNI	NG) ROTOR WE	IGHT.						ŀ
FAILURE M	ODES&EF	FECTS LURE WHILE IN	MOTION	- CAUSE	S HIGH VIBR	ATION AND OV	'ER-		PPLICABLE RATING MODES
	PERATURE		•				_	F, G,	Н
a BE	ARING FA	ILURE WHILE P	ARKED -	INCREAS	ED BREAKAWA	Y MOMENT LEA	DING		
2									ALL
0.5		WHEN BROKEN L ED BEARING -		ED ERICT	TON AND TEM	DEDATIBE			
3 05	TENTONNI	ED DEMING	THOREAGE	- TRICI	TON AND TEN	ILITATORE	·		
			_						ALL
4			-1	· · · · · · · · · · · · · · · · · · ·				i i	ţ
FA	AILURE FRE	QUENCY	-			FAIL URE S	EVERIT	Υ	
	FAILURE		_						
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN	FAILURE	MINIMAL I	MARGINAL II	CR	ITICAL 111	CATASTROPHIC
							 		
1	10	10.3	111				X		
2	Car	not be accura	tely es	timated			Х		
2	90	10.3	12.3				X		}
FAILURE	DETECTION	METHODS	<u> </u>				L	-	
					,	-			
1 TEM	PERATURE	AND VIBRATIO	NS SENS	ORS WOUL	D INITIATE	EMERGENCY SI	HUTDOW	N	
2 THE	DE TC NC)- INSTRUMENTAT	TONC TH	AT CENCE	S EVCESSIVE	. DDEVNVNVA J	רטטטווב	HUME	VED ONCE
IN	MOTION F	AILURE WOULD	BE DETE	CTED PER	FM(1) ABOV	E	UNQUE	TIONE	VER. UNCE
		EMPERATURE IN			` `			-	1
		RECTIVE ACTION (I			CT_SBUTDOWN				
Discossio	N AND COR	NECTIVE ACTION (I	FAFFLICA	BLL)				-	
						,			
		!	·						
						*-			
					 				
				_					
	vstem wi	ill be designe	d to al	low lubr	ication of	bearing if s	statio	nary	
		nded periods.							
-	OI EXCEI	ided per rous.		-	· · · · · · · · · · · · · · · · · · ·				
								<u>-</u>	
		·							
			-					· .	
					NAME RO	LF LUTH			DATE 8/7/78
OPERATING	G MODES				_ 		·		
A 8	SHUTDOW	N ON TO WARM UP	E S	TANDBY	TO STANDBY	G OPERA H TRANS I FEATH	SITION	TO FEATH	ER
L	·				· · · · · · · · · · · · · · · · · · ·				

SUBSYSTE		1	COMPONEN	R BEARING			AGE	27	
	OF COMPO	NENT	11111	IN DEANTING		FA	ME A NO	5.1.3	
1		4	TRANSMITS ROTOF	R TORQUE TO	LOW SPEED SH	HAFT, SUI	PPORTS	WEIGHT	
OF ROTO	OR, REAC	TS ROTOR DRAG	LOAD						
FAILURES	YEAR' FAI	EURE OF ELAST	OMER - 🔃 🛭	>	-			LICABLE TING MOJES	
				<u> </u>			-	ALL	
₂ F	AILURE C	F BOND BETWEE	N ELEASTOMER &	METAL PARTS		>	7	ALL	
3 D	ETERIORA	TION OF ELAST	OMER DUE TO OIL	_, OZONE, OF	R LIGHTNING -				
P	RIMARILY	SURFACE EFFE	CTS, BUT MAY S	HORTEN LIFE.	· · · · · · · · · · · · · · · · · · ·			ALL	
4	4								
	·								
F.	AILURE FRI	OUENCY			FAILURE S	EVERITY			
FAILURE MODE NO	FAILURE MODE FREQ. %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITIC	AL (CATASTRIPHIC IV	
1	33	22.8	15			Х			
2	33	22.8	15			Х			
3	33	22.8	15			Х		-	
FAILURE	DETECTION	METHODS							
1 VI	SUAL								
₂ VI	SUAL								
3 VI	SUAL								
1 10	N ÁND COR	RECTIVE ACTION (IF APPLICABLE)	DOTOD DUE TO	DEAD HEIGH	T AND DO	AC 1 01	NDC .	
·			SPLACEMENT OF I	KUTUK DUE T	J DEAD WEIGH	I AND DK	AG LUA	103	
		IN INCREASED		C VICUALLY I	DETECTABLE	TE EATL	UDE TO	FIDCT	
			RY SLOWLY AND I						
			E, BEARING WIL	L PRUDADLI (JUMPLETE TOU	6 UF LIF	E CTCL	.E3 3A'13-	
l ~	ACTORIL'		RTS MAY ACCELER	ATE DOND EA	TI LIDE				
3> 0					ILUKE.	<u> </u>			
·	PI	EKIODIC INSPEC	CTIONS REQUIRED	•					
				·····					
						·		<u> </u>	
				NAME D	LL KINC		100	Tr. 7/10/70	
OPERATIN	G MODES			NAME D.	W. KING			TE 7/19/78	
A	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H - TRANS I FEATH	ITION TO F	EATHER		

SUBSYSTE	SUBSYSTEM COMPONENT PAGE 28						
DRIVE TR			RADIAL	THRUST BEAR	ING	FMEAI	vo 5.1.4
	OF COMPO		DECREASING RUI	NNING FRICTI	ONS AND TO R	REACT ROTOR	MOMENT
			AND ROTOR THRU:				
(<u>11011 01</u>	LIMIONO	William Welland	THE HOTOL TIME			***	
FAILURE M	ODES & EF	FECTS BEARING FAIL	URE WHILE IN MO	OTION CAUSES	HIGH VIBRAT	TIONS ANDOPE	APPLICABLE RATING MODES
AND_TEMP	ERATURE	AND COULD CAU	SE FAILURE OF	RADIAL BEARI	NG AND GEARB	OX_BY F,	G, H, I
· & FAI	LURE TO	REACH THRUST.	·				
2. BEAR	ING_FAIL	URE WHILE PAR	KED - INCREASE	D BREAK-AWAY	MOMENT LEAD	DING A	LL
â TO	FM (1) <i>I</i>	ABOVE WHEN BRO	KEN LOOSE.	· 			
			ICREASED FRICTI ARY OVER EXTENI			RATION A	ALL.
DR	AINING C	FF BEARING SU	RFACES				
FA	AILURE FRE	QUENCY -			FAIL URE S	EVERITY	· · · · · · · · · · · · · · · · · · ·
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ RER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL 111	CATASTROPHIC IV
7	55	10.3	20.2	-		Х	
2,4		INCLUDED I	N 1 AND 3			Υ,	
3	45	10.3	24.7		Х		
		THAT SENSES EX PER FM ABOVE.	CESSIVE BREAKA	WAY TORQUE,	HOWEVER, ONC	CE IN MOTION	N FAILURE WOUL
3 EXCES	SSIVE TE	MPERATURE INIT	TIATES EMERGENC	Y SHUTDOWN.			
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				•
						·	
<u> </u>	<u> </u>	-		- 	^		
							_
SYSTEM	WILL BE	DESIGNED TO A	LLOW LUBRICATI	ON OF BEARIN	IG IF STATION	ARY FOR EXT	ENDED
PERIODS	5.						
		<u> </u>					
	 			NAME R.	LUTH		DATE 8/7/78
PERATING	G MODES	<u> </u>					
В	SHUTDOW TRANSITIO WARM UP	N DN TO WARM UP	D TRANSITION E STANDBY F-TRANSITION		G OPERA H TRANS I FEATH	SITION TO FEAT	HER

SUBSYSTE DRIVE TR			COMPONEN	R STOP			PAGE 2	6 I 5
	OF COMPO		THE ROTOR WHEN	THE TURBIN	NE IS SHUT DO	OWN.	LIMITS	TEETER
ANGLE.								
		255.076					1	
1 BI	ODES&EF RAKE FAI SLIPPA	<u>LS TO RELEASE</u>	- BRAKE LINING	8 & PLATE W	ILL WEAR OUT	DUE		PPLICABLE RATING MCCES
			OR IS WORN OUT -	-ROTOR BANGS	S ON MOTION I	LIMIT	-	<u> </u>
	TOPS						A,B,C	,D,E,F,H,I
		OP BUMPERS FA	AIL - EXCESSIVE	TEETER ANGI	_E, MAY CONTA	ACT		
İ	OWER						A,B,C	,D,E,F,H,I
4 L1	EAKS			 				G
F	AILURE FRE	EOUENCY			FAIL URE S	SEVERI	ΓΥ	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTRIPHIC
1	20	22.8	25				Х	
2	4	22.8	125			ļ	X	
3)	22.8	500	·	<u> </u>		Χ	<u> </u>
4 1-4 V	75	ISPECTION	6.7		X			<u>—</u>
3								
DISCUSSIO	N AND COF	RECTIVE ACTION (I	IF APPLICABLE)					
1. BRA	KE WILL	SLIP AND EVEN	ITUALLY WEAR OUT	r. NO MAJOR	R DAMAGE RESU	JLTS.		
2. REC	UIRES P	ERIODIC INSPE	CTION & REPLACE	MENT OF WOR	N BRAKE LINI	NG.		
3,4 REQ	UIRES P	ERIODIC INSPEC	CTION.					
		····						
					-			
								
				NAME	D. W. KIN	G		DATE 7/18/7
OPERATIN	G MODES			1				3/8/79
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION 1	O FEATH	E R

SUBSYSTE	m RAIN - E	nc a	'	NANOPMOD OT 12	RINGS			PAGE 3	0 o 5.1.6.1
	OF COMPO		<u>-</u>	JLII	KINGS			FNIEAN	0 3.1.0.1
PROVIDE BETWEEN	S THE RO	TATING PORTIC	DRIVE T	E PATH I RAIN	FOR THE FLO	W OF ELEC	TRICAL PO	OWER AN	D SIGNALS
				 				,	
<u>1 S</u>		S FAILURES RES							PPLICABLE RATING MCCES ALL
Р	OWER AND	SIGNAL LINES	S ARE AD	DRESSED	UNDER THET	R RESPECT	IAF		ALL
2 S	UBSYSTEM	<u>18 '</u>						•	
3			-						-
4									
	AILURE FRE	OLIENCY	 		·		JRE SEVERIT	~	
	FAILURE	COMPONENT	MEAN	TIME		TAILC	THE SEVERT		T
FAILÜRE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN (YE	FAILURE	MINIMAL 1	MARGINA		ITICAL III	CATASTRIPHIC IV
ALL	100	37.6	3						
			-						
			<u> </u>					-	
	DETECTION	METHODS			-	-			
1 🗅					· · · ·				
2				· · · · · · · · · · · · · · · · · · ·					
3	•					,	-		
DISCUSSIC	N AND COR	RECTIVE ACTION (IF APPLICA	BLE)		-			-
	SEE	INDIVIDUAL CA	ABLES FO	R FAILU	RE EFFECTS	AND DETEC	TION METH	HODS	
D	· · · ·				•				
						~			
}	-								
					-				·
						•			
	,	-				.			
<u> </u>			· 					··· -, -	
		-10	·-	_	- [
OREGIZE	C MODES				NAME	G. T	RUSK		DATE 8/17/78
В	SHUTDOW	N ON TO WARM UP	E S	TANDBY	I TO STANDBY	H T	PERATE RANSITION T ATHER	O FEATH	ER +

SUBSYSTE		nc	COMPONEN	RING JUNCT	TON POY	PA	GE 3 t
DRIVE T			31.17	KING JUNCI.	TON BOX	FM	EANO 5.1.6.2
			ICAL JUNCTION PO	INT FOR THE	E WIRES COMIN	IG OUT OF	THE SLIP
			BUTING POWER AND				
FAILURE M	ODES&EF	FECTS ruited conduct	tor within junct	tion box. l	oss of assoc	:-	APPLICABLE OPERATING MODES
1	ated fur	iction.	1		<u> </u>		ALL
2 S	hort cin	rcuited conductions, erra	ctors within jun	nction box. or loss of r	Loss of ass	ita.	ALL
	onductor unction.		thin junction be	ox. Loss o	f associated		ALL
4							
F	AILURE FRE	QUENCY			FAIL URE S	EVERITY *	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICA	CATASTROPHIC
1	50	1.1	200				
- 2	25	1.1	400				
3	25	1.1	400				
1 - 3 *				,			
DISCUSSIO	N AND COR	REGTIVE ACTION (F APPLICABLE)	-			-
*			es for failure	effects and	detection m	ethods	
	for ea	ach signal and	power line.				1
					<u>.</u>		. •
							· · · · · · · · · · · · · · · · · · ·
			*		·		
							0/27/70
:				NAME G	. TRUSK / H.	Roth	DATE8/17/78
В	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERAT H - TRANSI I - FEATHE	TION TO FE	Rev. 10/5/78

SUBSYSTE	М	,	COMPONEN	IT			PAGE 3	2
	RAIN - E		<u>POWER</u>	CABLE TO H	IYDRAULIC SYS	TEM	FMEAN	0 5.1.6.3.1
	OF COMPO		OF ACCESSORY P	OWER ON THE	LOW SPEED	SHAFT	FROM	THE SLIP ,
RING JU	NCTION E	OX TO THE PIT	CH CONTROL HYDR	AULIC SYSTE	M.			
 								
FAILURE M	10DES & EF	FECTS	ited. Hydraulı	c numn moto	rs may onera	te		PPLICABLE RATING MODES
at	reduced	capacity. W	TS may shutdown	• panip moco	15 1105 550.0			G,H
2 Ca		is shout sins	uited. Hydraul	ic numn mot	ore may oner	ato-		
			TS may shutdown		/ oper	<u>u</u>	F,0	G,H
3 Co	nductor duced ca	is grounded. pacity. WTS	Hydraulic pump may shutdown.	motors may	operate at		F,(G,H
4								
F	AILURE FRE	EQUENCY	<u> </u>	 	FAILURE S	EVERIT	, ,	
	FAILURE	COMPONENT	MEAN TIME	·	1			γ
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II		TICAL	CATASTREPHIC,
1 .	50	.15	>1500		,	1	*	
2	25	.15	>3000			1	*	
3	25	.15	>3000	-		1		
FAILURE	DETECTION	METHODS	<u></u>			,	ı	*
1 - 3	WTS may	shutdown if h	ydraulic accumm	ulator pres	sure.cannot	be ma	intain	ed.
				•				
2								
3					,		-	
DISCUSSIC	N AND COR Period	RECTIVE ACTION (I	FAPPLICABLE) CRT data should	l reveal tha	ıt pitch accu	mmula	tor pr	essure
	has be	en low.		,				
	·							·
P	ump moto	ors can run or	1 2 of the 3 pha	ises; howeve	er, motor tem	perat	ure wi	11 increase
a	nd capad	city will be r	reduced.	- '			· 	
						-		
						·		
							,	
								
				NAME	0 7711011	/// 5	-4,	DATE 0 /37 /70
OPERATIN	G MODES			Trawie	G. TRUSK	/н. к		DATE 8/17/78 Rev. 10/5/78
A B	SHUTDOW	N ON TO WARM UP	D-TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION T		
								

SUBSYSTE	М		ì	ONENT			PAGE 33	
DRIVE TR			co	NTROL CABLE TO	THE HYDRAUL	IC SYS	FEMA N	5.1.6.3.2
	OF COMPO		OF COMMANDS	AND OPERATION	IAL DATA ON T	HE LO	W SPEE	D SHAFT
FROM THE	SLIP R	ING JUNCTION	BOX TO THE R	OTOR PITCH CON	ITROL HYDRAUL	IC SYS	TEM.	
1_A_		or data wire	ıs open cır	cuited. Contr	ol_function			PPLICABLE RATING MODES
Ca	nnot be	accomplished	. WTS w111	shutdown.			F	G,H
		or data wire or data presei		to another wir I shutdown.	e. Incorrec	<u>t </u>	F,	,G,H
3 A	control accomp	of data wire lished. WTS w	ıs grounded vill shutdowr	Control fun	ction cannot		F	,G,H
4							- <u> </u>	
	AILURE FRE	CUENCY			FAILURE S	EVERITY		•
 	FAILURE	COMPONENT	MEAN TIME		TAILURES	LVENITY		
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILU (YEARS)	JRE MINIMAL	MARGINAL	1	ICAL II	CATASTRIPHIC IV
1	50	.15	>1500			1		
2	25	.15	>2000			1		
3	25	.15	>3000			1		
1 ~ 3				ial pitch sign				
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)		····		,	
				· · · · · · · · · · · · · · · · · · ·				
			7.77					
				 				
								
				NAME G.	TRUSK / H. R	oth		DATE 8/17/78
В	SHUTDOW	N QU-MRAW OT MC	E STANDB	TION TO STANDBY IY TION TO OPERATE	G OPERA H TRANS I FEATHE	ITION TO		REV. 10/5/78

SUBSYSTE	М		COMPONE	NT			PAGE	34	
	<u>RAIN - E</u>	 	ROTO	ROTOR ACTUATOR CONTROL CABLE FMEANO 5.1.6					
	OF COMPO		OF COMMANDS A	ND OPERATION	NAL DATA ON	THE L	OW SPE	ED SHAFT	
EDOM TH	r cith b	INC HINCTION	BOX TO THE ROT	OD HINCTION	POV .				
r kum in	F-9F1t-4	.1110 - UUING 11UIN -	· ·	UK-OUNG LION	-BUA				
FAILURE	ODES & EE	FECTS Or data wire	is open circu	ited. Contr	rol function	can-		PPLICABLE	
1 A	ot be ac	complished.	WIS will shutdow	wn.			OPE	RATING MODES ALL	
^		on data wind	ıs shorted to	anothor win	o incorrect		 -	·	
2 A C	ommands	or data prese	ent. WTS will s	hutdown.	- medirec			ALL,	
<u>3 A</u> . b	control e accomp	or data wire	is grounded. will shutdown.	Control fur	nction canno	<u>.</u>	,	ALL	
4		•	ı			_			
- F.	AILURE FRE	QUENCY.	-		FAIL URE S	EVERIT	Υ ,		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT' FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL,	MARGINAL II -		TICAL	CATASTRUPHIC	
. 1	50	.15	>1500			٠.	1		
2	25	.15	>3000	7.2	·	4	1	` -	
3	25	.15	>3000				1	-	
1 - 3	WIS SN	utsdown due t	o differential	-	Ton Signais.	. •	<u> </u>	•	
			-	-	······································				
DISCUSSIO	N AND COR	RECTIVE ACTION (F APPLICABLE)					<u> </u>	
					-				
									
					· · · · · · · · · · · · · · · · · ·				
						-	•	-	
				-					
			-		<u> </u>				
			- <u>-</u>					-	
		•	, ,						
	•								
	•		······································						
	-			NAME	G. TRUS	K / H.	. Roth	DATE 8/17/78	
DPERATIN	G MODES			NAME	G. TRUS	<mark>к / Н</mark> .	. Roth	DATE 8/17/78 REV. 10/5/7	

SUBSYSTE	м		COMPONE	TN	•		PAGE 3	5
DRIVE T	RAIN-EPS	<u> </u>	FLEX	CABLE ACROS	S TEETER BEA	ARING		
FUNCTION	OF COMPO	NENT						
PROVIDE	S A PATH	LACROSS THE T	EETER_BEARING	FOR_THE_FLOW	LOF COMMANDS	AND_	OPERAT	IONAL DATA
FROM TH	E. ROTOR	JUNCTION BOX	TO THE ROTOR.			<u>-</u> -		
			,					•
FAILURE N	ODES & EF	FECTS		- d	<u> </u>			PLICABLE
1 A C	ontrol c accompli	or data wire i Ished WTS wi	s open circuit 11 shutdown.	ea. Lontrol	runction car	not_		LL
	<u></u>							
			s shorted to a WTS will shu		Incorrect		Al	LL
<u>з А с</u> асс	ontrol o	or data wire a	s grounded. C	ontrol funct	non cannoț l	э у _	A	LL ·
				۵				
4								
	AILURE FRE	OUENCY			FAILURE S	EVERIT	\	
	FAILURE	COMPONENT	MEAN TIME		T AIL GILL	1	·	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL	CATASTROPHIC IV
1,2,3	100	11.41	10			Х	۲	,
1 WTS	shutsdow	n due to diff	erential <u>pitch</u>	position si	gnals.			
3 .		·						
DISCUSSIO	N ÁND COR	RECTIVE ACTION (F APPLICABLE)				-,	-
_		-						
				<u> </u>				
	_							-
								
								
								
				NAME	G. TRUSK			DATE 8/17/78
OPERATIN	G MODES							EV. 10/5/78
В-	SHUTDOW TRANSITIO WARM UP	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H-TRANS I FEATHE	ITION T		

SUBSYSTE	M			COMPONEN	IT			PAGE 3	6	
	RAIN - E			TEETE	R BEARING B	ONDING STRAP		FMEA NO. 5.1.6.3.5		
	OF COMPO	NENT FOR THE FLOW	QF LIG	HTNING C	URRENT AROU	ND THE TEETE	R BEAF	RING F	ROM THE	
ROTOR TO	THE DR	IVE TRAIN.								
FAILURE N	ngpes & éf	rap is open c	ircuite	d.					PPLICABLE RATING MOLES	
									ALL '	
₂ Bor	ding st	rap has high ı	resista	nce due	to fraying.					
									ALL	
3 Bor	nding st	rap has high i	resista	nce due	to poor bon	d connection	<u>. </u>		ALL	
					1				··	
4									1	
	AILURE FRE	OUENCY				FAIL URE S	EVERIT			
<u> </u>	FAILURE	COMPONENT		NTIME		-				
FAILURE MODE NO	MODE FREQ %	× to 6 PER HOUR		N FAILURE EARS)	MINIMAL I	MARGINAL II		rical `	CATASTREPHIC	
1	5	1.1	2000				1	*		
2	50	1.1	200			,	1	*		
3	45	1.1	222		•		1	*		
FAILURE	DETECTION	METHODS	-							
1 - 3	Period	dic Inspection	1	·			-			
2										
									- 	
3					<u>.</u>	 .				
DISCUSSIO	N AND COR	RECTIVE ACTION (I htning strike	F APPLIC	ABLE)	the result	ant extremel	v hiak	curr	ent will	
1	follow t	he path of le	ast res	sistance	to ground.	If an infin	ite or	· high	resistance	
		laces the low								
dundant	bonding	the teeter be straps will b	e used	to precl	ude this fa	ilure mode.	Strap	os wil	l be	
<u></u>	d esigned cally.	l to minimize Probability o					e insp	ected	periodi	
l ——		or will operat			<u>_</u>					
		WITT OPERAC	C WICH	the ecet	-	" inoperati	ve.			
						····				
[······································	
			-							
					NAME	G. TRUSK /	H. Ro	th	DATE 8/17/78	
OPERATIN	G MODES					-			Rev. 10/5/78	
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E	STANDBY	TO STANDBY TO OPERATE	G OPERA H TRANS I-FEATHI	ITION TO	O FEATH	IER	
L										

SUBSYSTE	М		СОМР	ONENT			PAGE 3	7
	<u> RAIN - </u>		R	OTOR JUNCTION	вох	. <u>.</u>	FMEAN	5.1.6.4
	OF COMPO		CAL JUNCTIO	N POINT FOR TH	IE RIGID CABL	E COM	ING OUT	THE
SLIP_R1	NG JUNC	TION_BOX_AND_	THE FLEXIBLE	CABLE GOING A	ROUND THE TE	ETER I	BEARING	•
10p	odes& er en_circu nction.	rects inted_conducto	r within ju	nction box. L	oss of assoc	<u>iated</u>		PPLICABLE NATING MODES
						_		
as	sociated	cuited conduct d functions, e	ors within erratic oper	junction box. ation, or loss	Loss of of meaningf	u1	ALI	_
3Co	ta. nductor on.	grounded with	ıın junctıon	box. Loss of	associated	func-	AL	
			· · · · · · · · · · · · · · · · · · ·			_		
4			······································					
F	AILURE FRE	QUENCY			FAILURE	SEVERIT	Y	
FAILURE MODE NO	FAILURE MODE	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILI (YEAR\$)	JRE MINIMAL	MARGINAL II		TICAL	CATASTRCPHIC IV
1	50	5	44			Х		
2.	25	5	88			Х		,
3	25	5 ·	88			1 x		
	DETECTION				- 			
. WTS	chutedou	un See indiv	undual signa	l and power li	nes			
1 WIS	3114 63401	- See many		i and pone				
2								
			1	~				
3		*						
DISCUSSIC	N AND COR	RECTIVE ACTION (F APPLICABLE)					
			•					
								
ļ								
	See indi	vidual signal	wires for i	mpacts.				· ·
								_
								
								———
<u> </u>				NAME G	TRUSK / H.	Roth	T _r	DATE 8/17/78
OPERATIN	G MODES			1.33 6.	17/03/ / 11.			Rev. 10/6/78
	SHUTDOW	N		TION TO STANDBY	G OPERA			
В		ON TO WARM UP	E STANDI			SITION T	O FEATHE	:R

SUBSYSTEM COMPONENT PAGE 38 DRIVE TRAIN QUILL SHAFT									
DRI	VE TRA	IN	- OUTER	SHAFT			FME A NO	5.2	.1
	OF COMPO		TORQUE FROM	THE LOWSP	EED SHAFT	TO T	HE GEA	R BOX	AND
	O T.TMT	T TORSTONAL	ROSONANCE				,	**	
***************************************	О ППП	<u>1 1010101111</u>	,	•				 -	
FAILURE M	ODES & EF	FECTS	•		-			LICABLE	
S	HAFT F	AILURE - WO	ULD ALLOW RO	TOR TO FR	EE WHEEL		F,G		
2				ı					
								·	
3			<u> </u>						
4								·	
F	AILURE FRE	OUENCY			FAILURE S	EVEDIT	~		
<u> </u>	FAILURE		MEAN TIME			T TENT	·		
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL . II		ITICAL III	CATASTF IV	
1	100	3.4	. 33.3					χ*	
2				,					
3 4					 	ļ			
	DETECTION	I METHODS			<u> </u>	-			
10			INITIATES (ELI	ECTDICAL) FA	MEDGENCY SHII	TOOWN	DUE TO	SHIDDEN	
			AS BACKUP TO						
					IN PROCEDURE	, 105	UVERSE	ED 2MI	
Or Or	I THE LO	M SPEED SHAFT	-INITIATES SHU	I DOWN .					
							·		
FAILURE	CAUSE AND	CORRECTIVE ACTIO	ON (IF APPLICABLE)						
	STRUCTU	RAI AND FATIG	JE ANALYSIS ACC	OMPLISHED T	O CONFIRM A	ΓΟΠΑΤ	F SAFFT	Y MARG	TN
			NOT EXCEED DES						
	IN DESIG	JIV. WIS WILL	NOT EXCLED DE	JIUN OVERSIE	LD LIMITS OF	IDEN I	HESE CO	MDI 110	113.
	* DESI	GNATED CATIST	ROPHIC DUE TO H	HIGH COST OF	REPLACING	THE QU	IILL SHA	FT.	
			•		-				_
									
				· · · · · · · · · · · · · · · · · · ·					
				*			<u> </u>		
				NAME RO	LF LUTH		0	ATE 8/	7/8
OPERATIN	G MODES						Rev	. 11/2	7 [,] /78
B	SHUTDOW TRANSITIO WARM UP	N QU-MRAW OT NC	E STANDBY	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATH	SITION T	O FEATHE	Я	

SUBSYSTE		TRAIN		QUILL SHAFT COUPLING				PAGE 39 FMEA NO 5.2.2	
	OF COMPO		LOW SPEED SHAI	FT TO GEAR	BOX AND TO A	CCOMMODA	TE SHAFT		
MIS	ALIGNME	NT							
FAILURE N	ODES & EF	FECTS	LURE - WOULD PI	COMIT DOTOR	TO EDECMUEC		APPLICA		
<u> </u>	IPLING 3	IRUCTURAL FATI	LUKE - WOULD FI	· ·	TO TREEWILLI		F,G,H	MODES	
2 COL	IPLING I	NCIPIENT FAIL	URE OR DAMAGE I	DUE TO OVER	LOAD,		F,G,H		
3								,	
4									
F.	AILURE FRE	EQUENCY	<u>`</u>		FAILURES	SEVERITY		;	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITIC		STROPHIC IV	
1	10	13.7	137		745	Х			
3	90	13.7	9.3		XID-	-	_		
4 .									
FAILURE	DETECTION	METHODS							
1 BRE	AK IN L	OAD PATH CAUS	ES LOSS OF GEN	ERATOR LOAD	WHICH INITIA	ATES EME	RGENCY SI	нит	
			O DRIVE GENERA CAUSE UNDETECT		RISE - FM(1)	ATE FAIL ABOVE	URE DETE	CTED PEF	
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)						
	- IF DET	ECTED BY INSP	ECTION PRIOR T	O FAILURE M	ODE 1 OCCURR	ING.			
	ROTOR	OVERSPEED IS	WITHIN DESIGN I	IMITS.					
			·	·					
						 			
		-			· · · · · · · · · · · · · · · · · · ·				
				-					
				NAME	ROLF LUTH		DATE	8/7/8	
В	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G-OPERA H TRANS I FEATHE	ITION TO F	EATHER		

SUBSYSTE	M VE TRAIN	1		COMPONEN		INSTALLATION	- I	PAGE 4	_	3.1
FUNCTION	OF COMPO	NENT			-		_	FMEAN		
T0 /	ATTACH G	G/B TO NACELLE	BASE	PLANE TO	MAINTAIN D	RIVE TRAIN A	ALIGNM	ENT AN	D TO	REACT
LOA	DS.				 		_			
EAN LIBE M	IODES & FE	EECTS .							PPLICA	
1 AT	TACHMENT	FECTS BOLTS WORKIN	NG LOOS	E, CAUS IN	G LOSS OF F	ALIGNMENT		OPE	RATING	MODES
		<u> </u>					.	G	i,H	
2 AT	TACHMEN ¹	<u>r BOLT FAILURE</u>	<u>CAUSI</u>	NG MAJOR	FAILURE OF	DRIVE TRAIL	<u> </u>	, G	i . H	
										
3		-						l		
4			-							
<u>. </u>							_			_
F	AILURE FRE	QUENCY	ļ			FAILURE S	SEVERIT	Υ		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEE	N TIME N FAILURE EARS)	MINIMAL I	MARGINAL II	, CR	ITICAL III	CATA	STROPHIC IV
1	100	1.1	L	04	ć			Χ		
3	· · · · ·			2>		<u> </u>	<u> </u>	_	╁──	Х
4	-				-					
FAILURE	DETECTION	METHODS -								
1 MI	SALIGNM	ENT WOULD BE I	DETECTE	D BY BEA	RING TEMPE	RATURÊ AND V	IBRATI	ONS SE	NSORS	S AND
		ULD_SHUT DOWN								
		LACK OF DETEC	-							
4					<u> </u>	- 				
		CORRECTIVE ACTI			CTION PRIO	R TO EXCESSI	VE VIE	RATION	1	•
		NG SHUTDOWN.				<u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>			-,	
		<u> </u>						_	•	
2	> REQUÍF	RES DOUBLE FAI	ILURE -	NEGLIGI	BLE PROBABI	ILITY.	• 1			
				•						
•							<u>.</u>			
										
					···		_			
			-		·- ··			-		
					NAME BO	F 1171	_		DATE	0/7/70
OPERATIN	G MODES		_		NAME RO	LF LUTH .			DATE	8/7/78
A B	SHUTDOW	N ON TO WARM-UP	Ε	STANDBY	N TO STANDBY	G OPER/ H TRAN: L-FEATH	SITION 1	O FEATH	IER	

SUBSYSTE	M		COMPONE			PAGE	41
DRIV	E TRAIN		GEAR	S AND SHAFTS	<u> </u>	FMEAI	vo 5.3.2
	OF COMPO		AND INCREASE	DDM /CDAM 1:	7 E DDM TO 1	OOO DDM)	
	RANSFER	ROTOR TORQUE	AND INCREASE	ר אטויו (דאטויו די	7.5 KPM 10 I	BUU RPM)	
FAILURE N	PER PE	NAN PATH DUE	TO CHIPPED GEA	R OR SHEARE) SHAFT - WO	ULD ' one	APPLICABLE
-				OK SHEARE	, <u> </u>		RATING MODES
		OR TO FREE WH					,G,H
2 D/	MAGED G	<u>EAR TEETH - C</u>	OULD EVENTUALL	Y LEAD TO F	1(1) ABOVE		. Č. II
							,G,H
3						_	
						,	
		· .			ż		
4					· · · · · · · · · · · · · · · · · · ·		
		OUENOV					
	AILURE FRE	EQUENCY			FAILURES	T	
FAILURE	FAILURE MODE	FAILURE RATE	MEAN TIME BETWEEN FAILURE	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
MODE NO	FREQ %	× 10 ⁻⁶ PER HOUR	(YEARS)	'	11	111	IV
1	5	3.4	667				Х
2	95	3.4	35			Х	
3	ļ				-		
4		<u></u>	<u></u>		<u></u>	<u> </u>	
FAILURE	DETECTION	METHODS					
1 105	S OF GEN	FRATOR LOAD D	UE TO BROKEN L	OAD DATH WIL	I INITIATE	(TECHNICAL)	EMEDGENCY
			S TO DRIVE GEN				
L							
			OR IN SUMP WHI		NN STSTEM.	RUTUR	OVERSPEED
			OWN, VIA RPM S	ENSOR.			
			ON (IF APPLICABLE)				
Roto	or overs	peed will be	within design	limits			
						<u></u>	
	-						
		· · · · · · · · · · · · · · · · · · ·				·	
			,				
							-
	<u>-</u>				F 111711		0.7740
				NAME RUI	LF LUTH		DATE 8/7/8
OPERATIN	G MODES						Rev. 10/25/78
	SHUTDOW	N ON TO WARM UP	D TRANSITION	N TO STANDBY	G - OPERA H TRANS	ATE SITION TO FEATI	HER
	WARM-UP			N TO OPERATE	I FEATH		

SUBSYSTE			COMPONE	·	_		PAGE	42	
	DRIVE TRAIN GEAR BOX BEARINGS FMEANO 5.3.3 FUNCTION OF COMPONENT								
						•		•	
	O ALIGN	GEAR TRAIN CO	DMPONENTS AND I	REDUCE GEAR/	SHAFT FRICTI	UN			
					···				
			₹						
FAILURE	19RES & EE	FECTS	RUNNING - RES	IL TANT MISAL	IGNMENT OF G	FARS	- A	PPLICABLE	
<u>1 D</u>	EAKING	AILONE WITTEL	KOMMING - KES	JE TANT MISAE	TUITIENT OF C	LANS		RATING MODES	
							Γ,	G,H	
2 B	EARING [<u>DETERIORATIONS</u>	S - INCREASE II	N TEMPERATUR	E AND NOISE		J		
	EVELS	<u>.</u>						A11,	
3									
							ļ	•	
				 				-	
4			<u></u>				ł		
				Ţ			<u> </u>		
F,	AILURE FRE	EQUENCY			FAILURE S	EVERIT	- Y		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL	CR	ITICAL III	CATASTROPHIC	
1	10	11.4	100		 	 		X	
2	90	11.4	11.1	<u> </u>	 		X		
3	33								
4			-					5	
FAILURE	DETECTION	METHODS							
. 1	2 011	TEMPEDATURE	AND VIDDATION	CENCODE CAU	CE CVCTEM CI	HITDOM		_	
1 1,	- 011	LIEMPERATURE	AND VIBRATION	SENSURS CAU	ISE STATEM SE	שטעו טו			
2							•		
3					-				
4							_		
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)				•		
		<u> </u>		<u></u>					
TEM	IPERATURI	E AND VIBRATIO	ON SENSORS WIL	L PICK UP IM	IPENDING FAIL	.URE P	RIOR T	0	
SER	IOUS STI	RUCTURAL DÁMA	GE.						
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<u></u>				NAME R	R. LUTH			DATE 8/7/78	
OPERATIN	G MODES						Rev.	10/25/78	
	SHUTDOW	N ON TO WARM-UP	D TRANSITION	N TO STANDBY	G OPERA H TRANS		O FEATH	ER	
ĺ ć	WARM UP			N TO OPERATE	I - FEATH				

	COMPONENT PAGE 43 ORIVE TRAIN HIGH SPEED SHAFT FMEANO 5.4.1									
FUNCTION OF COMPONENT TO TRANSMIT TORQUE FROM GEARBOX TO GENERATOR										
TO TRANS	MIT TOR	QUE FROM GEAR	BOX TO GENERATO)R	· · · • · · · · · · · · · · · ·		· · ·			
				-						
FAILURE N	BROKEN	SHAFT - WOULD	ALLOW ROTOR TO) FREE WHEEL			PPLICABLE RATING MCDES			
						F,G	,H .			
2							-			
3										
4							-			
F	AILURE FRE	EQUENCY			FAILURE S	SEVERITY				
	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL	CRITICAL	CATASTREPHIC IV			
_	100		22.2		-	X				
	100	3.4	33.3	-						
			(-			
FAILURE	DETECTION	METHODS			<u> </u>	<u> </u>	<u> </u>			
1 .	1055.01	F GENERATOR LO	OAD WOULD SHUT	DOWN GENERA	TOR AND FEAT	HER BLADES.				
		-								
	2HU I DUW	IN INTITATED I	HROUGH OVERSPE	- SENSUKS.	•		•			
		-								
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)			F	-			
						15				
	ROTOR O	<u>YERSPEED PRIO</u>	R TO SHUTDOWN W	MOULD BE MIT	HIN DESIGN C	JNIIS.				
			•							
		-								
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			-		<u></u>					
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				NAME R. LU	TH .		DATE 8/7/78			
OPERATING	MODES					Rev	. 10/25/78			
В	SHUTDOWI TRANSITIO WARM UP	N DN TO WARM ÚP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION TO FEATH	ER			

	DRIVE TRAIN COMPONENT HIGH SPEED SHAFT COUPLING FME A NO COMPONENT FME A NO 5.4.2								
FUNCTION	OF COMPO	-	1,				,		
TO TRA	NSMIT TO	RQUE FROM GEA	R BOX TO GENERA	TOR AND TO	ACCOMODATE SI	HAFT MISALIO	NMENT		
EALLIDE N	ODES & EF	FECTS					DD 10 40 5		
1 CO	UPLING S	STRUCTURAL FAI	LURE - WOULD PE	RMIT ROTOR	TO FREE WHEEL	OPE	RATING MILES		
			URE OR DAMAGE D			<u> F,G</u>	<u>,H</u>		
IN	CREASE 1	<u>IN_TEMPERATURE</u>	AND DECREASE	N EFFICIENC	<u> </u>	· ·			
				-					
3					· · · · · · · · · · · · · · · · · · ·				
		-							
4									
F	AILURE FRE	OUENCY			FAIL URE S	EVERITY			
FAILURE MODE NO	FAILURE MODE FREQ. %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN, TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL - II	CRITICAL III	CATASTR19HIC		
1	5	13.7	167			Х			
2	95	13.7	8.8			Х	,		
			,	- •			,		
FAILURE I	DETECTION	METHODS					-		
1 BREAK	IN LOAD	PATH CAUSES L	OSS OF GENERATO	OR LOAD WHIC	H INITIATES	EMERGENCY SI	IUT DOWN		
OF GEN	ERATOR A	AND THE FEATHE	RING OF THE BLA	ADES.	-	4			
INEFFI 3 FM(1)	CIENT JO ABOVE.	DINTS CAN CAUS	SE UNDETECTED TO	MPERATURE F	RISE - ULTIMA	TE FAILURE (DETECTED PER		
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)		,		-		
	CDECTION	A OF LITE & 2 N	ONTH INTERVALE	CHOIL D DETE	CT INCIDIENT	EATLUDES			
	SPECTION	V UF WIS @ 2-M	ONTH INTERVALS	סחטעבט עבונ	CI INCIPIENT	TAILUKES.			
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			<u> </u>			j.			
									
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						· · · · · · · · · · · · · · · · · · ·			
			-						
		•		NAME ROI	F LUTH		DATE8/7/78		
OPERATIN	G MODES					Re	v. 10/25/78		
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H-TRANS I FEATHE	ITION TO FEATH	ER		

COMPONENT PAGE 45 DRIVE TRAIN ROTOR BRAKE FMEA NO 5.5								
	OF COMPO						INEA	<u> </u>
10 POS1	LIION AND	HOLD ROTOR	-					
						·		
AILURE N	ODES & EF	FECTS C/ELECTRIC FAI	LURE WOULD CAUS	E BRAKE TO	CLOSE WHICH W	IOULD		APPLICABLE RATING MODES
<u>_</u>	BURN IT (OUT AT FULL TO	RQUE.				F,	G, H
			ERATE WOULD PER	-			Δ R	C,D,E,H,I
	<u>ANGLE AN</u>	D WOULD PRECL	UDE HOLDING ROTO	OR IN SELECT	ED POSITION.		7, 0,	
	AILURE FRE	OUENCY			- FAILURE S	EVERIT	·Y	·
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL	CATASTP17HI
1.	95	18.3	6.6				Х	
2.	5	18.3	125		X			
2. VIS	UAL INSP	ECTION		-				,
M	OD-2 DES	IGN INCORPORA	TES CAPABILITY T	O MANUALLY	TURN ROTOR AN	ND LOC	K	
L	OW SPEED	SHAFT IN DES	IRED POSITION.	· · · · · · · · · · · · · · · · · · ·				
		,			······································		 	
								· · · · · · · · · · · · · · · · · · ·
				·				
				POI	LF LUTH			- 9/7/70
OPERATIN	G MODES			NAME RUI	LI LUIII]	Rev. 10/25/
A B	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERAT H TRANSI I-FEATHE	TION TO	D FEATH	

	DRIVE TRAIN COMPONENT GEARBOX LUBRICATION FMEA NO 5.6.1									
UNCTION PROV	OF COMPO	NENT RICATION, AND	REMOVE	HEAT FR	OM THE GEAR	BOX BEARINGS	S AND	GEARS	•	-
					-				, ,	
	3					2				
AILURE N	OBR I CAN	FEOTAP FAILURI	E - AUX	ILIARY P	PUMP IS STAR	TED -		OPE		ABLE G MODES
			<u> </u>					F,G	,Н	
<u>2</u> S	EAL FAIL	LURE - LOSS OF	F FLUID	- LOSS	OF GEARBOX	IF UNDETECTI		F, (G, H	-
3 H	EATER FA	AILURE - WTS	WILL NO	T START	- LOW FLUID	TEMPERATURI	Ē	F. (G, H	,
4 B	LOCKED I	FILTER - PRES	SURE DI	FERENTI	AL ACROSS F	ILTER TRIPS		F,G	,Н,	1
	YPASS V	ALVE, WTS SHU	TDOWN AF	FTER TIN	ME DELAY.					
F	AILURE FRE	EQUENCY				FAIL URE S	EVERIT	Υ	-	•
AILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN	ITIME IFAILURE ARS)	M NILIAL	MARGINAL II		TICAL	CAT	ASTROPHIO IV
1	100	ŽĐ	6	2>		X	-		-	
2	100	10	12 30			X []>)	,		
3 4	100	 	pplicab	 ام			 '		+	
	AL INSPE	ECTION			<u>•</u>				1	
3. WTS 4. WTS	SHUTDO CAUSE AND THE G	OT START	YSTEM I	S REDUNI	DANT. IF A	PUMP FAILUR THE WTS WI	E DOES	S NOT	N -	
Þ		AND SEALS ARE				RATE IS FOR				
		BILITY OF BOT	H PUMPS	FAILING	BEFORE IN		15 KE	AIKEU		
	NEGLI	GIBLE.				-				
										
	 				CALLE ROL	F LUTH			DATE	10/20/7
PERATIN	G MODES								Rev.	10/25/7
В	SHUTDOW TRANSITION WARM UP	ÌN ÔN TO WARM UP*	E S	TANDEY	TO C. EFATE	G OPERA H TRANS I FEATHI	ITION T	O FEATH	- HER	3/8/79

	UBSYSTEM COMPONENT PAGE 47										
	DRIVE TRAIN ROTOR BEARING LUBRICATION FMEA NO 5.6.2 FUNCTION OF COMPONENT										
			חסדמת מו	DEVOT	MCC.						
Р	KOAIDE I	UBRICATION FO	אל אטוטא	DEAKI	CDI		-				
				يحسبب فمكلون				···			
FAILURE M	IODES&EF AL FAILI	FECTS JRE - LOSS OF	LUBRICA	NT - P	OSSIBLE FLU	ID CONTAMINA	TION		PLICA	BLE MODES	
									_ G,		
₂ CO	NTAMINA	TED FLUID - E	XCESSIVE	WEAR	ON MOVING P	ARTS				<u> </u>	
		• • • • • • • • • • • • • • • • • • • •			·			F	, G,	Н	
0.1	I IS CO	LD - TOO THIC	K FOR PR	OPER L	URRICATION						
3 01	L 13 CO	LD - 100 1111C		- COLLIN E	,				_		
								F.	, G,	<u>H</u>	
4				<u> </u>				_			
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FA	AILURE FRE	QUENCY				FAILURE S	SEVERIT	Υ	·		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN BETWEEN (YEA	TIME FAILUSE RS)	Mit Itač	MARGINAL II		ITICAL III	CATA	ASTROPHIC IV	
1	100	10	12			 	X	1>			
2		Cannot b	e accura	tely e	stimated	Х		1			
3		Negligib	le if oi	1 chan	ged	X					
4		_		-					L		
FAILURE I	DETECTION	METHODS									
1 BFARI	ING OVER	HEATS - WTS S	HUTS DOW	IN - VI	SUAL INSPEC	TION -				~ 	
·	CTION -					-					
3 NONE	CITON -	VISUAL					•				
									-		
4	24405 4415	CORDECTIVE ACTIV	ON ALE AGO!	1040171		···					
		CORRECTIVE ACTION			WN						
		LL BE CHANGED				O MINIMIZE			·		
		ATION AND ADJ				O MINIMIZE					
	CONTAMIN	ATTUN AND ADO	031 10 3		L CHANGES.						
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								3			
				·	NAME ROL	F LUTH		<u> </u>		10/20/7	
OPERATING	G MODES		The state of the s					F	Rev.	10/25/1	
B	SHUTDOWN TRANSITION	N ON TO WARM UP	Ë ST	ANDBY	M TO STAPIOBY	G OPERA H.TRANS I.FEATH	SITION T	O FEATH	R		
l											

	SUBSYSTEM COMPONENT PAGE DRIVE TRAIN GENERATOR LUBRICATION								
FUNCTION	OF COMPO	NENT				FMEA	•		
PROV	IDES LUB	RICATION TO T	HE SLEEVE BEAR	INGS SUPPOR	TING THE GEN	ERATOR ROTO	OR AT EACH		
END	OF THE G	ENERATOR FRAM	IE.			·			
									
FAILURE N	ODES&EF SS OF OI	FECTS L: LOSS OF L	UBRICATION CAP	ABILITY .			APPLICABLE RATING MODES		
	·					F,(a		
₂ D	IRTY OIL	: EXCESSIVE	WEAR ON MOVING	PARTS	<u> </u>	· .			
					<u> </u>	F,(3 		
₃ 0	IL TOO T	HICK (COLD)		· · ·					
			······		•	- F			
4							ų.		
			г						
F.	AILURE FRE	QUENCY	145 AN 7:145	 	FAILURE S	EVERITY	`		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITICAL	CATASTROPHIC IV		
1	100	10	11.4	-		- X-			
3	100	Negligible	with Preventat	ive Maint.	- X	х			
4	100		114				,,		
FAILURE	DETECTION	METHODS				J	·- 		
1 W	TS SHUTE	OOWN WHEN BEAR	RING OVER TEMPE	RATURE IS P	RESENT.		 .		
		ESS OVERTEMP							
	TS IS SH		0000.0		······································				
4						1			
			ON (IF APPLICABLE)	TO LITE CITY	DOM:				
			SPECTION PRIOR				- 1		
1. W	hen oil	level drops i te until ins	below oil ring. ufficient lubri	cation is p	on of the bea	iring begin ie bearings	are .		
e	xcessive nitiates	IV worn and with the work and with the work and with the work and the	ufficient lubri temperature ris	ses until be view of stor	earing overte ed data wil	emperature identify	protection the source		
· 0	T troup	le. Check oi	l-level sight of oil on floo	<u>lauge at eac</u>	<u>in end of ger</u>	<u>ierator hou</u>	sing for		
			should detect 1						
			rs will keep th			MED 6.8.3.	11.		
		11CUOC	O HILL ROOP OF			0.0.0.	• • •		
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	·			-					
				NAME H.	ROTH		DATE 10/20/8		
OPERATIN	G MODES						Rev. 10/25/78		
В	SHUTDOW TRANSITIO WARM-UP	N ON TO WARM-UP	E STANDBY	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATHI	ITION TO FEAT	HER		

SUBSYSTE		•	COMPONE				PAGE 4		_		
	DRIVE TRAIN ASSEMBLY - EPS GENERATOR ' FMEA NO 5.7										
C ONVERT	OF COMPO	TORQUE AT 180	OO RPM INTO EL	ECTRICAL POW	ER				ì		
•			-								
<u> </u>			L TO OPEN. CAU	SES LOSS OF	ELECTRICAL P	OWER	OPE F		BLE MCLES		
		D WTS SHUTDOW					F	, G			
			L SHORTED OR G		SES LOSS OF						
			T AND WTS SHUT				F	, G			
<u>з</u> G	NERATOR	OVERHEATS. C.	AUSES GENERATO	R CIRCUIT BR	EAKER TO OPE	:N					
		SES WTS TO SH	· · · · · · · · · · · · · · · · · ·		·		F	, G			
4 G	NERATOR	MECHANICAL F	AILURE: CAUSES	ABNORMAL PO	WER GENERATI	ON	•				
WI	HICH OPE	NS GENERATOR	CIRCUIT BREAKE	R WHICH CAUS	ES SHUTDOWN.		F	, G			
F,	AILURE FRE	QUENCY			FAIL URE S	EVERIT	Υ		i		
FAILURE MODE NO	FAILURE MODE FREQ. %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL III	CATA	STREPHIC IV		
1,2,3,4	100	10.3	11.1				Χ	-			
				<u> </u>				<u> </u>			
FAILURE	DETECTION	METHODS		<u> </u>	L	<u></u>		<u> </u>			
1 P(JUED DDA	TECTIVE DELAV	S SEE SECTIO	N 6 8		_					
	JWLK TINO	TECTIVE NEEDS	,								
2				·	· 						
3				5							
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)		۲						
											
			PROTECTIVE DEV				AND				
TE	MPERATU	RE. EACH INI	TIATES WTS SHU	TDOWN UPON W	ARNING SIGNA	L					
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	• 1										
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				NAME G. T	RUSK		Ti	DATE	8/17/78		
OPERATING	MODES						R	ev.	10/25/78		
В-	SHUTDOW! TRANSITIO WARM UP	N IN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION TO					
L											

SUBSYSTE	UBSYSTEM COMPONENT PAGE 50										
NACELLE PRIMARY TRUSS STRUCT. FMEA NO 6.1.1.											
				•				-			
PRIMAR'	Y TRUSS	THAT SUPPORTS	ROTOR SHAFT	GEARBOX							
GENERA	TOR SECO	INDARY STRUCTI	IRE MISC. FQUIP	MENT.							
TRANSF	ERS LOAD	TO YAW REAR	<u>ING SUPPORT ST</u>	RUCTURE		- -i					
1 CR	ACK IN V	FECTS VELD OR TRUSS	MEMBERS		·			PLICABLE SATING MODES			
IN	<u>ITIATES</u>	COLLAPSE OF N	NACELLE				ALL	-			
2 CO	RROS ION	OF WELD OR ME	MBER								
IN	ITIATES	COLLAPSE OF 1	NACELLE.				ALL				
<u>3 EX</u>	CESSIVE	NACELLE DEFLE	ECTION								
L0	NG TERM	DAMAGE TO BEA	ARINGS AND/OR	COUPLING			<u>F,</u>	G, H.			
4											
FA	AILURE FRE	QUENCY			FAILURE S	EVERIT	Υ.				
FAILURE MODE NO	FAILURE COMPONENT MEAN TIME FAILURE MODE FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL CRITICAL CATASTROPHIC										
1,2,3	100	11.4	10		X						
112/											
FAILURE	DETECTION	METHODS	_	<u> </u>		' -					
 1 HIG	H LEVE	L OF INITIAL	INSPECTION O	F WELDS AND	STRUCTURE.						
											
2 MOR	E FREQUE	NT INSPECTION	INTERVAL	 							
 3 ALIO	GNMENT (CHECK PERIODIO	:A) I Y .								
		RECTIVE ACTION (-				
			BE REDUCED BY	MORE EXTENSI	VE INITIAL	INSPEC	TION O	F_WELDS.			
PERIOD	IC INSPE	CTION OF CRIT	TICAL WELDS SH	OULD DETECT	CRACK BEFOR	E TOTA	L MEMB	ER FAILURE.			
MULTIP	LE LOAD	PATHS OF TRUS	SS STRUCTURE M	AY ALLOW MOR	RE EXTENDED	INSPEC	TION I	NTERVAL.			
i			BY FREQUENT P								
CRITIC	AL MEMBE	RS.									
					,						
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		-			····						
				NAME K.	HERNLEY	_		DATE 8-16-78			
OPERATIN	G MODES	·				-	R	ev. 10/25/78			
В	SHUTDOWN TRANSITION WARM-UP	N DN TO WARM UP	€ STANDBY	N TO STANDBY	G OPERA H-TRANS I FEATH	T NOITI	O FEATH	ER			

SUBSYSTE NACELLE	M 3	, ,	COMPONEN SECONDA	RY SUPPORT	STRUCT.	PAGE 5	
	OF COMPO	NE'NT _				LIMENI	<u> </u>
S <u>UPPORT</u>	S ENCLOS	URE AND WALK	NAYS AROUND GEN	ERATOR BAY			
					· · · · · · · · · · · · · · · · · · ·		
FAILURE N	ACRES 1 NF	West's ·					PLICABLE RATING MODES
EN	CLOSURE	DAMAGE -				ĄLL	
₂ CO	RROSION	DAMAGE _					-
EN	CLOSURE	DAMAGE				ALL	
3							
4							
F.	AILURE FRE	QUENCY			FAIL URE S	EVERITY	•
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME ' BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC IV
1,2	100	11.4	10		X		
					 		
		-	-				
FAILURE	DETECTION	METHODS			<u> </u>	<u> </u>	<u> </u>
	011 1 EUE	OF THITTIN !	IELD INCDECTION	•			
¹ HI	GH LEVEL	OF INITIAL A	WELD INSPECTION	<u> </u>			
2 FR	EQUENT 1	INSPECTION					~
							-
3							
WELD CR	ACKING (RECTIVE ACTION (I	IF APPLICABLE) D BY MORE COSTL	Y INITIAL	INSPECTION O	R ENCLOSURE	ISOLATION
			QUENT VISUAL IN				·
			E PROBABILITY C	<u> </u>			•
102111							
							
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	 -		.				
							
							
				NAME K.	HERNLEY		DATE8-16-78
OPERATIN	G MODES					Re	v. 10/25/78
В	SHUTDOWN TRANSITIC WARM UP	N ON TO WARM UP	D-TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I-FEATHE	ITION TO FEATH	ER

NACFILE	М		0	OMPONEN	T,			PAGE	52	
NACELLE YAW BEARING SUPPORT STRUCTURE FMEANO 6.1.3										
			,		_	-			-	
<u> [RANSFEI</u>	RS LOADS	FROM NACELLE	TO YAW	BEARIN	G -	· · · · · · · · · · · · · · · · · · ·				
			-							
FAILURE N	ODES & EF	FECTS	 · ·- ·-						PPLICABLE	
<u>1CR</u> /	ACKS_IN_	WELDS - NACEL	LE_DISPL	ACEMEN	Ι				RATING MODES	
								ALL		
₂ COF	RROSION	OF WELD OR ME	MBER - N	ACELLE	DISPLACEME	INT			÷	
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4									·	
										
F#	AILURE FRE	QUENCY	3		·——	- FAILURE S	EVERIT	Υ	T	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN T BETWEEN F (YEAF	AILURE	MINIMAL !	MARGINAL II		TICAL	CATASTROPHIC	
	-	7 1.1 6				V 19	.,	,	• -	
	1	ncluded in 6.	<u> . </u>			X 17	X			
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EALLURE !	DETECTION	METHODS								
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1		NSPECTION	-	•		,	-	•		
1			-	•			-	·		
1 2 FRI	EQUENT I	INSPECTION	F APPLICABLE					•		
1 FR	EQUENT I				FL OF INITI	AL INSPECTIO		•		
2 FRI 3 DISCUSSIONELD CRI	EQUENT 1	INSPECTION RECTIVE ACTION (I	BY HIGH	L LEV		AL_INSPECTION				
2 FRI 3 DISCUSSIONELD CRI	EQUENT 1 IN AND COR ACKING (T INSPEC	INSPECTION RECTIVE ACTION (ICAN BE REDUCED CTION OF CRITI	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		•		
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		•		
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	INSPECTION RECTIVE ACTION (ICAN BE REDUCED CTION OF CRITI	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		•		
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI				
1 2 FRI 3 DISCUSSION WELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI				
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		•		
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2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		•		
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2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI		-		
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI				
2 FRI 3 DISCUSSIONELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	K BEFORE FAI			DATE 8/16/78	
2 FRI 3 DISCUSSION WELD CRI FREQUENT	EQUENT I	RECTIVE ACTION (ICAN BE REDUCED	D BY HIGH ICAL WELD	I LEV OS MAY	DETECT CRAC	CK BEFORE FAI				
2 FRI 3 DISCUSSION WELD CRI FREQUENT MULTIPLI OPERATING	EQUENT I	INSPECTION RECTIVE ACTION (I CAN BE REDUCED CTION OF CRITI & GUSSETS INC	D BY_HIGH	I LEV DS MAY ME TO	DETECT CRAC	CK BEFORE FAI	TE		DATE 8/16/78 ev. 10/25/7	

	SUBSYSTEM COMPONENT PAGE 53										
NACELLE	ACELLE FWD BEARING SUPPORT FMEA NO 6.1.4 UNCTION OF COMPONENT										
			THE CHACT TO I	מאכרווב דחוו	cc						
I <u>RANSFE</u>	KS KAUIA	AL LUAD FRUM L	<u>IVE-SHAFT TO I</u>	VACELLE TRUS	55.						
FAILURE N	AODES & FE	EFCTS					APPLICABLE				
1 WE	LD FAILL	JRE RESULTS IN	N ROTOR DISPLAC	CEMENT			ERATING MODES				
							A11				
2 WI	LL DAMA	GE/DESTROY BO	TH SHAFT BEARI	NGS, LIVE SE	HAFT, AND						
CO	UPLING.	. <u> </u>					A11				
3				· · · · · · · · · · · · · · · · · · ·							
4											
F	AILURE FRI	EQUENCY			FAILURE S	SEVERITY					
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL.	MARGINAL II	CRITICAL	CATASTROPHIC				
1& 2	`	Included in 6	5.1.1			χ	у*				
1,04 .2		,		-	1						
											
FAILURE	DETECTION	METHODS									
	ll rever	THETTAL THOR	-o-ton								
1 HIG	<u>ה</u> רדּאַדָּר	<u>INI</u> TIAL INSPI	ECTION	······································		·					
₂ FRE	QUENT I	NSPECTION				•					
₃ IN	CREASING	G VIBRATION SI	ENSED BY #1 VII	BRATION MON	ITOR RESULTI	NG IN WTS S	SHUTDOWN.				
DISCUSSIC	N AND COR	RECTIVE ACTION (I	F APPLICABLE)	VIII NEDADI E	ADDITIONA	. UELD ADEA	A R LITCH				
			S WELD IS MOST								
			SSIBILITY OF CA								
			AINT ELIMINATES	S CORROSIVE	DAMAGE. RE	DUNDANT SUF	PORT DESIGN				
REDUCES	POSSIB	ILITY OF SUDDI	EN COLLAPSE.				· · · · · · · · · · · · · · · · · · ·				
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	* IF	UNDETECTED									
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						-					
	 			NAME I	<pre>. HERNLEY</pre>		DATE 8/16/78				
OPERATIN	G MODES			1	N. HERNLET	R	ev. 10/25/78				
A B	SHUTDOW	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS	ATE SITION TO FEAT					
											

SUBSYSTE	<u> </u>			COMPONEN	NT.				PAGE (54
NACELLE			•	AFT BEA	RING SUPP	ORT_			FMEAN	o 6.1.5
FUNCTION TRANSFER	OF COMPOR	NENT L & THRUST	LOADS FR	OM LÎVE	SHAFT TO	NACELL	E TRUSS			
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FAILURE M 1 WEL	ODES & EF	RE .			·		-			PPLICABLE RATING MODES
LIV	<u>'E' SHAET</u>	LIFTS & JA	<u>MŠ DRIVE</u>	TRAIN		-			F,	G, H
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4					·					- '
. FA	VILURE FRE	OUENCY					FAIL URE S	EVERIT	<u>. </u>	
·	FAILURE	COMPONENT	MEA	N TIME			TAILOILE	1	<u>-</u>	
FAILURE MODE NO	MODE FREQ %	FAILURE RATI	E BETWEE	N FAILURE	MINIMAL I	M	ARGINAL II		ITICAL III	CATASTROPHIC , IV
1	Inclu	led in 6.1.		,					Χ .	
f-a					h			 		
				_				<u> </u>		<u> </u>
FAILURE 0	DETECTION	METHODS					 -	<u> </u>		<u> </u>
			-							
1 HI(GH LEVEL	OF INITIAL	INSPECT	ION						•
FRE	QUENT	INSPECTION	BY MAIN	NTENANCE	PERSONNEL	-				, i
#2	VIBRATI	ON SENSOR 1	NITIATES	WTS SHU	ITDOWN					
DISCUSSION	N AND COR	RECTIVE ACTION	N (IF APPLICA	ABLE)	VIII NEDADI	r T:	100 ADE	A4111 T.1	יחור ו	NAD DATHE
		PORT TO TRU								
<u>REDUNDAN</u>	VI STRUC	TURE, AND I	HIGHER FA	CTORS OF	SAFETY	O MINI	MIZE PR	ORABIL	.11Y O	CATASTROPHI
				•	•				1.04	<u> FAILUR</u> E
<u>MAINTENA</u>	ANCE OF	PAINT ELIM	NATES CO	RROSIVE	DAMAGE.	. <u> </u>				
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					NAME	K. HE	RNLEY			DATE 8/16/78
OPERATING	MODES									Rev 10/25/78
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SUBSYSTE	М		COMPONE		-		PAGE 5		
NACELLE			ENCLOSU	RE			FME A N	6.1.6	
PROVIDE	S ADEQUA	TE ENVIRONMEN	ITAL CONDITIONS	FOR THE MA	AINTENANCE PE	RSONNE	L & E	QUIPMENT.	
<u>1 SK</u>		RINGER CRACKS	AT FASTENERS			}		PLICABLE ATING MODES	
		ENTUAL PARTIA	AL SKIN LOSS		,			A11	
LE	AKS - EV	OF FASTENERS /ENTUAL PARTIA						A11	
3 CO	RROSION	OF SKIN OR ST	TRINGERS RESULT	ING IN LEAF	(S -			A11	
4 DA	MAGE DUE	TO LIGHTNING	STRIKE AND/OF	HAIL				A11	
<u> </u>									
F.	AILURE FRE		MEAN TIME		FAILURE S	EVERITY			
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL 11	CRIT		CATASTROPHIC IV	
1-4	Inc	luded in 6.1.	1	X					
					 	-			
1-3 FR		INSPECTION	TO PROVIDE LIC	GHTNING PAT	₹.		,		
DISCUSSIO	ON AND COR	RECTIVE ACTION (I	F APPLICABLE)	 ,					
	,,,,,,,								
					_				
					INTENANCE OF		-		
			EDUCE CORROSIVE G MORE COSTLY (NUMBER OF	
	·								
									
 									
				NAME K.	HERNLEY			DATE 8/16/78	
OPERATIN	G MODES							ev. 10/25/7	
В	SHUTDOWN TRANSITIO WARM-UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO	FEATH	E R	

SUBSYSTE			COMPONE				PAGE (
YAW DRI	VE SYSTE	M	. BRAKE D	ISC ·		.	FMEAN	o 6.3.1
UNCTION UPPORT	OF COMPO	NENT ARING AND PRO	VIDES CLAMPING	SURFACE FO	OR BRAKE CALI	PERS	•	-
				1				
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AILURE N	odes & ef ACKS, OR	FECTS BREAKS - COL	ILD CAUSE BRAKE	FAILURE A	ND/OR YAW BEA	RING		PPLICABLE RATING MODES
	ILURE			• • • • • • • • • • • • • • • • • • • •				\LL
2 BR	AKE SURF	ACE WARPING,	PITTING, OR GA	LLING - CA	USING ERRATIO	BRA	CING	
				.			' 1	<u> </u>
	RT- OR LL	BRICANT ON D	<u> (SC - ERRAȚIC (</u>	OR CHATTERI	NG BRAKES			ALL
••	•	ts. 2 , 7		•		-		<u> </u>
· 4 ·			-					
	AILURE FRE	FOLIENCY		•	FAILURE S	EVERIT	Y	
		COMPONENT	MEAN TIME	<u> </u>				1
FAILURE MODE NO	MODE FREQ %	FAILURE RATE x 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	' MINIMAL	MARGINAL		TICAL	CATASTROPHI
1	33	4.6	75.8 -	-	x			x 1
2	^ 33	4.6	75.8	ه	, X			ī
3	33*	4.6	75.8	-	- X			
	DETECTION					-		
1 VI	SUAL INS	SPECTION OF D	ISG					
2 ER	RATIC BE	RAKING .		· · · · · · · · · · · · · · · · · · ·				1
з SL	OW OR EF	RRATIC YAW MO	TION .	-			•	
		RECTIVE ACTION (·	<u> </u>			
OW ALL	OWABLES	WILL MINIMIZE	E POTENTIAL FA	ILURES' .				
				,	4			
	-							
	IF UND	TECTED TO PO	INT OF YAW BEAL	RING FAILUR	Ē			
							<u>. </u>	
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			-					
				NAME .	. W. ACKER			DATE 8/7/78
					· M · ACINEIN			
PERATIN	G MODES			,	N. ACILLI		Re	v. 10/25/78
. А	- SHUTDOW	N DN TO WARM UP	D TRANSITIO	N TO STANDBY	G - OPERA H - TRANS			ev. 10/25/78

SUBSYSTE YAW DRIV	M SYSTE	М ,	COMPONE BEARING	NT G, GEAR, PIN	IONS	- PAGE	57 NO 6.3.2
FUNCTION THE BEAF	OF COMPO	NENT PORTS THE NAC	ELLE AND PERMI		· · · · · · · · · · · · · · · · · · ·		
		`	E TORQUE FROM				
				6		F	
FAILURE N	ARING ST	FECTS RUCTURAL FAIL	URE - COULD CA	USE WTS TO	BECOME INOPE	KABLE OPE	APPLICABLE RATING MODES
					· · ·		'.G, H
1			<u>ETTING - COULC</u> ETFLY STOPPED	CAUSE YAW I	MOTION TO BE		G, H
1	_	-	SE LOSS OF YAW	ROTATION.			,
D-T		LUDE - MOULD	CAUSE LOSS OF	VAW DRIVE	•	F,	G, H
4 11	,	LUKE - WOOLD	CHOSE FOSS OF	TAW DRIVE			1 .
F.	AILURE FRE	EQUENCY			FAILURE S	SEVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PÉR HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL -	CRITICAL	CATASTROPHIC IV
1,2,3,4	10Q	1.1	100 •			· X .	
			<u> </u>	, ,	•	• 7	
FAILURE	DETECTION	METHODS .	•				
		PECTION.	p				• • • • • • • • • • • • • • • • • • • •
₂ 0B	SERVATIO	N OF ERRATIC	YAW MOTION, OF	R LACK OF MO	TION		
3 5	CECC OD	ILINUSUAL NOTSE	-	•			•
	0200 0	RECTIVE ACTION (•	-			
	-			•			
	EXERC1	SE OF YAW SY	STEM TO MINIM	IZE BRINELLI	NG		
							•
	BEARIN	NG GEAR AND P	INION SHOULD BE	E DESIGNED W	ITH A "WEAK	LINK" TO M	IINIMIZE
	DAMAGI	E TO EXPENSIV	E_COMPONENTS_				
			<u> </u>				
	. -						
							<u> </u>
				NAME J.	W. ACKER		DATE 8/7/78
В	SHUTDOW	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H - TRANS I FEATHE	ITION TO FEAT	ev. 10/25/78 Rev. 11/27/78 HER

SUBSYSTE	M		COMPONEN	IT		P	AGE 58	• •
	<u>Ė SYSTE</u>		GEAR BOX	(·	F	MEANO 6	.3.3
UNCTION	OF COMPO	NENT .	WO STAGES OF GI	EAR BENNETT	ON PERMITTIN	Б Д НТО	HEB CDE	-n
						- TITC	-	
			E THE LOWER SPI	EED DKIVE P	INTON			· · · · · · · · · · · · · · · · · · ·
		PEED GEAR)						<u> </u>
1 OIL	ODES & EF SEAL F	AILURE - LOSS	OF LUBRICANT A	<u>AND SUBSEQU</u>	ENT GEAR BOX	FAILUF	APPLIC REOPERATION	ABLE IG MODES
		_			· · · · · · · · · · · · · · · · · · ·		F_G	<u> </u>
-			- WTS WILL NO	T YAW: IN E	XTREME WINDS		; F,G,I	4
		E STRUCTURAL	MIT TORQUE - W	TOW LITW 2T	YAW OR COMM	ΙΔΝΟ	. , , ,	·
3 457	IN DOX I	AILS TO TRANS	INTI TORQUE - W	13 WILL NOT	TAN OR COMP		- A1	LL
		<u> </u>				+-		<u>- L</u>
4		·						-
<u> </u>								
F#	AILURE FRE				FAILURES	EVERITY		
AILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITI		ASTROPH IV
	- 85	14.8	9		-	X		
	10	14.8	154			Х		
	5	14.8	308	- -		Х	-	
<u>2.</u>		AILURE TO YAW	ON_COMMAND				-	1
3.	ERRATI	C YAW- MOTION	·		· · · · · · · · · · · · · · · · · · ·		- ·	
ISCUSSIO	N ÁND COR	RECTIVE ACTION (IF APPLICABLE)			-		
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				NAME (J. W. ACKER		DATE	8/7/78
PERATING	MODES		·			·		10/25/
A - B -	SHUTDOW	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA H TRANS I-FEATHE	ITION TO		r

SUBSYSTE	М".		COMPONEN	NT	٠ ٢	PAG	E 59
YAW DRI			HYDRAUL	IC MOTOR		FME	ANO 6:3.4
THE HYDE	OF COMPO	NENT OTOR SUPPLIES	THE PRIME POW	ER TO THÊ Y	AW DRIVE GEA	R TRAIN,	ON COMMAND,
	•	S TO YAW	3		. ` `		, ·
۰			- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1				
FAILURE N	ODES&EF	FECTS	- SYSTEM MAY L	OSE PRESS.	(FLUID) & FA	IL C	APPLICABLE PERATING MODES
1	OPERATE				**		F, G, H
2 MO:	TOR FAIL	S TO OPERATE	- SYSTEM WILL	NOT YAW ON'	COMMAND		F,_G, H
3					·		
		 	<u></u>				
4							-
				-	ī		
F.	FAILURE FRE	COMPONENT	MEAN TIME		FAILURE S	EVERITY	_
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II	CRITICAL	L CATASTROPHIC IV
1	85	13.7	9.8		Х	D)	•
2	15	13.7	55.6			X	
1 LEAK		JAL, RESERVOI	R LEVEL DEPLETI NOT ASSUME CO			LOW TORQ	UES.
		RECTIVE ACTION (I	FAPPLICABLE) EADING TO GEARE	DOV EATLURE	- 		-
CKII	IUAL IF	UNDETECTED LE	ADING TO GEAR	OUN FAILURE.	- •	_	
	•	-					
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			<u>-</u>		~		·
			<u> </u>			υ	
<u> </u>	· · · · · · · · · · · · · · · · · · ·						
				NAME J. W.	ACKER		DATE 8/8/78
OPERATIN	G MODES						Rev. 10/25/78
В	SHUTDOWN TRANSITION WARM UP	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO FEA	ATHER

SUBSYSTE	М		COMPONEN	! T			PAGE (50		
	VE SYSTE		HYDRAUL	IC PUMP & N	10TOR		FME A N	o 6.3.5		
	OF COMPO		CONTROLLED 200	n psi press	CURE ON DEMA	IND. T	n opei	RATE 17AW		
·			CALIPERS, AND R							
HIDRAUL	10 mo ron	, TAN DRAKE C	ALITEKS, AND K	- DIANE	CALIFERS.					
EALLURE N	ODES & EF	FECTS						PPLICABLE		
1 PU	MP LEAKS	EXTERNALLY -	- SYSTEM MAY BE	DEPLETED,	THEN FAIL T	0		RATING MODES		
OP	ERATE						F	.G.H		
2 PU	MP FAILS	TO MAINTAIN	PRESSURE - SYS	TEM MAY NOT	FUNCTION PR	ROPER	•			
LY	(NO BRA	KE RELEASE, S	SLOW YAW)				£	,G,H		
			LOSS OF PRESSU	RE WOULD PE	OHIBIT BRAKE					
		R YAW MOTION	· ·		-		F	,G,H		
4 MO	TOR FAIL	.S - SAME AS #	/3		··· _					
				-			F	,G,H		
F,	AILURE FRE	QUENCY			FAILURE S	EVERIT	Υ			
FAILURE COMPONENT MEAN TIME BETWEEN FAILURE MINIMAL MARGINAL CRITICAL CATASTROPHIC MODE NO FREQ % x 10 6 PER HOUR (YEARS)										
1	33	3.4	101	-	X			-		
2	10	3.4	34				Χ			
3,4	57	3.4	58.5				х .			
	DETECTION	METHODS	<u> </u>	<u> </u>			<u>··</u>			
1-4 W	ITS Shut	sdown (low or	essure sensor)							
<u></u>		340Mii (1011 pi	cosure sensory	-		=				
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DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)							
			-							
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				~	t					
				 						
				NAME	J. W. Acker			DATE 8/8/78		
OPERATIN	G MODES						Re	v. 10/25/78		
В	SHUTDOW TRANSITIO WARM-UP	N DN TO WARM UP	D TRANSITION E STANDBY F-TRANSITION	TO STANDBY	G OPERA H TRANS I-FEATHE	ITION T				

SUBSYSTE	М		COMPONE	NT '		PAGE	61
	VE SYSTE		RESERVO	IR		FMEAN	0 6.3.6
	OF COMPO		DRAULIC FLUID	FOR THE YAW	HYDRAULICS	YSTEM	
	11/11/10 /	301121 01 111	DIVIOETO 1 EOTO		11101110210	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
					·		
FAILURE N	ODES&EF	FECTS EAK - EVENTUA	ALLY PRODUCES A	LOW LEVEL	ALARM, SPREA	ADS OPE	PPLICABLE RATING MODES
01	L IN NAC	ELLE, SHUTS D	OWN SYSTEM			F,	, G, H
<u>2 1 I</u>	QUID LEV	EL GAGE FAILS	S - PRODUCES FA	LSE HIGH OR	LOW READING		G, H
3	,						<u> </u>
			· ·				'
4						·	
	AILURE FRE	CUENCY	, 		FA'LUDE C	EVEN TV	
	FAILURE	COMPONENT	MEAN TIME		FAILURE S	EVERIT	T
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE' (YEARS)	MINIMAL	MARGINAL II	CRITICAL '	CATASTROPHIC IV
1	90	6.8	18.5		x - D		
2	10	6.8	68	X			
			-				
FAILURE	DETECTION	METHODS					
1_VISU	AL_INSPE	CTION OF RESE	RVOIR, SPILLED	OIL IN NAC	ELLE		
10	IJ CVCTEM	A DDESCUDE OD	LEVEL OR SYSTE	M INODEDATI	VE		
2 LU	W SISIEN	T PRESSURE OR	LEVEL ON SISIL	IN THUFERALL	VL		
3							
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				
					-		
₽	IF DETE	ECTED BY INSPE	ECTION PRIOR TO	CRITICAL F	AILURE		·
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	-						
				NAME J.	W. ACKER		DATE 8/8/78
OPERATING	G MODES	-				Rev	7. 10/25/78
В	SHUTDOWN TRANSITIO WARM-UP	N ON TO WARM UP	E STANDBY	TO STANDBY	G-OPERA H TRANS I FEATHE	ITION TO FEATH	ER

SUBSYSTE	М		COMPONEN	IT	-	P	AGE 6	2
YAW_DRIV	E-SYSTE	М	HEAT_EX	CHANGER		F	MEA N	0 6.3.6.2
	OF COMPO		IIT MAX'IMUM TE	MOCDATURE	_			
OOLS III		PLOID TO LIN	III MAKIMUM IE	MPERATURE				
	`							
AILURE M	ODES&EF	FECTS D. DEPLETES	RESERVOIR, WT:	S SHUTS DOW	. T'NOW .	YAW.		PPLICABLE TATING MODES
		ASE ROTOR BRA						.G, H
			M OVERHEATS, W	TS SHUTS DOL	dN			
2 1111	<u>-11103 [A [</u>	IVIED! SISIE		13 31013 001	111 •		F.	G, H
2 50	I EATLS	CVCTCM OVER	ITATO UTO CUIT	LC DUM			' ,	<u> </u>
S EWI	LAILS,	SISTEM OVERE	HEATS, WTS SHUT	7 DAMIN'			F	G, H
							. ' 9	<u> </u>
4			•					
F	AILURE FRE	QUENCY			FAILURE S	EVERITY		· · · · · · · · · · · · · · · · · · ·
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL	CRITIC		CATASTROPHI IV
	20	2.3	250		X	X D	>	- ,
	40	2.3	125			Х		
}	40	2.3	125			Х		
FAILURE (DETECTION		, , , , ,					<u>. </u>
. 001	FOTEMDED	ATURE SIGNAL	•			-		
1 001		ATORE STAIRL						
2 LE/	AKING OI	L IN NACELLE	- VISUAL/LOW P	RESS. SIGNA	L		-	
. UVI	אווו זכ	CVCTCM FAILUR	- NE OVERTEMB O	TONAL				
			RE - OVERTEMP S	IGNAL				
DISCUSSIO	N AND COR	RECTIVE ACTION (F APPLICABLE)		•			•
CR1	ITICAL I	E NOT DETECTE	D PRIOR TO SHU	TDOWN	· · · · · · · · · · · · · · · · · · ·			
CIV.	LITONE I	NOT DETECT	1 -	* 1				
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			-	NAME	I. W. ACKER			DATE 8/8/78
OPERATING			.		(0.0050		ке	v. 10/25/78
'в	SHUTDOWN TRANSITION WARM UP	N ON TO WARM UP	E STANDEY	N TO STANDBY	G-OPERA H TRANS I FEATH	OT NOITIE	FEATH	ER _

SUBSYSTE	м		COMPONE				PAGE	63
	IVE SYST		ACCUM	IULATORS -			FME A N	0 6.3.6.3
	OF COMPO		EASED ROTOR BE	NANE TE CACT				
KEDOÇE	PUMP KI	PPLE, DAMPEN	HYDRAULIC SYST	EM PULSATIL	JNS			
FAILUBE N	IQDES & EF	SS OF ACCUMU	JLATOR CAPABILI	TY, RESULTI	NG IN LOSS			PLICABLE RATING MODES
	VE FUNCT		1				F,	G, H
2 0IL	LEAKS-L	OSS OF ACCUMU	JLATOR CAPABILI	TY, LOSS OF	ABOVE FUNCT	IONS		-
r	POSS	SIBLE SYSTEM F	AILURE				F,	G, H
3					·		ı	
								
4								
-	AILURE FRE	OUENCY			, FAILURE S	CVERIT		
	FAILURE	Γ	MEAN TIME	<u> </u>	PAILONES	- SEVENII	<u>' </u>	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL		TICAL III	CATASTROPHIC IV
1	50	27.4	8.3		<u> </u>	,		
3	50	27.4	8.3		X	 	X D	
4					 		 _	_
FAILURE	DETECTION	METHODS		•				
1 MONT	TOR GAS	PRESSURES IN	ACCUMULATORS					
		CTION FOR OIL						
			RESERVOIR LEVE	i				
FAILURE	,		ON (IF APPLICABLE)				•	-
- 1	If Under	tected						
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			-					
				NAME J.	W. ACKER			DATE 8/8/78
OPERATIN	G MODES							. 10/25/78
, A	SHUTDOW		D TRANSITION	N TO STANDBY	G OPERA	TE		·
	WARM UP	ON*TO WARM UP	E STANDBY F TRANSITION	N TO OPERATE	H-TRANS I FEATHI		O FEATHE	-n

SUBSYSTE	М		, COMPONEN	NT -			PAGE 6	4*
	DRIVE		RELIEF	VALVES (3	3)		FME A N	0 6.3.6.4
	OF COMPO		HE HYDRAULIC S	VCTEM IN TÙ	IC CVENT OF /	N DIIMD	DDECC	HDE
			HE HIDRAULIC 3	LOIEM TH IT	IC EVENT OF P	1 FUME	- KLJJ	OKL
COMPENSA	ATOR FAI	LURE						
FAILURE M	ODES & EF AKS EXTE	FECTS RNALLY - MAY	DEPLETE RESERV	OIR AND CAU	ISE SÝSTEM FA	AILURE	OPE F	PPLICABLE RATING MODES
2.15	NC THE	DVALLY CVCT	TOW DECCUE NO	ULD BE LOW	MAY NOT OR	DATE		
	,		FM PRESSURE WO	ULU DE LUM,	NOT NOT UP	RAIL	_	С П
		KE ACTUATORS PEN AT PRESET	PRESSURE, CO	ULD CAUSE H	IYDRAULIC CON	1PON-		G, H
			IP COMPENSATOR		,		F	G, H
Liv	3 OVERTIN	ESSURE II 1 01	ii com Engator	INILO				о, п
4			7			——	_	^ "
	AILURE FRE	- CUENOV			FAILURE S	EVEDIT		G, H
			MEAN TIME		FAILURES	EVERII	·	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL III	CATASTROPHIC IV
]	70	51.3	3.2 -	*	-	- X		
2	20	51.3	11.1	_		Х	-	
3	10	51.3	22.2	*	Х	X	- D -	
	DETECTION	METHODS	-		· · · · · · · · · · · · · · · · · · ·	<i>;</i> ; -		<u> </u>
1 VIS	UAL INSP	PECTION, WTS s	shutdown		-	- -		
				LOW DDEC	CCUDE LITE C		IM.	-
2 75	KIUDIC I	ESTING FOR PE	RESSURE SETTING	- LOW PRES	220KE' MI2 2	HU I DUW	in	- : .
3 SI	GNAI SHU	JTS DOWN WTS.			-			-
		RECTIVE ACTION (IF APPLICABLE)					
		•	•	•	_			
₽	CDITTCAL	TE DDESSIDE	LOSS SUFFICIEN	NT TO INITIA	ATE SHIITDOWN			
	WALL TO AL		,	11	1112000.100	•		
				7				
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· · · · · · · · · · · · · · · · · · ·				· ———				
			<u> </u>	NAME	J. W. ACKER			DATE 8/8/78
OPERATIN	G MODES			-			Re	v. 10/25/78
В	SHUTDOW TRANSITION WARM-UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H TRANS I FEATH	SITION T	O FEATH	ER

SUBSYSTE	м /E SYSTE	<u></u>	COMPONEI SOLENO I	NT D VALVES	(2)		PAGE 6	5 o 6.3.6.5
	OF COMPO		100				FMEAN	0 0101010
TO RELEA	ASE ROTO	R BRAKE AND/O	R YAW BRAKE, O	N COMMAND				
			•					
			- ROTOR BRAKE,	OR YAW BRA	KE WILL NOT	RE-		PPLICABLE RATING MODES .
LE	ASE - WTS	CANNOT START					F, G,	Н
			TE - ROTOR BRA					
			S RELEASED BY F		ING BACK THRO	DUGH	A, B,	C, D, E, I
<u>3 SY</u>	STEM, OR	YAW CONTROL	VALVE IS SHUTT	LED.				
								
4								
<u> </u>		CUENCY		7	54411050	51/5017	<u> </u>	
	FAILURE FRE	COMPONENT	MEAN TIME	•	FAILURE S	EVERII	. Y	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV
1	95	27.4	4.4	١			X	
2	5	27.4	87.8				χ	
FAILURE	DETECTION	METHODS						
PERIODI	C CHECK	FOR VALVE OPE	RATION					
}								
2 BR.	AKE(S) F	AIL TO RELEAS	SE OR APPLY (WH	IEN SYSTEM I	IS OTHERWISE	OK).		
3								
DISCUSSIC	N AND COR	RECTIVE ACTION (I	F APPLICABLE)					-
								
— <u> </u>	-		20 2				~ ~	
							·	
								
ļ ——								
				 				
								
				- 				
				NAME J.	W. ACKER			DATE 8/8/78
	SHUTDOW			N TO STANDBY	G OPERA	TE	Rev Rev	. 11/27/78
	WARM UP	ON TO WARM UP	E STANDBY F TRANSITION	TO OPERATE	H TRANS		O FEATH	- H

1	UBSYSTEM COMPONENT PAGE 66									
	AW DRIVE SYSTEM MOTOR CONTROL VALVE FMEANO 6.3.6.6 UNCTION OF COMPONENT ONTROLS YAW MOTION BY CONTROLLING FLOW AND DIRECTION OF FLOW OF HYDRAULIC FLUID TO YAW									
			OLLING FLOW_AND	DIRECTION	OF FLOW OF	HYDRA	ULIC FI	_UID_TO_YAW		
DRIVE MO		,			+		- - , , ,			
1.20 1.20 1.10										
FAILUREN	RSE SIN FE	RNATLY - COUL	D CAUSE UNCONTI	ROLLED, ERR	ATIC YAW MOT	ION		PLICABLE RATING MODES		
'			 				ALL	ATING MODES		
₂ FAI	LS TO 0	PEN - WTS WIL	L NOT YAW ON CO	OMMAND						
-			-	·			F, G,	H		
3 FAI	LS TO C	LOSE - WTS WI	LL NOT STOP. YA	W BRAKE WIL	L NOT APPLY	ON				
	1MAND	· · · · · · · · · · · · · · · · · · ·					F, G,	E, H, I		
		RNALLY - COUL	D DEPLETE SYST	EM FLUID, C	AUSE OPERATI	ONAL				
		UNDETECTED					F, G,	Н		
	AILURE FRE			· · · · · · · · · · · · · · · · · ·	FAILURE S	EVERIT				
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ÎTICAL III	CATASTROPHIC IV		
1	30	18.3	20.8	•	Х			-		
2	10	18.3	62.6	-		х				
3	20	18.3	31.3		X					
FAILURE I	DETECTION 40	METHODS 18.3	15.6		X			•		
1.2 ERRAT			ES NOT FOLLOW	COMMAND - M	_	R SHL	ITS WTS	DOWN.		
	CUAL TNC	DECTION. LOCC	מר ממרכנותר כ	ENCED. LOCC	OF LEVEL CE	NCED				
4. VI	SUAL INS	PECTION: LOSS	OF PRESSURE S	ENSED, LUSS	OF LEVEL 3E	NSEU.	<u>-</u>	*		
3 WTS	WILL S	HUT DOWN IF Y	AW MOTOR MOVES	NACELLE TO	-WRONG POSIT	ION.				
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				÷ -	,		
					<u> </u>					
		=								
			~		-		• -			
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					-					
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				<u> </u>						
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				NAME J.	W. ACKER		 j	DATE 8/9/78		
OPERATIN	G MODES			TAVINE U.	W. AUNEK			v. 10/25/78		
A	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G-OPERA H TRANS I FEATHI	ITION	ro feath			

SUBSYSTE	M VE SYSTE	·M	COMPONEN		OSES - YAW :	PAGE	
FUNCTION	OF COMPO	NENT	•			STOTEL FME	(NO 0.3,0.7
SUPPLIE	S PRESSU	RIZED HYDRAU	LIC FLUID TO Y	AW HYDRAULI	C MOTORS		
							<u> </u>
						· · · · · · · · · · · · · · · · · · ·	
FAILURE N	ODES&EF PTURE -	LOSS OF SYSTE	M PRESSURE & F	LUID - SYST	EMS WOULD FA	AIL OF	APPLICABLE PERATING MODES
то	OPERATE	· • • • • • • • • • • • • • • • • • • •				- F	, G, 'H
2.1	AKAGE						-
			_			F	, G, H
				-		'	
` <u>4</u>			···		,		
F.	FAILURE FRE		MEAN TIME		FAILURE S	TEVERITY	
FAILURE MODE NO	MODE TREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II	CRITICAL	CATASTROPHIC IV
1	10	37.6	30.3				
2	90	37.6	3.4		D X	DX	
FAILURE	DETECTION	METHODS		\	```	<u> </u>	
l vi	SUAL INS	SPECTION OF SY	/STEM	,			
				ATTOM DECIM	77110 TN 01111		
LO	W PRESSU	JRE OR RESERVE	OIR LEVEL INDIC	ATTON RESUL	IING IN SHU	II DOWN	
]							
DISCUSSIC	N AND COR	RECTIVE ACTION (F APPLICABLE)				
ļ, - 							· · · · · · · · · · · · · · · · · · ·
DEPE	NDS ON S	SEVERITY OF LE	EAK. LOSS OF P	RESSURE INI	TIATES SHUT	DOWN. MIN	OR LEAKS
_ MAY	BE DETEC	CTED BY VISUAL	INSPECTION.		·		
							
							
							
	- 						
					·	<u> </u>	
	• •					·	_
				NAME J.	W. ACKER		DATE 8/9/78
OPERATIN					.		ev. 10/25/78
В.		N ON TO WARM UP	D TRANSITION E STANDBY			SITION TO FEA	THER
c	WARM UP		F-TRANSITION	TOUPERATE	I FEATH	cn	

SUBSYSTE YAW DRI		M ·	FITTING	S, TUBES, H	OSES, YAW	REARE	GE 68 EANO	6.3.6.8
	OF COMPO		DRAULIC FLUID	TO YAW BRAK	CE CALIPERS.		,	2
		, ,	•					
		<u> </u>	·	•				
1 RU	_	LOSS OF SYSTE	M PRESSURE & F	LUID			OPERAT	ICABLE FING MODES
SY:	STEMS WO	ULD FAIL TO O	<u>PFRATF</u> PRESSURE & FLUI	D SYSTEMS I	IOULD FAIL TO	-	F, G	<u>, H</u>
	ERATE.		KESSONE & TEOT	D 3131EH3 F			- -	u
	LIGHT L.					-	F, G	, п
3				 -				
					· · · · · ·			
4								
F	AILURE FRE	QUENCY	ν,		FAILURE S	EVERITY		<u> </u>
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICA	AL C	ATASTROPHIC IV
1	10	3.4	333			Х		•
2	90	3.4	37		x D	Х		
					_,	_		
VISU	DETECTION AL INSPE W PRESSU	CTION	OIR LEVEL RESUL	TING IN SH	UTDOWN			
DEPENDS	ON SEVE	RECTIVE ACTION (I	LOSS OF PRESS	SURE INITIA	res shutdown	MINOR	LEAKS	MAY
			<u> </u>			-		
				-				
			-		 			
-			,—		- -			
				NAME J	. W. ACKER		DA	NTE 8 /78
OPERATIN	G MODES		 		**************************************		Rev.	10/25/78
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY	G - OPERA H - TRANS I FEATH	SITION TO F	EATHER	;

SUBSYSTE YAW DR	M IVE SYST	EM :	COMPONE FITTI		HOSES,ROTOR	BRAKE	PAGE.	69 • 6.3.659
	OF COMPO			**************************************				· · · · · ·
SUPPLIES	S PRESSU	RIZED HYDRAUL	IC FLUID TO RO	TIOK BRAKE	CALIPER.	<u> </u>	-	
				-				
EALLIDEA	ODES & EF	EECTS						PPLICABLE
1_RU	PTURE		M PRESSURE & F	LUID, SYST	EM FAILS TO	}		RATING MODES
	ERATE						Ξ,	G, H
2 LEA	AKS - LO	SS OF SYSTEM	PRESSURE & FLU	IID, SYSTEM	FAILS TO OPI	ERATE		
							<u>F,</u>	G, H
3								
4	•							
								
, F.	AILURE FRE	· · · · · · · · · · · · · · · · · · ·			FAILURE S	SEVERIT	′ ———	· · · · · · · · · · · · · · · · · · ·
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGĪNAL II		TICAL II	CATASTROPHIC IV
1	10	3.4	333			Х		
2	90	3,4	37		1_ X	X		
FAILURE	DETECTION	METHODS	`.					
l vi	SUAL INS	SPECTION						
			D LEVEL DECULA	TNO TN CINI	TDOUN			
10	M PRESSU	IKE & KESEKVUI	R LEVEL RESULT	ING IN SHU	1 DOWN			
DISCUSSIC	N AND COR	RECTIVE ACTION (I	F APPLICABLE)		-			
					-			
	DEPEN	IDS ON SEVERIT	Y OF LEAK. LO	SS OF PRES	SURE INITIAT	ES SHU	TDOWN.	
		. 						
<u> </u>						<i></i>		
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-								
				_ -				
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				NAME J.	W. ACKER		6.1	DATE 8/8/78
OPERATIN	G MODES	 			HOREIN	<u> </u>		. 10/25/78
ľ	SHUTDOW	N	D TRANSITION	N TO STANDBY	G OPERA			
В		ON TO WARM UP	E STANDBY F TRANSITION		H - TRANS	SITION TO	FEATH	ER
L								

SUBSYSTE		CTCM #	COMPONEN		LOW PRESSUR		69.1
	ORIVE SY		niun ri	VESSONE VIND	EOW FRESSON	FME A	NO 6.3.6.10
THE F	ILTERS R	EMOVE CONTAMI	NANTS FROM THE	YAW DRIVE	SYSTEM HYDRA	ULIC FLUID	•
							
			•	+			
AILURE A	ODES & EE	FECTS	EPLETE HYDRAUL	IC SYSTEM F	LUID, CAUSIN	IG CO	APPLICABLE
	TEM FAIL		CICCIC INDICIOL	10 31312.17			F, G, H
0 DI II		TED COULD	RESULT IN CONT	AMINATION A	C ETI TEDS		г, и, п
	BY- PAS		KESULI IN CONT	APITINA I TON F	19 LILIEKO		F, G, H
	177 1713	-		-	-		1 3 43 11
3		· · · · · · · · · · · · · · · · · · ·					
 			· · · · · · · · · · · · · · · · · · ·	•		-	-
4	- ,						~
F.	AILURE FRE	EQUENCY			FAILURE S	EVERITY -	
	FAILURE	FAILURE RATE	MEAN TIME				
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTROPHIC
1	100	1	100		- х	X D	
2			pplicable			X	
<u>3</u>				<u> </u>	 		+
	<u>!</u>					<u>. </u>	
AILURE	DETECTION	METHODS				1	
		OK FOR EXTERN					-
RES	ERVOIR C	OIL LEVEL INDI	CATOR WOULD-IN	DICATE GROS	S LEAK.		
3	-						
1	·			·			·- <u>-</u>
AILURE			ON (IF APPLICABLE) INSPECTION PRIO	R TO SYSTEM	NWOOTHHE		
<u> </u>	11 1101	DETECTED DE		K TO STSTEE	Shorbonit.		
2.	ETI TEDO	MILL DE CHAN	NGED AT REGULAR	MATNTENANO	E INTERVALS	···.	
	ITETER	WILL BE CHAP	MED AT REGULAR	WATHIENANC	E INTERVALS.	·	
	 .						
						-	
	· · · · · · · · · · · · · · · · · · ·		 ;				
		<u>-</u>		*			
	- 	<u> </u>		 		<u> </u>	·
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				NAME J.	W. ACKER		DATE 10/23/ ev. 10/25/78
PERATIN	G MODES					- Re	av. 10/25//8
	SHUTDOW		D TRANSITION	TO STANDBY	- G OPERA		3/8/79

SUBSYSTE		VCTCM	COMPONE	COMPONENT CHECK VALVES (4)				69.2
	DRIVE		CHECK	VALVES (4	·)		FMEAN	6.3.6.12
	OF COMPO		DDCVCNT CLUID I	CDOM CLOUTNO	TN A DEVEN	D.T.	SECTION	7.11
	LINES.	ARE USED TO	PREVENT FLUID I	KUM FLOWING	IN A KEVEK	SE DII	KECITON	<u> </u>
	LINES.			 				
FAILURE	IPPES & EF	FEGEN IN BOTH	OR BRAKE LINE -	NO EFFECT	HMI ESS SOLEI	NO I D		PLICABLE
			ROTOR BRAKE WO			1010		G, H
			BRAKE LINE - 1		<u> </u>			<u>u, 11</u>
<u>-</u>							F.	G, H
₃ FAI	LURE TO	CHECK IN PUMI	POUTLET LINE -	- FLUID MAY	BLEED BACK	INTO		
PUM	P ON SYS	STEM SHUT-DOW	N				F,	G, H
4 FAI	LURE TO	CHECK IN PUMI	CASE DRIVE L	INE - PUMP C	ASE COULD BE	<u>. </u>		
PRE	SSURIZE	IF SYSTEM RI	ETURN PRESSURE	WAS EXCESSI	VE.		F,	G, H
	AILURE FRE		2		FAIL URE S	EVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL J	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV
1	100	3	33		X			
2	100	3	33 33	X	ļ			
3	100	3	33	XX	 x			
	0.535.031.01	METHODS		L				
	DETECTION		00 054045 144				_	
1-4 SY	STEM FUI	ACTIONAL TEST	, OR REMOVE AND	J LEST COMPL	DNENI.			
				···				
								
			ON (IF APPLICABLE) ARE CATASTROPH	אור איינד וי	IOUI D TAKE A	ומנוחח	E EATL	IIDE
			VALVES ARE IN					DICE
	- DO ANI	mind. MLJL	VALVES ARE IN	THE STOTEM	AS A BACK	Ur U		
l								
				· · · · · · · · · · · · · · · · · · ·				
1								
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			4					
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				NAME (I. W. ACKER			DATE 10/23/8
OPERATIN	G MODES						Re	v. 10/25/78
ј в	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	O FEATH	ER

SUBSYSTE	M DDIVE CY	CTEM	COMPONEN	COMPONENT NEEDLE VALVE				PAGE 69.3		
	DRIVE SY		INCED	LL VALVE		FME	A NO	6.3.6.13		
	OF COMPO		דה זכטי אדר דייר	CVCTCM PRCA	CUDE OAGE CO		DE 6			
			TO ISOLATE THE	STSIEM PKES	SUKE GAGE SC	II MAY	RF ZEK	VICED		
UR CA	LIBRATE). ————————————————————————————————————								
					· · · · · · · · · · · · · · · · · · ·					
FAILUREN	ODES & EF	FECTS FAK - COULD !	DEPLETE SYSTEM	HYDRAULIC F	IIIIN AND DES	SIII T 6	APP LIC	CABLE NG MODES		
	WTS SHU		<u> </u>	THE WASHINGTON	COLU.	ł	F. G.			
			MPLETELY - WOU	LD PRECLUDE	DEAD-WEIGHT		<u> </u>	<u>n</u>		
			SE OF INTERNAL				A			
- IE	SIING IF	IÉ RAGE DECAUS	DE OF INTERNAL	LLAK.			<u> </u>			
3								•		
-								-		
4		e				Ì				
	-		-							
F.	AILURE FRE	EQUENCY		•	FAILURE S	EVERITY		-		
	FAILURE	RAILURE RATE	MEAN TIME				\neg			
FAILURE MODE NO	MODE	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II	CRITICA	L CA	TASTROPHIC		
	<u></u>		33			x D				
2	75 25	4.4	100	Х	<u>-</u>	X D	+			
3	25	7.7	100							
4			·							
FAILURE	DETECTION	METHODS			-					
			NSPECTION, OF F	PESERVOIR LE	VEL INDICATO	np ,				
										
2 FAIL	URE 10	CLOSE - MOOLD	BE OBVIOUS TO	MAN CHECKIN	G OK SERVIC	ING GAGE.				
3	<u>.</u>									
4					·					
FAILURE	CAUSE AND	CORRECTIVE ACT	ON (IF APPLICABLE)		-					
→ P If	undete	cted by visua	l inspection pi	rior to WTS	shutdown.	ı				
		_	·		_					
	-						_			
i —— }			-							
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	,		-					<u></u>		
					·					
				NAME .]	. W. ACKER		ДДАТ	目0/23/8		
OBERATIO	G MODES			1	. H. ACKER			10/25/78		
OPERATIN		(N)	OITIZNART O	N TO STANDBY	G OPERA	ATE		- 5, 25, 70		
В		ON TO WARM-UP	E STANDBY	N TO OPERATE		SITION TO FE	ATHER			
٠ د	WARM UP		L IMANSITIO	TO OF LINATE	i FEAIM	L-11				

SUBSYSTE	М		COMPONEN	NT	-		PAGE	70
	<u>VE SYSTE</u>		WEATHE	R SHIELD		^	FMEAN	10 6.3.7
	OF COMPO		ARING, BRAKE CA	LIPERS. AND	DISC FROM	THE WE	EATHER	
<u></u>					٥^* •			
			-		`	, 		
FAILURE	ODES & EF	FECTS					`	PPLICABLE
<u>1 FA</u>	ILURE OF	THE WEATHER	SHIELD WOULD H	IAVE ONLY_LO	ONG TERM			ALL
				,			-	
2 <u>FA</u>	ILURE DL	<u>JE TO EXTREME</u>	WINDS, LIGHTNI	NG STRIKE,	AND/OR HAIL	·	-	٠ . ٩
3								
				,				
4				_	•			
			•	_				
F.	ALURE FRE	QUENCY			FAILURE S	SEVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC IV
1		Negligible		Х				
2		Site depend	ent	Х				
•								
		RECTIVE ACTION (EGULAR INTERVAL	S & AFIER	SEVERE WEATH	ick Col		NS.
					 			
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	-		•	•				
			•	NAME	J. W. ACKER			DATE 8/8/78
OPERATIN	G MODES				<u> </u>		ı	Rev. 10/25/78
В	SHUTDOWI TRANSITIO WARM-UP	N DN TO WARM UP	D TRANSITION E STANDBY F-TRANSITION	TO STANDBY	G OPERA H TRANS I FEATH	SITION T		

		•	COMPONEN			PAGE	71
YAW DRI	VF_SySTE	M	MISCEL	LANEOUS FAS	TENERS	FMEAT	vo 6:3.8
FUNCTION	OF COMPO	NENT -	, IVDDAIII TO OOMDOS	THE TAL PL	,		
	RS HOLD	BEARING AND H	YDRAULIC COMPON	NENIS IN PL	ACE	 	
						,	
FAILURE N	ODES & EF	FECTS			•		APPLICABLE
			TENER HAS NO EF	FECT ON OPE	<u>RATION OF W</u>	IS OPE	RATING MODES
BE	LAUSE UP	REDUNDANCY.			 		ALL
2	·•		-	····			
• • •	_		-				
3		•					
3			•	,	· · · · · · · · · · · · · · · · · · ·		
- 							
4							•
		· · · · · · · · · · · · · · · · · · ·		·			
F.	AILURE FRE	QUENCY			FAILURE S	EVERITY	-
FAILURE	FAILURE MODE	COMPONENT FAILURE RATE	MEAN TIME BETWEEN FAILURE	MINIMAL I	- MARGINAL	- CRITICAL	CATASTROPHIC
MODE NO	FREQ %	× 10 ⁶ PER HOUR	(YEARS)	<u> </u>		111	IV
1		Negligible	-	Х		-	-
				i a		-	•
		4					1
							1
EALL LIBE (DETECTION	METHODS .				L	
FAILURE (DETECTION	METHODS	•	 		•	
		• `	EGULAR SCHEDULE	•		. :	
		• `	EGULAR SCHEDULE	•			
		SPECTION ON RI	EGULAR SCHEDULE	•		. :	
1 VI		• `	EGULAR SCHEDULE		,	. :	1
1 VI 2	SUAL INS	SPECTION ON RI					1,
1 VI 2	SUAL INS	SPECTION ON RI					1
1 VI 2	SUAL INS	SPECTION ON RI					1
1 VI 2	SUAL INS	SPECTION ON RI					1,
1 VI 2	SUAL INS	SPECTION ON RI					' • . •
1 VI 2	SUAL INS	SPECTION ON RI					1
1 VI 2	SUAL INS	SPECTION ON RI					1
1 VI 2	SUAL INS	SPECTION ON RI					· · · · ·
1 VI 2	SUAL INS	SPECTION ON RI					1
1 VI 2	SUAL INS	SPECTION ON RI					
1 VI 2	SUAL INS	SPECTION ON RI					· · · · · · · · · · · · · · · · · · ·
1 VI 2	SUAL INS	SPECTION ON RI					-
1 VI 2 3 DISCUSSIO	SUAL INS	SPECTION ON RI					
1 VI 2 3 DISCUSSIO	SUAL INS	SPECTION ON RI					
1 VI 2 3 DISCUSSIO	SUAL INS	SPECTION ON RI					
1 VI 2 3 DISCUSSIO	SUAL INS	RECTIVE ACTION (I			J. W. ACKER		DATE 8/8/78
1 VI 2 3 DISCUSSIO	SUAL INS	SPECTION ON RI					
1 VI 2 3 DISCUSSIO	SUAL INS	RECTIVE ACTION (I	F APPLICABLE)	NAME	J. W. ACKER	R	DATE 8/8/78 ev. 10/25/78

SUBSYSTE YA	M W DRIVE	SYSTEM		COMPONE BRAKE	NT CALIPERS			PAGE 7	0.3.9
FUNCTION	OF COMPO					,			
\ 1 <u>. </u>		PERS ARE SPRIM			·				
2. WH	EN HYDRA	AULIC PRESSURE			·			, PERMIT	TING YAW
MOTIO			NTAINS_	DRAG ON	DISC FOR DA	AMPING P	JRP0SES		
1 ME		FECTS OR SPRING FA NG OR DRAG TOP		- BRAKE >	WOULD RELE	ASE: RE	DUCING		PLICABLE SATING MODES -ALL
		FAILURE - BRA			RELEASE, PRO	HIRITING	OR .	+	
\ 		S YAW MOTION			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		-	$-\mid_{E,\;G,}$	1
		FAILURE - YAL	√ BRAKE	TOROUF	MAY NOT BE	ADFOLIATE	FOR	-, -,	
	RRICANE		· Dilling	1011402	101 00	TIDE QUITTE	- 1010	- A, E,	Ţ
110	KKIOAKE	MINDS						7, 2,	
4						·		-	
F	AILURE FRE	QUENCY				FAIL	URE SEVE	RITY	
-	FAILURE	COMPONENT		TIME					
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR		I FAILURE ARS)	MINIMAL	MARGIN	AL	CRITICAL	CATASTROPHIC IV
1		Negligible -	6 unit	s for	holding vaw	nos1t101			
<u> </u>		Regingible		3.6.8	lioraring yaw	P031 C101	· /	X 	
2	7.00	Negligible -			holdana yaw	DOE: +10		 	V
5 FAILURE	100 DETECTION		o unit	.5 101	pording yaw	position	1 19		Х

1 VI	SUAL IN:	SPECTION - A	LL MODE	S UF FA	ILUKE				
₂ ER	RATIC M	OTION OR EXCE	SSIVE N	OISE/LA	CK OF YAW MO	NO NOITO	COMMAN	D. WTS	SHUTS DOWN
3 (LC	W HYDRAI	ULIC PRESSURE	OR LEV	EL SIGN	IAL).				
	N AND COR	RECTIVE ACTION (F APPLICA	BLE)					.
D		ING HOLDING T			W WTS TO WEA	ATHERVANE	E. LOS	S OF DRAG	TORQUE
,	MAY C	AUSE YAW MOTI	ON TO B	E ERRAT	IC.				
									
12	PROBA	BILITY OF FAI	LURE GE	SPRING	OR_OTHER_ME	CHANICAL	ITEM_	ON_THE_SI	NGLE
		BRAKE IS APPR	**						
	МОМТН	INSPECTION P	ERIOD.		AR WILL BE				
								•	-
							•		
			•						
									
		<i></i>			NAME	J W. /	ACKER		DATE 8/8/78
OPERATIN	G MODES								ev. 10/25/78
В	SHUTDOW TRANSITIO WARM UP	N ON TO WARM UP	E S	TANDBY	N TO STANDBY	нт	PERATE RANSITIO EATHER	Re N TO FEATH	ev 11/27/78 ER 3/8/79

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SUBSYSTE			COMPONE	-	<u></u>	PAGE	
		CONTROL SYST	EM COOLIN	G EQUIPMENT		FMEA	NO 6.5.1
FANS	EXHAUST	HOT AIR FROM	NACELLE, DRAW	AMBIENT	AIR INTO	NACELLE TO	NIATRIAM C
LESS	THAN 10%	NACELLE SUPE	RHEAT ON WARM	DAYS.			
FAILURE N	PAN OR	MOTOR FAILS -	NACELLE OVERH	IEATS - WTS	shuts dov	vn OP	APPLICABLE ERATING MODES
	ıf ov	erheat affe	cts componer	its.	· · ·	- ;	F, G, H
2					٠ .	· · ·	et ,
3							
		No.					·
4		3					
	AILURE FRE	OLIENCY	•	-	FAILURE S	EVEDITY	
	FAILURE	COMPONENT	MEAN JĪME		TATEORES		
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × to 6, PER HOUR	BETWEEN FAILURE (YEARS)	MIÑIMAL I	- MARGINAL	CRITICAL	. CATASTROPHIC
_1	100	1.1	100		X		
			3		 		
					<u> </u>		
FAILURE	DETECTION	METHODS		•	•		
1 NACEL	LE TEMPE	ERATURE_SENSOR	R(S) INDICATE (OVERTEMPERA:	TURE		
NACEL	1 E ADED/	ATING COMPONEN	NTS INDICATE () VERTEMPERA	TUDE		-
INCLE	LL OF LIVE	TING GOTH GITE	INDICATE (JA PIKI PIKI PIKA	TOKE		
					<u> </u>		
DISCUSSIO	N AND COR	RECTIVE ACTION (F APPLICABLE)			,	
	> IF COME	PONENTS OVERHI	EAT SUFFICIENT	Y TO CAUSE	WTS SHUTDOW		
	·····	<u> </u>					
	THE US	E OF A NACELL	E OVERTEMPERAT	URE SIGNAL	DIRECTLY SHU	TTING THE	
			LY BEING CONSI		,		
			141				
							,
					- 3		
	,			· · · · · · · · · · · · · · · · · · ·	·		
				NAME J.	W. ACKER		DATE 8/7/78
OPERATIN							Rev. 10/25/78
В	SHUTDOW TRANSITION WARM UP	N . ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H - TRANS I - FEATH	SITION TO FEAT	Rev. 11/27/78

SUBSYSTE			COMPONEN			PAGE	
		<u>CONTROL SYST</u>	EM HEATIN	G EQUIPMENT	<u> </u>	FMEA	10 6.5.2
FUNCTION	OF COMPO	NENT C AT THIS LID	iting, NO KNOW	N DECHIDEME	אד דה שבאד ד	חב אערבווב	•
100 -	INEKE I		ITTING, NO KNOW	N KEQUIKENE	IN TO TIENT I	TIL MACLELL	
		·					
			· · · · · · · · · · · · · · · · · · ·				
FAILURE N	ODES & EF	FECTS					PPLICABLE RATING MODES
							*
2	,		-				
	•	-					
3					-		
	, •		·				
							
4							
		CUENCY	· · · · · · · · · · · · · · · · · · ·		544.455.0	51150171	
	AILURE FRE	COMPONENT	MEAN TIME		FAILURES	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC
							
					 		
 							-
FAILURE	DETECTION	METHODS					
1					•		
		f					
2	 						
3							•
	N AND COD	RECTIVE ACTION (I	E ABBLICABLE)				
DISCO2210	N AND CON	HECTIVE ACTION (I					
		-				-	
							
· · · · · · · · · · · · · · · · · · ·				 	·		
-				 _			
							
						 	
		<u>,</u>					
				NAME	J. W. AC	CKER	DATE - 8/8/7
OPERATING	MODES		**				Rev. 10/25/7
A	SHUTDOW	N NALTO MA PAGUE		TO STANDBY	G OPERA	TE	
	WARM UP	ON TO WARM UP	E STANDBY F TRANSITION	TO OPERATE	H-TRANSI	ITION TO FEATH R	EU.

SUBSYSTE	M - EPS		COMPONEN TO THE	T HIGH VOLT GENERATOR A	AGE POWER CA	BLE	PAGE FME A N	74.1 o 6.6.1.	1.
	OF COMPO		W OF HIGH VOLTA	GE GENERATO	OR OUTPUT CUE	RENT		·	
			ACCESSORY UNIT.						
	<u> </u>								
FAILURE N	odes& er	FECTS it: One or m	ore high voltag	e power pha	ses go to ze	ro;		PPLICABLE	DES
		TC* open, WTS			·			G	
2 Sho	rt circ	uit: Possibl	e phase-to-phas	e or phase-	to-neut faul	t;	Ì		
GCE	and BT	C open, WTS s	huts down.					G	
3 Gro	ounded co	onductor: <u>Ma</u>	ssive fault on	one conduct	or; GCB and	BTC		-	
	en, WTS	shuts down.			 		<u> </u>	G	
4									
F.	AILURE FRE	EQUENCY			FAIL URE S	EVERIT	I		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I -	MARGINAL	CR	ITICAL III	CATASTRO	 ЭРНІС
1	50	1.6	142				χ		
2	25 25	1.6	284 284				-X		
4	23	1.0	204				^		
FAILURE	DETECTION	METHODS							
1 - 3.	Power o	utput from WT	S indicates zer	o: BTC and	GCB position	n indi	icate "	open".	
2	<u> </u>			<u>., ., ., ., ., ., ., ., ., ., ., ., ., .</u>				<u> </u>	
3									
4				·					
			on(IF APPLICABLE) otection relay	will cause	the GCB to o	nnen.	or as	a	
			l current prote						
	llisecon								
			ıt dıfferentia	current p	rotection or	gener	rator		
			circuits will					nin	
	llisecon								
3. Sa	ne as #2	plus the gro	und current re	lay will can	use the GCB	to ope	en with	nin	
mi	llisecon	ids.							
									
					<u>. </u>				
*GCB -	Generat	or circuit br	eaker				 -		
		contactor	·	NAME H.	Roth	•		DATE 9/27	
В	SHUTDOW	N ON TO WARM UP	E STANDBY	I TO STANDBY	G OPERA H TRANS I FEATHI	ITION		Rev. 10/2 ER	25/78

SUBSYSTE NACELL	м .E - EPS		COMPONED HIGH V	NT OLTAGE POWE	R CABLES	9	PAGE 7	_ h	. 6.1
	OF COMPO		· -1						
			OW OF HIGH VOL			URREN	T FROM	THE	
GENER!	TOR ACC	ESSORY UNIT T	O THE CABLE TR	ANSITION ME	CHANISM.				
FAILURE A	ODES & FE	FECTS					Λ.	PLICA	DI E
			more phases go	to zero vo	ltage; GCB*	and_	OPER	ATINO	MODES
		, WTS shuts d					G		
			le phase-to-ph	ase fault;	GLB and BIC	open,	r		
1	<u>rs shuts</u>				otom CCD an		G		
			lassive fault o	n one condu	ictor, acb an	iu	G		
	copen.	WTS shuts do	wn.				u		
4									
F.	AILURE FRE	EQUENCY			FAIL URE S	EVERIT	Y		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINJMAL I	- MARGINAL		TICAL	CATA	ASTROPHIC IV
1	50	1.6	142				χ		
2	25	1.6	284				K	-	
3	25	1.6	28 4				X		
FAILURE	DETECTION	METHODS							
1 - 3.	Power	output from V	NTS indicates z	ero; BTC ar	nd GCB positi	on in	dicate	"op	en."
2							-		
3									
		RECTIVE ACTION (the CCD t				hadus
			<u>protection rel</u> cection circuit						_backup,
·	millisec		ection circuit	, will cause	the bic co	open	WICHIN		
			contractor uni	+ (RTCII) di	fferential c	urren	t prot	ecti	
			rent protection	*					
		thin milliseco		in circuits	WITT COUSE	one do	D una		
			ground current	relav will	cause the GO	:B to	open w	ithi	
	millised		ground current	relay will	cause one ac	00	open n		···
								-	
*GCB	- Gene	rator circuit	breaker						•
BTC	- Bus	tie contracto	<u>r</u>	NAME	G. Trusk/ H.	RUTI	ī T	DATE	8/17/78
OPERATIN	G MODES			IMAINE	- Husky II.				9/26/78
A B	SHUTDOW	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	Re	v. 1	0/25/78

SUBSYSTE	M		COMPONE	NT		PAGE	76 -
	E - FPS		MAIN 4	80 VOLT FEE	DERS	FMEA	NC 6.6.2.1
FUNCTION	OF COMPO	NENT THE FLO	W OF 480 VOLT	ACCESSORY P	OWER FROM TH	IF CARLE TE	ANSITION
PROVIL	JE A PAI	THE CENEDATOR	ACCESSORY UNI	T	THE THOIL IT		
MECHAI	112M 10	THE GENERATOR	ACCESSORT UNI	1			
FAILURE M	odes& er	FECTS uit: Limited	excitation po	wer availab	le to genera	itor OPI	APPLICABLE ERATING MODES
10	oss of s	ome single ph	ase 480 V load	s.		-	A11 .
2 Sh	nort cir	cuit: Same e	ffect as open	circuit, af	ter appropri	ate	
•		<u>e device clea</u>					A11
3 G1	rounded	<u>conductor: S</u>	ame effect as	open circui	t after		
ar	opropria	te protective	device clearı	ng.	•		A11 -
4	· 				·		
							·
F/	AILURE FRE			·	FAILURE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTROPHIC IV
1	50	.15	>1500			Х	i
2	25	.15	>3000			Х	,
3	25	.15	>3000			Х	
	MTS will	shutdown via	Failsafe syst	em.		-	r
2			<u>-</u>		-		-
3					 		· · · · · · ·
DISCUSSIO	n and cor n_uninte	RECTIVE ACTION (I	FAPPLICABLE) er supply provi	des 40VDC p	ower to prof	tection	-
		and critical					
			-	,			
						-	
-				`			
					•	,	
						•-	
			*				
				^		`	
		·	<u> </u>	NAME H. RO	THG. Trusk		DATE 8/17/78
В-	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY N TO OPERATE	G OPERA H TRANS I-FEATHI	NE SITION TO FEAT	îRev. 9/26/78 Rev. 10/25/78 HER

SUBSYSTE	М		COMPONE	NT			PAGE	17		
NACEL	NACELLE - EPS AC POWER CABLE TO THE CONTROL SYS, FMEANO 6.6.2.2									
PROVIDES A PATH FOR THE FLOW OF ACCESSORY POWER FOR OPERATION OF THE CONTROL SYSTEM.										
CABLE	RUNS FR	OM THE CB PAN	NEL IN THE GEN	ERATOR ACCES	SSORY UNIT TO) THE	NACELI	E CONTROL		
UNIT.		<u> </u>					•			
FAILURE N	opes & er able is	_{FECTS} open cırcuite	d. Computer b	ecomes inop	erative. WT	S		PPLICABLE RATING MODES		
s	huts dow	ın						A11		
2 C	able 1s	shorted to gr	ound. Compute	er becomes i	noperative.	WTS		e		
s	<u>huts dow</u>	m.						All		
3					•	•				
	_						-			
4										
F	AILURE FRE	EQUENCY			FAILURE S	EVERIT	<u> </u>			
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL	CRI	TICAL	CATASTROPHIC IV		
1	75	.15	>1000				χ			
2	25	.15	>3000				Χ			
			-							
FAILURE	DETECTION	METHODS		·						
1 & 2.	Power o	utput from WT	S indicates ze	ero.			,			
							_			
2				· · · · · · · · · · · · · · · · · · ·				- · · ·		
3					· ·					
		RECTIVE ACTION (I								
1_&_	2WTS	shut down wil	l be initiated	l via the fa	ilsafe_shuto	lown s	ystem.			
		 			· · · · · · · · · · · · · · · · · · ·			_		
								.		
							·····			
				*=						
										
					- -					
					<u> </u>					
										
				NAME G.	Trusk / H. RC	TH	$\neg \neg$	DATE8/17/78		
OPERATING	G MODES						- R	ev. 9/26/78 v. 10/25/78		
B	SHUTDOWN TRANSITIC WARM UP	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I-FEATHE	ITION T				

SUBSYSTE	М .		. COMPO	NENT	DC (UNINI	ROL SYSTEM) POWER	PAGE 7	3 6 6 2 3
	ELLE -		CABL	<u>.t 10</u>	THE CONT	RUL STSTEM		FMEAN	6.6.2.3
	OF COMPO					00 0050477		-	**************************************
PROVIDE	S A PAI	H FOR THE FLO	W OF UNINIER	KUP I	ARLE- DC F	UR OPERATIO	JN UF I	HE CON	IRUL SYSTEM
JCABLE_F	RUNS FRO	M THE GENERAT	OR ACCESSORY	<u>UNI</u>	T.TO THE	NACELLE α	ONTROL	UNIT.	
		•	4			•		•	_
FAILURE M	odes&er	_{FECTS} open circuit:	WTS shuts	down		,			PLICABLE ATING MODES
			•	- '	-	-			A11
2 (able is	short to grou	ind: 'MTS chi	utc d	0.00		- V		
<u> </u>	able 15	Short to grou	1117' WID 2111	<u> </u>	OMII			-	
			-		<u> </u>		··		All
3									•
					•			ļ <u>.</u>	
4					0		٠.	Ì	-
		,	•		2				,
, F	AILURE FRE	QUENCY		$\overline{}$		FAILURE	SEVERIT	TY *	
	FAILURE	COMPONENT	MEAN TIME	- 🖯		T	1		<u> </u>
FAILURE MODE NO	MODE	FAILURE RATE	BETWEEN FAILU		MINIMAL	MARGINAL	CR	ITIČAL III	CATASTROPHÎC IV
	, meg %	x 10 ⁶ PER HOUR	(TEANS)		<u> </u>	, ,			
1	75	15	>1000	, 7-	, 'A-	, ,	1 -	X	·
2 -	· 25	· .15	>3000	-	32 /	4		χ -	
			•				1		
	DETECTION	METHODS	,-	_ _			<u></u>		
FAILURE				•		• •			•
1 & 2.	Power o	utput from Wi	S indicates	zero	•				•
		٠.		₹		_	-		-
2		···			<u> </u>				~
		•	•						
3		·							
		RECTIVE ACTION (4	~			<u>_</u> `;	4 -
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OPERATIN	G MODES		0		NAME G.	TRUSKY H. R	ŌТН.	R	DATE 8/17/78 ev. 9/26/78 v. 10/25/78

SUBSYSTE	M	 	COMPONEN	ντ ,			PAGE	79
NACELL	E - EPS		- POWER	CABLE TO T	THE YAW DRIVE	SYS	FMEA N	o 6. 6. 2.
PROVID	OF COMPO E A PATH	NENT I FOR THE FLOW	OF ACCESSORY	POWER FOR (PERATION OF	THE Y	'AW DRI	VE SYSTEM.
CABLE	RUNS FRO	M THE CIRCUIT	F BREAKER PANEL	IN THE GEN	NERATOR ACCES	SSORY	UNIT T	O THE YAW
DRIVE	SYSTEM.		•	•,	•			
FAILURE N	ODES & EF	FECTS pen circuited	. WTS shuts do	own	•			PPLICABLE RATING MODES
	•					·		G, H
² Cab	le 1s sl	horted to gro	und, protective	circuitry	clears, WTS			
shuts	down			·			۲,	G, H
<u> 3</u> .		· · ·	•					
		<u> </u>		···				
4		•						
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F,	AILURE FRE	QUENCY	.		FAILURE S	EVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL 11		TICAL III	CATASTROPHIC
1	75	.15	>1000 ·	45	-	>	(
2	25	.15	>3000	4		>	(,
	·	,	<u>t</u>	•		•		
FAILURE	DETECTION	METHODS		•			•	
1 & 2.	Power	output from W	TS indicates ze	ero.				-
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2			<u>.</u>		·			
3	,				•			
		RECTIVE ACTION (I	(5 ADDI (0ADI 5)			<u> </u>		
			motor does not	t run or de	velop suffic	ıent p	ower 1	to f
		· · · · · · · · · · · · · · · · · · ·	pressure. Exc				_	
			rs initiates sl		<u>,</u>	<u> </u>		<u> </u>
	cator a	ila Willa Seliso	13 1111614663 31	iu cuomii.				
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				NAME G.	TRUSK/ H. R	отн		DATE 8/17/78
OPERATIN	G MODES			<u> </u>				Rev. 9/26/78 ev. 10/25/78
В-	SHUTDÓW TRANSITIO WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F-TRANSITION	TO STANDBY	G OPERA H TRANS I FEATHI	ITION T		

SUBSYSTE	M			NT POWER CA		PAGE					
NACELLE	NACELLE - EPS PITCH CONTROL SYSTEM . PAE (NO 6.6.2.5										
	A PATH	FOR THE FLOW	OF ACCESSORY								
TO THE	LOW SPE	ED SHAFT SLIP	RING ASSEMBLY	· _							
FAILURE M	opes&er	_{FECTS} open circuite	ed (one or more	conductors	s). WTS shut	S OPE	PPLICABLE RATING MODES				
de	own	-					F, G, H				
2 C	able is_	short circuit	ed to ground (one or more	phase condu	ctors).					
W	<u>TS shuts</u>	down		-			F, G, H				
3					 -						
											
4			- <u>-</u>	·							
F	AILURE FRE	OUENCY			FAIL URE S	EVERITY					
1	FAILURE	COMPONENT	MEAN TIME	, ,			Ť				
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL 1	MARGINAL II	CRITICAL III	CATASTROPHIC				
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2	25	.15	>3000			X					
FAILURE I	DETECTION	METHODS		-							
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2											
3											
		RECTIVE ACTION (I		•	•	"					
		•	n p motor does 1		•	•	r to mainta in				
			e Loss of pro			o snut wis					
aown	. Verii	y power cable	<u>continuity,</u>	repair as re	equired.						
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В	SHUTDOW TRANSITION WARM UP	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO FEATI	Rev. 10/25/78				

SUBSYSTE	COMPONENT POWER CABLE TO PAGE 81									
	NACFILE - FPS GEARBOX OIL HEATERS FMEANO 6.6.2.6									
J				CCODY	המערה במנ	. ^[NEDATION OF	TUC .	UDE OT	LUCATOR
		FOR THE FLOW				-				
		. CABLE RUNS		E CIRC	UIT BREAK	KER	PANEL IN TH	IE GEN	NERATOR	ACCESSORY
		AR BOX ASSEME	BLY.							
FAILURE N	odes & ef le open	rects circuited (o	ne or mo	re cond	luctors).	I	f gearbox o	<u>1]_</u>	OPE F	PPLICABLE RATING MODES
temp	is low.	WTS will not	enter "o	perate'	' mode				D,	E, F, G, H
² Cat Prote	ole is sective c	h <mark>ort circuite</mark> ircuitry clea	d to gro	und (or gearbox	<u>ne or mor</u> c oil tem	<u>ер</u>	<u>hase conduc</u> s low WTS w	<u>tors</u>) 111		E, F, G, H
		perate" mode.							,	<u> </u>
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F	AILURE FRE	QUENCY	•	` [FAILURES	EVERIT	Υ	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN T BETWEEN F (YEAF	AILURE	MĮNIMAL I		MARGINAL II		ITICAL III	CATASTROPHIC IV
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2	25	.15	>3000						1*	
						7		~		
FAILURE	DETECTION	METHODS								
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Power	output	from WTS 1nd	ilcates Z	ero. <u>-</u>						
2										
3										
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABL	.E)			of acambay	hoot		d nouse
		<u>ıl temperatur</u>		, verity	Continu	пц	or gearbox	neat	ers an	u power
cable	e. Repa	ir as require	d							
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		as been opera		a/or a	ır temp.	15	nigh enough	το κ	eep of	vescosity
low_	failure	will be "mini	mal."	 	(TDUCY			0/17/70
				· <u>-</u>	NAME	u.	TRUSK / H.	ROTH		DATE8/17/78 ev. 9/26/78
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В-	SHUTDOWN TRANSITIO WARM UP	N TO WARM UP	E STA	NDBY	TO STANDBY		G OPERATHE FEATHE	TION T	O FEATHE	

SUBSYSTE	М			TPOWER, CABL		PAGE	82				
	NACELLE - EPS LUBRICATION SYSTEM FMEANO 6 6.2.7										
PROVID	OF COMPO	NENT TH FOR THE FLO	OW OF ACCESSORY	POWER FOR	OPERATION O	F THE LUBRI	CATION SYSTEM				
CABLE	RUNS FRO	M THE CIRCUI	T BREAKER PANEL	IN THE GEN	NERATOR ACCE	SSORY UNIT	TO THE LUSE				
SYSTEM		, .	3"		•		-				
FAILURE M	odes& er	_{FECTS} open circuite	d (one or more	conductors). Lube syst	em OPE	PPLICABLE RATING MODES				
hā	is r <u>e</u> du <u>n</u>	dant wiring a	nd pumps.				A11				
2Ca	ble is	short circuit	ed to ground (c	one or more	conductors)	<u></u>	,				
Pr	otectiv	e circuitry c	lears. Lubė sy	<u>stem has r</u>	edu <u>ndant pu</u> m	np.	A11				
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F.	AILURE,FRE	QUENCY		··	FAIL URE S	EVERITY .	·				
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTROPHIC IV				
l	75.	.15	>1000	1,		• Х					
2	25	.15 -	>3000			Х					
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DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLÉ)		-						
		- for 1 less o	f_oil pressure	mocults an	UTC shutdow						
	orn pump	S 1411 1055 U			WIS SHUCCOW	11.					
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				NAME G	. TRUSK/ H.	ROTH	DATE 8/17/78				
OPERATIN							Rev. 9/28/78				

SUBSYSTE	м E - EPS		COMPONE	NT POWER C	CABLE TO THE	,	PAGE	83 ₁₀ 6.6.2.8
	OF COMPO	NE NT		.0(THOE STOTES		FMEAN	10 0.0.2.0
PROVID		H FOR THE FLO	OW OF ACCESSORY		<u></u>			
UNIT T	O THE EN	,	CONTROL SYSTEM.			3		
FAILURE N	odes&er able is	_{FECTS} open circuite	ed (one or more	conductors	s). ECS is			PPLICABLE RATING MODES
1	noperati	ve. Nacelle	temperatures m	nay exceed a	llow limit			A11
2 C	able 1s	shorted to gi	round (one or n	ore conduct	ors). Prote	ective		
d	evices c	lear. Nacelle	e temperaturs n	nay exceed a	llowable lu	nits.		All
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Ę F.	AILURE FRE	QUENCY		,	FAILURE S	EVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE: × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL , 11		TICAL	CATASTROPHIC
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FAILURE	DETECTION	Methods "		^,.,	<u> </u>			
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DISCUSSIO		RECTIVE ACTION (• `	•	a	•	,
			at 2 month inte			:	<u> </u>	
	* WTS	will-shut dow	<u>m if temperațu</u>	re falls or	rises to un	accep.	<u>table</u>	limits
	(con	trol system'w	<u>ııll become ino</u>	<u>perative re</u>	sulting in s	hutdo	wn).	· · · · ·
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0050 - 5::::				INAME G. IF	RUSK/ H. ROTH	<u> </u>		DATE 8/17/78 Rev. 9/26/78
8 -	SHUTDOW	N IN TO WARM UP	E STANDBY	TO_STANDBY &	G-OPERA H TRAÑS I-FEATHE	ITION TO	Re	v. 10/25/78

NACELLE - EPS ELECTRICAL FACILITIES EQUIPMENT	SUBSYSTE		. •		YT' POWER CAE			PAGE 8	34]
PROVIDES A PATH FOR THE FLOW OF ACCESSORY POWER FOR THE OPERATION OF THE ELECTRICAL FACILITIES LOCATED IN OR ON THE NACELLE. CABLE RUNS, FROM THE CIRCUIT BREAKER PANKE IN THE GENERATOR ACCESSORY UNIT TO LIGHTS, CONVENIENCE OUTLETS AND AIRCRAFT WARNING LT FAILURE MODES & EFFECTS. 1 Cable 15 Open Circuited (one or more conductors). Affected OPENATING MODES FUNCTION 15 inoperative (lights or portable equipment). 2 Cable 15 short circuited to ground (one or more-conductors). Protective devices clear. 3 4 FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE OF ATTEMPT OF THE MINIMAL MARGINAL CRITICAL CATASTROPHIC IVEAHS) 1 & 2 100			* #	ELECTR1	CAL FACILI	TIES EQUIPME	NT · I	FME A NO	6.6.2.9
IN THE GENERATOR ACCESSORY UNIT TO LIGHTS, CONVENIENCE OUTLETS AND AIRCRAFT WARNING LT FAILURE MODES & EFFECTS 1 Cable 15 open circuited (one or more conductors). Affected OFERATING MODES function is inoperative (lights or portable equipment). 2 Cable is short circuited to ground (one or more conductors). Protective devices clear. 3 4 FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FAILURE COMPONENT FAILURE MODE MODE NO FRE HOUR VICEAS: 1 & 2 100				OW OF ACCESSORY	POWER FOR	THE OPERATION	ON OF	THE EL	ECTRICAL
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function is inoperative (lights or portable equipment). 2 Cable is short circuited to ground (one or more conductors). Protective devices clear. 3 4 FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE SEVERITY MEAN TIME BETWEEN FAILURE IVEARS I IN MARGINAL III CATASTROPHIC IV TO PER HOUR IVEARS I IN THE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY FAILURE SEVERITY THE SEVERITY FAILURE							AND AIR	RCRAFT	WARNING LT
2 Cable is short circuited to ground (one or more-conductors). Protective devices clear. 3 4 FAILURE FREQUENCY FAILURE MODE FAILURE MODE FAILURE MODE FAILURE HODE FAILURE MODE FAILURE MODE FAILURE MODE FAILURE MODE FAILURE MODE FAILURE MODE FAILURE AT 0 6 PER HOUR IVEARS 1 ** To 6 PER HOUR 1 ** 2 100					-	,			
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FAILURE MODE NO FREQ % x 0 6 PER HOUR (YEARS) I MINIMAL MARGINAL CRITICAL CATASTROPHIC No. 15 No.	F	AILURE FRE	EQUENCY			FAILURE S	EVERITY		
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	В-	- TRANSITIO		E STANDBY		H - TRANS	SITION TO		

MODE NO FREQ % x 10 6 PER HOUR (YEARS)	.2.10
MECHANISM TO THE GENERATOR ACCESSORY UNIT. FAILURE MODES & EFFECTS 1 Cable 1s open-circuited. Emergency WTS shut down. 2 Cable 1s short circuited to ground. Protective devices clear, emergency. WTS shut down. 3 4 FAILURE FREQUENCY FAILURE FAILURE COMPONENT FAILURE FAILURE FAILURE FAILURE FAILURE FAILURE FAILURE FAILURE FAILURE FAILURE (YEARS) III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CATAS III CRITICAL III CRITICAL III CATAS III CRITICAL III CR	
FAILURE FRAUDRE APPLICABLE Table 15 open circuited. Emergency WTS shut down. 2 Cable 15 short circuited to ground. Protective devices clear, emergency WTS shut down. FAILURE FRAILURE COMPONENT FAILURE MODE NO FREO % 10 PER HOUR FAILURE STORM TOWN III CATASTITUTE FAILURE FAILURE TOWN TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUTE OF THE TOWN III CATASTITUTE FAILURE OF THE TOWN III CATASTITUT	TION
F, G, H 2 Cable 1s short circuited to ground. Protective devices clear, emergency WTS shut down. 3 4 FAILURE FREQUENCY FAILURE MODE MODE FAILURE F	
F, G, H 2 Cable 1s short circuited to ground. Protective devices clear, emergency WTS shut down. 3 4 FAILURE FREQUENCY FAILURE MODE MODE MODE T FAILURE RATE NO PER HOUR (YEAR) 1 75 .15 >1600 X 2 25 .15 >3000 X FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero.	
F, G, H 2 Cable is short circuited to ground. Protective devices clear, emergency WTS shut down. 3 4 FAILURE FREQUENCY FAILURE MODE MODE TEALURE FAILURE F	
2 Cable 1s short circuited to ground ? Protective devices clear, emergency. WTS shut down. 3	•
FAILURE FREQUENCY FAILURE FAILURE COMPONENT FAILURE NODE NO FRED % FAILURE ATTE (YEARS) 1 75 .15 .1500	
FAILURE FREQUENCY FAILURE FAILURE COMPONENT FAILURE RATE NODE NO FREQ % 10 6 PER HOUR (YEARS) 1 75 .15 .1500 X 2 25 .15 .3000 X FAILURE DETECTION METHODS 1 & 2 . Power output from WTS indicates zero.	
FAILURE FREQUENCY FAILURE FAILURE COMPONENT FAILURE RATE MODE NO FREQ % 10 6 PER HOUR (YEARS) 1 75 .15 >1000 X 2 25 .15 >3000 X FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero.	
FAILURE FREQUENCY FAILURE FAILURE COMPONENT FAILURE RATE MODE NO FREQ % 10 6 PER HOUR (YEARS) 1 75 .15 >1000 X 2 25 .15 >3000 X FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero.	
FAILURE MODE NO FROW TAILURE ANTE MODE NO FROW TO FAILURE ANTE NO FROW TO FAILURE ANTE NO FROM THE NO FROM THE NO FROM THE NOOD TO THE NOOD THE NOO	
FAILURE MODE NO FROW TAILURE ANTE MODE NO FROW TO FAILURE ANTE NO FROW TO FAILURE ANTE NO FROM THE NO FROM THE NO FROM THE NOOD TO THE NOOD THE NOO	*
FAILURE MODE NO FREO % 10 6 PER HOUR (YEARS) MINIMAL MARGINAL CRITICAL CATAS 1 75 .15 .15 .2000 X 2 25 .15 .2000 X FAILURE DETECTION METHODS 1 & 2 . Power output from WTS indicates zero. 2 3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	<i>.</i>
2 25 .15 >3000 X FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero. 2 3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	STROPHIC IV
FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero. 2 3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	
FAILURE DETECTION METHODS 1 & 2. Power output from WTS indicates zero. 2 3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	
1 & 2. Power output from WTS indicates zero. 2 3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	
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3 DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	
DISCUSSION AND CORRECTIVE ACTION (IF APPLICABLE)	
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	8/17/7 7/27/78
OPERATING MODES Rev. 9 Rev. 10 A SHUTDOWN D TRANSITION TO STANDBY G OPERATE B - TRANSITION TO WARM UP E STANDBY H - TRANSITION TO FEATHER C - WARM UP F TRANSITION TO OPERATE I - FEATHER	/27/78 1/25/78

	SUBSYSTEM COMPONENT COMPONENT PAGE 86 NACELLE - EPS GENERATOR CONTROL CABLE FINE AND 6.6.3.1										
	OF COMPO	NE NT					FMEAN	6.6.3.1.			
			W OF GENERA	TOR EXCITATION	CURRENT AND	GENER	RATOR W	INDING			
TEMPERA	TURE SI	GNALS BETWEEN	THE GENERA	TOR AND THE GE	NERATOR ACCES	SSORY	UNIT.				
FAILURE N	onducto	FECTS r in cable is	open circu	ited. Tempera	ture data lo	st		PLICABLE ATING MODES			
and	d/or gen	erator excita	tion lost.	WTS will shut	down.		F,	G, H .			
	-			e short circui		ffect					
as	#1. WI	S shuts down.					<u> </u>	G, H			
3 A (<u>conducto</u>	<u>ŕ in cable is</u>	shorted to	ground same e	ffect as #1.						
· WT	S shuts	down.					F,	G, H			
4											
							L				
F	AILURE FRE	QUENCY	*****		FAILURE S	EVERIT	Υ	<u>.</u>			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILU (YEARS)	JRE MINIMAL	MARGINAL II		ITICAL III	CATASTROPHIC IV			
1	50	.15	>1500				Χ				
2	25	.15	>3000			ļ <u>.</u>	X				
3	25	.15	> 3000	- 			Λ				
	DETECTION	METHODS			<u> </u>			<u> </u>			
1 For	temnerat	ure - no remo	vs[n2rh at	For excitati	ion - GCR and	RTC	trinned	nower			
from	WTS ind	licates zero.	te dispitaj.	TOT EXCITATE	dob and	0.0	от тррес	, ponci			
3 & 2	GCB and	BTC tripped,	power from	WTS indicates	zero.	_					
4			•	′			-				
FAILURE	CAUSE AND	CORRECTIVE ACTIO	ON (IF APPLICABI	LE)			ı				
							·				
		·-·					-				
						<u> </u>	-				
											
					<u> </u>						
							·	<u> </u>			
	_										
					TDUCK / II DO	T11		0/17/70			
	0.46757			NAME G.	TRUSK/ H. RO	I H		DATE 8/17/78 ev. 9/27/78			
В	SHUTDOW TRANSITIO	N DN TO WARM UP	E STAND	ITION TO STANDBY BY ITION TO OPFRATE	G OPERA H TRANS I FEATHI	TION T	Re	ev. 10/25/78			
	WARM UP		F INANSI	TION TO OFT HATE	I FEMINI						

SUBSYSTE	М		COMPONE	NT · CONTROL	CABLE TO TH	ΙE	PAGE 87	,	
	- EPS			RATOR ACCESS				6.6.3.	. 2
	OF COMPO		W OF COMMANDS	AND OPERATI	ONAL DATA BE	TWFFN	I THE NA	ACELLE	
			TOR ACCESSORY						
CONTROL	. UIII A	IND THE GENERA	TON MODESSON	0.0.2.1.					
FAILURE	ODES& EF	FECTS or in cable 1	s open-circuit	. WTS shut	s down.			PLICABLE ATING MOI	
		· · · · · · · · · · · · · · · · · · ·		·				F, G, H	<u> </u>
2 Tv	o or mo	re conductors	ın cable are	shorted tog	ether. WTS			7	
sl	uts dow	m.						F, G, H	
<u>3 A</u>	conduct	or with a cor	trol function	is short-cı	rcuited to g	rounc	-	•	٠
W.	[S shuts	down		·			F	, G, H	
4 A	conduct	or carrying o	perational dat	ta is short-	circuited to				
		WTS shuts dow	ŗn				_	-, G, H	
F,	AILURE FRE	r	MEAN TIME	<u> </u>	FAILURE S	EVERIT	ry		
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	, MARGINAL		ITICAL III	CATASTRO	ЭРНІС
1	50	.15	> 1500				(
- 2	25	.15	> 3000			Х			
3,4	25	.15	> 3000			Х			
FAILURE	DETECTION	METHODS							
1-4 Pow	er outpu	it from WTS 11	ndicates zero,	BTE is trip	oped.		 -		
								- '	-
DISCUSSIO	N ÁND COR	RECTIVE ACTION (r field enable	signal will	l not enable	the 1	field c	urrent	
<u> </u>			xcitation of t					4. 134.14	—
			ll prevent clo						
	genera	cor output wi	in prevent cro	strig the bit	or cause v	5 55	<u> </u>		
									—
					·				
					 			-	—
		· · · · · · · · · · · · · · · · · · ·							
					······································				— .
			***	- 					
				-				•	
				NAME G	. TRUSK/H.	ROTH		ATE 8/1	7/78
8	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H - TRANS I FEATHE	T NOITE	F Re TO FEATHE	Rev. 9/2 ev. 10/2 R	27/78 25/78

SUBSYSTE			COMPONE	NT	THE DOTOR	•	PAGE	8
	E - EPS		CONTR	OL'CABLE TO	THE RUTUR		FMEAN	6.6,3.3
	OF COMPO		. '					
			W OF CONTROL S			DATA	REIMEE	N THE NACELU
CONTROL	L UNIT A	IND THE LOW SP	PEED SHAFT SLIP	RING ASSEM	BLY.	<u>. </u>		
		, ,	•		•	,		
1 A	odes & ef conduct	or in the cab	le is open-cir	cuited. Lo	ss of associ	ated		PPLICABLE RATING MODES
C(ommand f	unction or da	ita. *			Ţ	F.	G. H
2 Tı	wo or mo	re conductors	are shorted t	ogether. 1	oss of assoc	iated	,	<u> </u>
- ···	ommand f	unction on er	roneous data.	*			1	G , H .
· · · · · · · · · · · · · · · · · · ·			· · · · · ·					в, п,
			le is short-ci			<u>s</u>	i	
0.	r associ	ated Command	function or en	roneous dat	d. ^		F,	G, H
4		•		r				
	•	e		1			[
F	AILURE FRE	QUENCY	-	,	FAILURE S	EVERIT		
	FAILURE	COMPONENT * *	MEAN TIME	• ,				· · · · · ·
FAILURE MODE NO	MODE	FAILURE RATE	BETWEEN FAILURE (YEARS)	MINIMAL ,	MARGINAL II		ITICAL ,	CATASTROPHIC
		× 10 ⁶ PER HOUR	(TEANO)	, ,	,,		····	
1,	50	15	>1500	,-		X	(
'2	25	:15	>2000	•	•	,	,	,
3						, , ,	·	
	25	.15	>3000				`	L
	-	•	, down or fails	to deliver	power.			
	ui.	TOTT WITE STIGHTS			,			•
2		•		_	• , '			
	·	5	• -					
3	-							
DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLE)	•				
See	FMEA.she	ects 7.7.13 th	rough 7.7.26					
Fail:	sate sys	stem initiates	s shutdown if n	ecessory.				-
				· · · · · · · · · · · · · · · · · · ·		••		
*	UTC mass	ha chutdam c	on control fund	stan may be	locked out			- commands
			or control func imately would l			or III	iproper	Commanus
·	<u> </u>	——————			Silucdowii.			
			,		•			
								•
								
				<u>.</u>				
				ž.				
				NAME_	G. TRUS	к /Н.	. Roth	DATE8/17/78
OPERATIN	G MODES							Rev. 9/28/78
. A	SHUTDOW TRANSITIO	" - N DN TO WARM-UP	E STANDBY	N TO STANDBY	G OPERA H TRANS	ITION T		ev. 10/25/78
	WARM UP		1 INANSTITU	N TO OPERATE	1 - FEATH	<u> </u>		1

SUBSYSTE NACELLE	M E ~ EPS		COMPONEN	OL CABLE			PAGE 8	9 6.6.3.4		
	OF COMPO		W OF CONTROL S	YSTEM OPERA	TIONAL DATA	BETWE				
CONTROL	L UNIT A	ND THE NACELL	E MOUNTED WIND	SENSOR.						
		· ·								
FAILURE N	CONDUCT	or in cable 1	s open-circuite	ed. Wind d	ata is lost	from		PLICABLE NATING MODES		
one s	ensor.	WTS shuts do	wn .	`			E, F,	G, H, I		
-			s short circuit			<u>r.</u>				
			e sensor. WTS				E, F,	G, H, I		
			s shorted to gr	round. Win	d data 1s			0 11 7		
	from one	e sensor. WI	S shuts down.				<u> </u>	G, H, I		
4										
F	AILURE FRE	QUENCY			FAILURE S	EVERIT	Y			
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHI IV		
1	50	.15	>1500				X			
2	25	.15	>3000				X			
3	25	.25	>3000				Х			
	detects	wınd sensor d	lifference betw	een two sen	sors.	·				
2				<u>-</u> -		•				
3	·	• 								
<u>Data</u>	from one		does not agree			her wi	ind ser	ısor		
<u>which</u>	causes	the WTS to b	e shut down in	the lockou	t mode.					
										
							· ·			
					 					
			•		······································					
		<u>-</u>		NAME G.	TRUSK / H.	ROTH		DATE 8/17/7		
PERATING	G MODES							Rev. 9/28/ v. 10/25/78		
-B	SHUTDOWI TRANSITIO WARM-UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA H · TRANS I FEATHE	ITION T				

SUBSYSTE	М		COMPONEN	IT			PAGE	90
NACE	ELLE - E	PS	CONTRO	OL CABLE TO	THE TOWER		FMEAN	10 6.6.3.5
FUNCTION	OF COMPO	NE NT						
PRO	IDES A	PATH FOR THE	FLOW OF CONTROL	SYSTEM COL	<u>MMANDS AND O</u>	PERATI	ONAL	DATA
BET	WEEN THE	NACELLE CONT	ROL UNIT AND TH	E TOWER SL	IP RING			
FAILURE N	MODES & EF	FECTS ble is open c	ircuited. WTS	may shut d	own, fail to			PPLICABLE RATING MODES
COI	nnect WT	S to utility,	or not shut do	own when re	quired.			ALL
			circuited to gi			No 1		
2 111	<u>e 111_ca</u>	DIE 13 3101 C	circuited to gi	Odria: Sam	c crice us			ALL
<u>3 W11</u>	res in c	able are shor	ted together.	Same effec	t as No. 1			ALL
4								
F	AILURE FRE	EQUENCY			FAILURE S	EVERIT	Υ	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC IV
1	50	.15	1400		χ *	Х	*	
2	25	.15	2800		χ*		*	
3	25	.15	2800		χ*.	X	*	
4	<u> </u>				·			1
FAILURE	DETECTION	METHODS						l
1 2 1		1 control	; WTS shutdown	if chitica	1 cyctoms in	volve	 -	*
1-3 LC	055 01 111	anual Control	, WIS SHULLOWII	11 Critica	1 39360113 111	VO 1 V C		
					<u> </u>			
				·				
						_		
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON_(IF APPLICABLE)	•				
* M	<u>anual co</u>	mmand "auto/s	<u>hutdown" or sta</u>	atus signal	<u>s orıginatin</u>	g at 1	the ba	se may
n	ot be re	ceived by con	trol equipment	in the nac	elle. Comma	nds or	rigina	ting in
			received at t					
			onnect"). If f	•				
m	ode and	"utility bus	tie disconnect	" command c	<u>annot be sen</u>	t via	the c	ontrol
s	ystem, t	he EPS "direc	tional power"	relay will	trip the BTC	when	power	reverses
d	ue to lo	w or no wind;	generator in	the nacell	e is protect	ed tro	om dam	age by
			ated in, and co					
	. 0 000 0 10	il devices roc	acea misana con	iter of ited by	scircuics wi	CITIII	one nu	<u>ccrrc.</u>
l ——								
\		<u> </u>						
				<u>,</u>				
			· 	NAME G	. TRUSK/H. R	<u>0TH</u>		DATE 8/17/78
OPERATIN	G MODES					•		Rev 10/11/78
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	N TÖ STANDBY N TO OPERATE	G OPERA H TRANS I FEATH	TE SITION T ER	O FEAT	Rev. 10/25/78 Rex. 11/27/78

SUBSYSTE			C	OMPONE		THE CEAR BO		PAGE	91
	ACELLE -			CONTR	OF CAREE 10	THE GEAR BO	X	FMEAN	o 6.6.3.6
l .	OF COMPO		IE ELON O	г стат	HC AND DEDE	ODMANCE THEO	DMATT	ON EDO	\ <u>.</u>
		A PATH FOR TH				URMANCE INFU	RMA I I	UN FRUI	<u>M</u>
	HE GEARB	OX TO THE NAC	ELLE CON	IRUL U	NI I				
		FEOTO				· · · · · · · · · · · · · · · · · · ·			
1 W	ire in c	ғестs able is open	<u>cırcuıte</u>	d: WT	S may shut	down .			PPLICABLE RATING MODES
								F, G	, Н
2 W	ire in c	able is short	ed to ar	ound:	WTS may sh	ut down.			
			- · · · · · ·					F, G	, Н
3 W	ires in	cable are sho	rt circu	ited:	WTS may shi	ut down			
<u> </u>	.,					40 401111		F, G	Н
·						·		- , .	<u>,</u>
4	_		•					}	
E	AILURE FRE	QUENCY				FAILURE S	EVERIT	Y	
<u> </u>	FAILURE	Γ	MEAN	rime			Γ		Τ
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN F		MINIMAL I	MARGINAL II		ITICAL III	CATASTROPHIC
	50	3.5	1400				ļ		
2	50 25	.15	1400 2800				X X	 -	
3	25	.15	2800				X		
4									
FAILURE	DETECTION	METHODS *							
1-3	If WTS s	huts down, po	wer outp	ut ind	icated is ze	ero.			
21-3									
3									
4			•					-	
	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLI	CABLE)					
		s down due to	•		n that data	indicates r	otor a	at zero	sneed.
ľ		e vibration o	•						
	<u> </u>	2 775740701. 0	- CACCS	170 10	W Speca bear	mg tempera	curc.		
									
2	JTC about			. 4 - 4 2 -					• •
l — — —		s down due to							
		is on vibrat		_		e circuits,	redun	dant s	ignals are
	provided	l to maintain	<u>data int</u>	<u>egrity</u>	•	·		-	
					· · · · · · · · · · · · · · · · ·				
* :	See FMEA	7.7.7 throug	h 7.7.12						
									
-					NAME G.	TRUSK/H. RO	TH		DATE 8/17/78
OPERATIN	G MODES					<u> </u>		F	Rev 10/12/78
	SHUTDOW				N TO STANDBY	G OPERA			ev 10/25/78
	WARM UP	ON TO WARM UP		ANDBY ANSITIO	N TO OPERATE	H TRANS I FEATHI		OFEAIR	e n
L									

MODE NO FREG % X10° PER HOUR (YEARS) 1 11 11 111 111 111 111 111 111 111 1	SUBSYSTE		.DC		NT CONTROL C			PAGE	92
PROVIDES A PATH FOR THE FLOW OF COMMANDS AND OPERATIONAL DATA BETWEEN THE NACELLE CONTROL UNIT AND THE LURRICATION SYSTEM. FAILURE MODES & EFFECTS 1 to open circuited: WTS may shut down. Oil pump openating modes are fire in cable is short circuited to ground: same effect as No. 1, additionally, data cannot be monitored. 2 Wire in cable are short circuited: WTS may shut down 4 FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FREQUENCY FAILURE FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FREQUENCY FAILURE FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FAILURE HATE BYNESH FAILURE HATE HAD BETWEEN FAILURE HATE HAD BETWEEN FAILURE HAD BYNESH FAILURE HAD BYNES				I THE L	ORKICATION	SYSTEM		FMEAN	0 6.6.3.7
THE NACELLE CONTROL UNIT AND THE LUBRICATION SYSTEM. FAILURE MODES & EFFECTS WITE In Cable is open circuited: WTS may shut down. Dil pump open and not be turned on or off, but redundant path provided. F, G, H 2 Wire in cable is short circuited to ground: same effect as No. 1, additionally, data cannot be monitored. F, G, H 4 FAILURE FREQUENCY FAILURE FRATE MODEN FAILURE FRATE FAILURE FRATE MODEN FOR S 1.05 PER HOUR INVERSIS MINIMAL MARGINAL CHITICAL CATASTROPHIC IVERSIS MODEN FROM S 1.5 2800 X* X* X* X* X* X* X* X* X* X* X* X* X*						.=			
FAILURE FREQUENCY FAILURE FREQUENCY This is not be trace and considered to ground: same effect as No. 1, additionally, data cannot be monitored. From the first in cable are short circuited: WTS may shut down The failure frequency FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FREQUENCY FAILURE BODE FAILURE RATE BETWEEN FAILURE MODE NO FRE MODE TO THE MODE FAILURE RATE BETWEEN FAILURE FAILURE DOOR TO THE MODE FAILURE BETWEEN FAILURE THE MODE FAILURE FAILURE CATASTROPHIC TO THE MODE FAILURE RATE BETWEEN FAILURE THE MODE FAILURE FAILURE CATASTROPHIC TO THE MODE FAILURE TO THE MODE FAILURE CATASTROPHIC TO THE MODE FAILURE	PRO	VIDES A	PATH FOR THE	FLOW OF COMMAN	<u>DS AND OPER</u>	ATIONAL DATA	BETW	EEN	
may not be turned on or off, but redundant path provided. 2 Wire in cable is short circuited to ground: same effect as No. 1. additionally, data cannot be monitored. 3 Wires in cable are short circuited: WTS may shut down FAILURE FREQUENCY FAILURE FROUENCY FAILURE FROODENCY FAILURE FROODENCY FAILURE FROODENCY FAILURE FROODENCY FAILURE FROODENCY 1 50 .15 1400	THE	NACELLE	CONTROL UNIT	AND THE LUBRI	CATION SYST	EM			
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	dentify	problem circu	<pre>1t, inspection</pre>	is require	d to pinpoint	t spec	cific p	roblem.
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SIG	NALS BET	WEEN THE NACE	LLE AN	D THE DR	IVE TRAIN.	ALSO PROVID	ES A	PROTEC	TED		
ELE	CTRICAL	JUNCTION FOR	INCOMI	NG NACEL	LE CABLES						
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SUBSYSTEM COMPONENT PAGE 94									
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IHE_	GENERAT	UK.				···			
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2>		e contactor u	nıt has	fuses	that backup	the GCB and	l prot	ect the	2
	genera					<u>- </u>	,		
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SUBSYSTE	M		COMPONEN			PAGE 9	
NACELLE	- EPS		VOLTAGE	REGULATOR		FMEAN	o 6.8.2.1
FUNCTION	OF COMPO	NENT	,				
ROVIDES	AND CON	ITROLS DC POWE	R TO THE GENERA	ATOR EXCITER	<u> </u>		
						-	
FAILURE M	odes & ef Output	_{FECTS} : voltage is z	ero: GCB & BTC	trip. WTS	shuts down.	OPE	PPLICABLE RATING MODES
						F	<u>, G, H</u>
2	<u>Output</u>	voltage too	low: GCB & BTC	trip. WTS	shuts down	' F	, G, H
3	Output	voltage too	high: GCB & BT	C trip. WI	S shuts down	•	
						F	<u>, G, H · </u>
4					· · · · · · · · · · · · · · · · · · ·		
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						- X	<u> </u>
3	25 DETECTION	11.4	40		<u> </u>		
2		, a spay	S indicates zer	,			
3			_				
	N AND COR	RECTIVE ACTION (I	E ARRI ÌCARI EI		ı		· · · · · · · · · · · · · · · · · · ·
			TC will not clo	nse since nă	nwer outnut f	rom denerat	or is zero
			of excitation				VI 13 201 V.
				· · · · · · · · · · · · · · · · · · ·			
Z. Pri	<u>or to B</u> er BTC (C closure: O	utput voltage i r factor become	is high, syr	ichronizer in Ling either	hibits BTC	closure
			n trips the GCE		ing, etcher	power racto	·
					<u> </u>		
			·				
		•					
							
				NAME	G: TRUSK / H	. Roth	DATE 8/17/7
PERATING	MODES						REV. 10/9/78
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	TE SITION TO FEATE	REV. 10/25/3

SUBSYSTE			COMPONE				PAGE (96			
NACE			POWER	FACTOR CONT	ROLER (PFC)		FMEAN	0 6.8.2.2			
1	OF COMPO		OL SIGNAL TO T	HE VOLTAGE	REGULATOR TO	MAIN'	TAIN A	CONSTANT			
			THE GENERATOR.								
	OI TOMEN	THOTON TROIT	THE GENERATION.			• •					
	ODES & EF		E CONTROL CTON	ALC TO THE	VOLTAGE			PPLICABLE			
			DE CONTROL SIGN				OPE	RATING MODES			
1			CTOR IS NOT CO			AN					
			GH A SIGNAL TO	INE VK: P	<u>r 15 LESS IN</u>	AN	•	G			
DESIRED, SEED 3 THE PFC PROVIDES TOO SMALL A SIGNAL TO THE VR: PF IS GREATER											
THAN DESIRED, SEE											
IMAN DESIKED, SEEP.											
											
F	FAILURE FREQUENCY FAILURE SEVERITY										
FAILURE MODE NO	FAILURE MODE - FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILUŖE (YEARS)	MINIMAL - I	MARGINAL		TICAL	CATASTROPHIC IV			
1,2,3,	100	22.8	5	<u> </u>	X		> ·				
					 						
FAILURE	DETECTION	METHODS				<u>l</u>		<u> </u>			
1 _3	NO DETE	CTION OF FAIL	URE UNTIL CERT	AIN ELECTRI	CAL PARAMETE	RS SU	CH AS	* -			
Χż	DIFFERE	ENTIAL CURRENT	OR OVER-CURRE	NT ARE EXCE	EDED.						
*											
4		. 									
			ON (IF APPLICABLE)	ODIENO ADE	ENCOUNTEDED	TUE 1	VD DDO	IIDEC.			
1-3			NDITIONS NO PR								
ļ			HOWEVER, IF HI								
			EITHER DIFFERE								
			TE WTS SHUT DO		OFF 12 NOT 2	LIPPE	U THEK	E WILL			
			IS EXCESSIVE.		AND MANUTERIA	L DEAL	DOLLES				
2&3			RANCE, IT. IS N	UI DETECTED	AND MAXIMUM	I KEAL	POWER	15			
	NOI AVA	AILABLE FROM T	HE WIS.								
			(D.T.T.O.)	NEDATED DIT							
- - - 			IDITIONS THE GE								
			OR TO SLIP A PO	<u> </u>							
<u> </u>	CURRENT	rs, wts may sh	HUT DOWN.	- [TS DOWN IF C						
OPERATION		LIMITS.		INAME G. I	RUSK/H. ROTH			DATE 8/17/78			
В	SHUTDOW	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION	I TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO		Rev. 9/8/78 v. 10/25/78			

ACELLE.	М		COMPONEN			PAGE	97
	- EPS	NE AIT	FIFLD C	CURRENT RELA	<u> </u>	FMEAN	0 6.8.2.3
	OF COMPO		ABLING AND DISA	ARITNG THE C	SENERATOR EXC	ΙΤΔΤΙΩΝ	
OVIDES	A DINEC	TIENNO OF EN	ABEING AND BISH	DETITO THE C	ZENEIOTION EXC	I INTION.	
AILURE N	opes & er	_{FECTS} closed; excita	ition current ca	annot be rem	moved from the	e OPE	PPLICABLE RATING MODES
ger	erator 1	field windings					G
			or cannot be exc	cited			
							F, G, H
3							
<u>-</u>							
4							
4							
F	AILURE FRE	QUENCY			FAIL URE SE	VERITY	
	FAILURE	COMPONENT	MEAN TIME		MARGINAL		
MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	II	CRITICAL III	CATASTROPHI IV
1	20	3.4	168	X			
2	80	3.4	42	^	 	v	
<u> </u>		3.1	7-				
₂ Gene	erator po	ower indicates	s zero power, Bl	C* indicate	es open.		
3							
iscussio	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				
							· . · .
* Bus T	Tie Cont	ractor					
		ractor rcuit Breaker		NAME H.	ROTH/G. TRUSK		DATE8/17/78
**Gener	ator Ci	rcuit Breaker		NAME H.	ROTH/G. TRUSK	R	DATE8/17/78 Rev. 9/25/7

SUBSYSTE		, <u> </u>	COMPONE	NT OLTAGE RELA	· · · · · · · · · · · · · · · · · · ·	PAGE9	
NACELLE FUNCTION	OF COMPO	NENT					NO 6.8.3.1
			VOLTAGE AND P		·	CONTROL SY	STEM ANITIATI
UTDOMŇ_	WHEN THE	E GENERATOR VO	OLTAGE EXCEEDS	A PRESET LI	MIT.		
AILURE N	ODES & EX	FECTS					APPLICABLE
1_0v	er_volta	ge relay fail	s open. No ef	fect			RATING MODES
2 Nv	er volta	ge relax fail	s closed		VTS shutsdown	/	F, G, H
	CI VOICA	ge relay lari		·-·-··	, sing es dolari		F, G, H
3					/		
-	<u> </u>						
4					/		•
F,	AILURE FRE	EQUENCY		/	FAILURE \$	EVERITY	
AILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITICAL	CATASTROPHIC
1	80	3.4	42	X			
2	20	-3.4	168			X	
				<u></u>			
1 No	ne ,	METHODS				۲.	
₂ GCE	3 and BT	C position in	dıcates open	-			
3 -	N AND CAR	HECTIVE ACTION (I	E APPLICABLE)				
	/		ontrolled by ut	ility buss.	If_over_ex	citation oc	curs while
<u>o</u> n	/ine, o	ver temp sens	ors will initia	ite shutdowr	1		
		•			-		
			-		-117ZER		
	· · · · · · · · · · · · · · · · · · ·	····		. 5	NCHROW.		
				TO WITHIN			
			PERFOR	MEC.			
			EUNCTION '				
		CCL ETED -	·				
		UL-	FUNCTION PERFORM	NAME U D	ROTH/G. TRUSK		DATE 8/17/78
ERATING	MODES		 	<u> </u>	KOTH/ INGOK		Rev. 9/25/78
A B -	SHUTDOWN	N DN TO ŴARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION TO FEAT	Rev. 10/25/7

SUBSYSTE	M		COMPONEN	т	ů.	PAGE	99
ACELLE -	EPS		UNDER FI	REQUENCY_RE	LAY	FME	NO 6,8.3.2
	OF COMPO		VOLTAGE AND PRO	OVIDES A ST	GNAL TO TRIP	THE GENER	RATOR CIRCUIT
			WER OUTPUT FREQU	•			
KEMKEK_)	AUEN IIIE	GENERATOR TO	WEN OUT OF THES	OLINOT TREES	, below it the	021 221121	
FAILURE M	ODES & EF	FECTS	ails open. No	offoct			APPLICABLE
1 011	uer ireg	dency relay i	aris open. No	errect.			F, G, H
2 Un	der fred	wency relay f	ails closed. G	CR tring an	nd WTS shuts	down	1, 0, 11
- 2 011	401 1109	dency terus i	4113 C103C4 4		ia WIS SHUCS	down.	F, G, H
3					· . <u></u>		1, 4, 11
-				,			
. 4							
FA	ILURE FRE	QUENCY		•	FAIL URE S	EVERITY	· •
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC IV
]	80	3.4	42	Х			
2	20	3.4	168		-	Х	
		-	•		ľ		
gC gC	3 and BT	C position in	dicates open.				
		**	by low rpm; if	off-line rp	m sensor res	ults in re	edundant
			y buss control		, any flucti	ons would	be due to
loss o	f utilit	y power, init	<u>iating shutdown</u>	•			
							
-					 	 	
						 	
							
			•				· · · · · · · · · · · · · · · · · · ·
							
				NAME H.	ROTHG. TRUSK		DATE 8/17/78
PERATING	MODES			Time			Rev. 9/25/78
В	SHUTDOWI TRANSITION	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	-	G OPERA H TRANS I FEATH	SITION TO FEA	Rev. 10/25/78

								·
SUBSÝSTÉ			COMPONEN	NT RRENT RELAY	_		GE 100	D 2 3
NACELLE FUNCTION		SNIC AIT	UVERCUR	KKENI KELAI		FM	EANO 6.	8.3.3
		•	T CURRENT AND PE	ROVIDES A S	IGNAL TO TRI	P THE GEN	NFRATOR	CIRCUIT
			UTPUT CURRENT E)			*	10	•
BKEAKEK.	WHEN IN	C. UCINERATUR OL	TIENT COUNTILL FO	VOEEDS A LVE	ESEL EILLE.			
FAILURF,	ANNES & FE	SECTE SALE	No. 7 CC.			1	APPLICA	
<u>1_</u> UVE	rcurren	t relay tails	open: No effec	ct			OPERATIN	G' MODES
			· · · ·	1 1 1 1 2			G	
2 UVE	rcurren	t relay tails	closed. GCB tr	rips and Wi	S_shuts_dowr	1	' G	
		-						
3		· .						
		, , , , , , , , , , , , , , , , , , ,	~ · · · · · · · · · · · · · · · · · · ·	 	•			
4			<u>-</u>	·	<u></u>		٠ .	,
			·			<u> </u>		
F	AILURE FRE	EQUENCY			FAILURE	SEVERITY	•	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MÉAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL 11	CRITICA	AL CAT	ASTROPHIC
1	80	3.4	42	, X	 	-		
2	20	3.4	168		:	+ · · ·		
	20	3.4	100		-		- -	-> -
- ALL LIRE	DETECTION	N METHODS	<u> </u>	•	1	<u></u>		
) ME THOSE					<u>ئ</u>	•
1 None	<u>: </u>					•		
2 GCR	and RTC	position indi	acatos onon			-		
- 000	יאויקידווף.	_pustrium_rna	Icares when		· ····································			
3		1						
		RECTIVE ACTION (I				•		-
			tion available i					nt.
			ition, ground cu	urrent sens	ing or diffe	rential c	urrent	
sensi	ng will	cause the GCE	B to open.					
								
				·				<u></u>
							•	
	-							
							··	
				NAME.	11 00711/	G. TRUSK	T _{DATE}	8/17/78
				NAME	H. ROTH/	J. IKUSK		9/25/78
PERATING		·a.	D. TO ANGUTION	TO STANDRY	C 0050	A T.C	rev.	10/25/78
	TRANSITION	ON TO WARM UP	E STANDBY	TO STANDBY	G OPER. H TRAN	ISITION TO FE	EATHER	

SUBSYSTE	VI .		COMPONE	NT.		PAGE	101
NACEL	E-EPS		REVERS	E POWER REL	AY	FMEAN	vo 6.8.3.4
FUNCTION MONIT			PUT POWER AND	PROVIDES A	SIGNAL TO TR	IP THE GENE	ERATOR
CIRCU	T BREAK	CER WHEN THE	ENERATOR OUTPU	T POWER FAL	LS TO A LEVE	L WHERE THE	POWER
FLOW	MAY REVE	RSE.					
FAILURE M	ODES&EF _AY FAIL	FECTS S OPEN: GENE	RATOR MAY ACT	AS A MOTOR	IF A REAL		APPLICABLE RATING MODES
REVER	SAL OF F	OWER OCCURS.	-	 			G
2 RE	AY FAIL	S CLOSED: GO	B TRIPS AND WT	S SHUTS DOW	N		G
3							<u>-</u>
4							····
			<u> </u>				
	ALURE FRE		MEAN TIME		FAILURE S	EVEHITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITICAL	CATASTROPHIC
1	80	3.4	42	X [,]			
3	20	3.4 -	168	<u></u>	-	Х	
4					 		
² GEN ³ IND	ERATOR F	POWER INDICATI	ION INDICATES A	ERO POWER I			C POSITION
							-
		-	-				-
	····			NAME G. T	DUCK ALL DOTT		DATE 0/17/7
OPERATIN	S MODES			1 6. 1	RUSK/H. ROTH	<u> </u>	Rev. 9/8/78
Â B	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H TRANS I FEATHI	ITION TO FEATH	Rev. 10/25/7

SUBSYSTE NACELLE			COMPONEN	CURRENT RE	I AY		GE 102
FUNCTION		ANT NIT	drooms	CONNENT NE		FME	AND 6.8.3.5
			CURRENT FLOW	IN THE NEUT	RAL LINE TO 6	GROUND AN	D PROVIDES A
			CIRCUIT BREAKE				
LEVEL TO	INDICAT	TE AN ELECTRIC	CAL FAULT.				
	ODES& EF R fails						APPLICABLE OPERATING MODES
		-				,	G
2 GC	R fails	closed. WTS	shuts down.				G
3							
4							
					· · · · · · · · · · · · · · · · · · ·		
F/	AILURE FRE		ME AN TIME		FAILURE \$	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 6 PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICA	CATASTROPHIC
1	80	3.4	42 -	X			
2	20	3.4	168		ļ	X	
		res periodic				-	
_2 <u>0</u> F	PR or OC	RECTIVE ACTION (I R_will_probabl ault_continued	ly initiate shu	tdown, over	temp. senson	rs would	ınıtiate shut-
				· · · · · · · · · · · · · · · · · · ·			<u> </u>
							-
				NAME	G. TRUSK / F	H ROTH	DATE 8/17/78
PERATING	G MODES				, ,		Rev. 9/25/78 Rev. 10/25/78
В	SHUTDOWI TRANSITIC WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA	ITION TO FE	

SUBSYSTE NACELLE			COMPONEN	T NTIAL PROTI	CTION	RFI AY	Ĭ	PAGE	103
	OF COMPO	NE NT	J DITTERE				1	FMEAN	vo 6.8.3.6
			RRENT FLOW IN TH	IE VARIOUS I	BRANCHS	OF THE	GEN	ERATOR	R STATOR
WINDING	AND PROV	VIDES A SIGNAL	TO TRIP THE GE	NERATOR CI	RCUIT B	REAKER	WHEN	THE C	DIFFERENTIAL
CURRENT	EXCEEDS	A PRESET LIMI	IT TO INDICATE A	FAULT WITH	HIN THE	DIFFER	RENTI	AL PRO	TECTION ZONE
FAILURE A	NODES& EF PR fails	PECTS open, no eff	ect						APPLICABLE RATING MODES
		·	·						G
2 Di	PR fails	closed, WTS	shuts down						٧
			•						G
3									
4.									
		- OUTNOY							
F,	FAILURE FRE	COMPONENT	MEAN TIME		T F A	AIL URE SE	VERIT	Y 	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 RER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARC			TICAL	CATASTROPHIC IV
1	80	3.4	- 42	X					
2	20	3.4	168	······································				Χ	·
		-				•		_	
ALLURE	DETECTION	METHODS	•		1			-	
1 None	- Requ	ires periodic	checks						
² Gene	rator po	wer indiction	indicates zero	power; GCB	_and_B	TC posi	tion_	indic	ates "open".
3									
DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLE)						
			1						
		· ·				#			·
									_
									
					 -				
	 -								
					<u></u>				
				- 					
									
				· · · · · · · · · · · · · · · · · · ·					
						 			
				NAME	H. ROT	H/ G.	TRUS	<u> </u>	DATE 8/17/7 Rev. 9/25//8
JPERATING	G MODES SHUTDOW	NI .	D TRANSITION	TO STANDOV	c	- OPERAT	·E	R	ev. 10/25/78
В		ON TO WARM UP	E STANDBY F TRANSITION		۲	TRANSI FEATHEI	TION T	O FEATI	HER

			MOD 2 Failure Mod	de and Effects	Analysis		
SUBSYSTE			1	T GENERATOR		PAGE	103.1
	E - EPS		OVER TEM	PERATURE REL	AY (OTR)	FMEA	AND 6.8.3.7
	OF COMPO		AL OF EACH GENERA	TOD FIFID WI	NUTNE VND DOU	VIDES A ST	CNAL TO THE
							BNAL- 10 THE
UNIKUL 3	TSIEM INI	TIATING A SHOT	DOWN WHEN ANY WI	INDING EXCEED	A FRESET ET	711 1 .	
FAILURE N	AODFS & EF	FECTS					APPLICABLE
1 Re	lay fails	s open: Genera	ator may operate				PERATING MODES
			struction of int	<u>erwiding ins</u>	<u>ulation</u> and m	assive	G
		ault currents		·			
2. Re	lay fails	s closed: WTS	shuts down				G
3							
4							
			<u> </u>				
F	FAILURE	COMPONENT	MEAN TIME		FAILURE S	EVERITY	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 6 PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC IV
1	80	3.4	42				ן*
2	20	3.4	168			- Х	
£ 16	DETECTION	METHODS					
1 & 2.	GCB & B	TBS open, power	r output from WTS	indicates z	ero.		
2							
3							
DISCUSSIO	N AND COR	RECTIVE ACTION (I	F APPLICABLE)				
1. EX	cessive i	winding tempera	atures are caused				
			-current, differe				
			CB and cause WTS				
			system will preve		ng the genera	tor exitat	ion until
th	e windin	g temperature	is within accepta	ible limits.			·
				·			
		·	·		·	·	·
			· ···_				
					·····		
1* on	ly 1f bac	kup protection	devises fail (1.	e., Over-cur	rent, differe	ntial curr	ent, or
gro	und faul	t)(Less than .	1% chance per 30	NAME	`H. ROTH		DATE 9/27/78
PERATING	MODES		years).				
В-	SHUTDOWN TRANSITIO WARM UP	N DN TO WARM UP	D-TRANSITION E STANDBY F-TRANSITION		G OPERA H TRANS I FEATHE	ITION TO FEA	ТНЕЙ

SUBSYSTE		-	GENERAT		OVERTEMPERAT	UIXL. I	103.2
NACELLE	- EPS OF COMPO	NE NT	<u></u>	RELAY		FMEA	0 6.8.3.8
			ntrol system to	shutdown t	he WTS if a	bearing o	ver-
			ved from the te				
FAILURE M	odes&eF lay fai	ғестs ls open: Gene	erator may oper	rate with ov	erheated bea	rings OPE	APPLICABLE RATING MODES
re	sulting	ın eventual d	destruction of	the bearing	.]*	-	G
2 Re	lay fai	ls closed: \	WTS shuts down.				G
3	_						
4							
			<u> </u>			EVEN TV	
F,	FAILURE FRE	Τ	MEAN TIME		FAILURE S	EVENIIT	
FAILURE MODE NO	MODE FREO %	FAÍLURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC IV
1	80	3.4	42				1*
3	20	3.4	168		-	X	ļ
4				 			
FAILURE	DETECTION	METHODS -					
1 Nor	e remot	ely, until WT	S shutdown.				
2 BTC	;	open, power o	utput from WTS	<u>indicates</u> z	ero.		
3							
4						-	
t			ON (IF APPLICABLE)	tod boswins	. ia lana af	lubuiannt	Control
			for an overhea	_			-
			outs to effect		cown or tall	sare snuta	own in
the	e event	of generator	bearing overhea	H			
1*	Bearin	g may seize a	nd cause signi	ficant-damag	e to the str	ructure. T	his would
	requir	e two relays	to fail, due to	redundant	system. Pro	babilıty o	f joint -
		•	n .1% ın 30 yea				·
					~		
					····		
				NAME	II DATI		DATE 0 /27 /70
OREDATIV	G MODES	<u> </u>	,	INAME	H. ROTH	<u> </u>	DATE 9/27/78
В	SHUTDOW	IN ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATH	ITION TO FEAT	Rev 10/25/78 HER

SUBSYSTE			COMPONE				PAGE]	
NACE	LLE - E	PS	LOSS 0	FEXCITATION	RELAY		FMEAN	o 6.8.3.9
	OF COMPO			• • •		•		
			the generator	circuit bre	eaker when ex	citat	ion po	wer
to_t	he gene	rator field i	s lost.					
FAILURE N	ODES & EF	FECTS Cuit: Relay	does not opera	te				PPLICABLE RATING MODES
<u></u>	pen cir	care. Acray	ades not opera				F.	-
			202		····	·		<u>u.</u>
2	telay do	es not issue (GCB trip signa	<u> </u>				
		· · · · · · · · · · · · · · · ·					<u>F.</u>	G.
<u>3</u> F	Relay is	sues GCB trip	signal premat	urely				
							F.	G.
4								
	AILURE FRI	EOLIENCY	<u> </u>	T	FAIL URE S	EVERIT		
	···	I	MEAN TIME		T		' -	T
FAILURE	FAILURE MODE	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL		TICAL	CATASTROPHIC
MODE NO	FREQ %	X 10 PER HOOR	(YEARS)		11		 	IV
1	80	3.4	42		<u></u>		<u>x</u>	
2	10	3.4	333		<u> </u>		<u>x</u>	ļ <u></u>
3	10	3.4	333		 	 	х	
	L		L	<u> </u>		<u> </u>		<u> </u>
FAILURE	DETECTION	METHODS				_		
¹- 3	WTS Shu	t Down						
<u>-</u> 3	NIS SIIU	L DOMI						
*								
*			01. (15 ABBL 10ABL 5)					
			on (IF APPLICABLE) o the generato	m if ovcitat	tion is lost	and G	CP 1c	not .
1 & 2	Dalliay	e may occur c	o the generato	r ii excitat	1011 15 1050	anu u	CD 13	no c
			y manner. Oth		on devices wi	ill-tr	ip the	BTC
	to re	move the gene	rator from the	system.				
								
								
								
					·			
			-					
					• -			
				NAME H.	ROTH			DATE 10-18-7
				IAMINE II.				
OPERATIN				N TO STANSON	6 0055	- c	R	ev. 10/25/78
	SHUTDOW TRANSITI	N ON TO WARM UP	E STANDBY	N TO STANDBY	G - OPERA H TRANS	ITION T	O FEATH	ER
С	WARM UP		F TRANSITIO	N TO OPERATE	I FEATH	: H		

NACELLE - EPS FUNCTION OF COMPONENT Provides a means to sign	ן סטווב						
	TONL	R FACTOR RELA	4Y		FMEA N	o 6	.8.3.1
Provides a means to sign							
	<u>gnal the control s</u>	ystem to shut	t down if th	e powe	r fac	tor	
exceeds preset limits.						-	-
FAILURE MODES & EFFECTS					Al	PPLICA	BLE
1 Relay does not ope	<u>rate: Power facto</u>	r may exceed	tolerable l	evel			MODES
causing generator	heating.				-	G	
2 Relay operates pre	maturely: Frequen	it unnecessari	v shut downs				
i noray operates pro-						G	
						<u> </u>	-
3							
	· · · · · · · · · · · · · · · · · · ·						
4							
	-						
FAILURE FREQUENCY		T	FAILURE S	EVERITY			
	MEAN TIME			-		T	
FAILURE FAILURE RANGE FAIL	AIE DETWEEN SANTIDE	MINIMAL	MARGINAL	CRIT	ICAL	CATA	STROPH
TOBE NO THEU X X TO TENT						L.	
1 80 3.4	42	 		x			
2 20 3.4	167			X		ļ	
3						ļ	
4		<u> </u>				Щ	
WTS Shut Down When WTS Shut Down							
ļ							
·	ACTION (JE APPLICABLE)						
·	ACTION (IF APPLICABLE)		,				
	EACTION (IF APPLICABLE)		,				
	E ACTION (IF APPLICABLE)		,				
	EACTION (IF APPLICABLE)						
	E ACTION (IF APPLICABLE)		,				
	E ACTION (IF APPLICABLE)		, ,				
	E ACTION (IF APPLICABLE)		, , ,				
	E ACTION (IF APPLICABLE)		,				
	E ACTION (IF APPLICABLE)		, , ,				
	E ACTION (IF APPLICABLE)						
	E ACTION (IF APPLICABLE)		,				
	E ACTION (IF APPLICABLE)		, ,				
	E ACTION (IF APPLICABLE)		, ,				
	E ACTION (IF APPLICABLE)				,		10.10
4 FAILURE CAUSE AND CORRECTIVE	E ACTION (IF APPLICABLE)		H. Roth				10-18-
· · · · · · · · · · · · · · · · · · ·	E ACTION (IF APPLICABLE)						10-18- 10-25-
AILURE CAUSE AND CORRECTIVE	D TRANSITIO				·	Rev	

SUBSYSTE	MIACELLE	- EPS	GENERATO	Ř BEARING U RELAY	NDERTEMPERA	TURE	PAGE]		8.3.11
	OF COMPO						·		*
			NTROL SYSTEM FO	<u>R INHIBITIN</u>	IG START-UP (OF THE	WTS V	VHEN	THE
GENERA	OK BEAK	ING TEMPERATU	RE IS TOO LOW.					<u> </u>	
FAILURE N	MODES & EF	FECTS tacts stuck o	pen: WTS rotor	will not r	otate or WTS	 S		PPLIC	ABLE G MODES
	ıll shut						0.2		G, H
2 Re	lay con	tacts remain	closed: Genera	tor may be	rotated with	nout			
<u>lı</u>	<u>ıbrıcatı</u>	on. (Double 1	failure)	· · · · · · · · · · · · · · · · · · ·				G	
3									
4									
F.	AILURE FRI	EQUENCY			FAILURE S	EVERIT	Υ		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CAT	ASTROPHIC IV
1	80	3.4	42				Х		
3	20	3.4	167	Х				 -	
4									
FAILURE	DETECTION	METHODS							
1 WTS	S will n	ot start.							
² If	damage	is severe, ev	entual bearing	over-temper	ature shutdo	own du	iring		
e "or	perate"	mode							
6	CALISE AND	CORRECTIVE ACTIV	ON (IF APPLICABLE)				<u> </u>		
FAILURE				····					
2. Nor	rmally n	<u>ot detectable</u>	since relay co	<u>ntacts shou</u>	ld be closed	l unde	r conc	litio	ns
			nnel are at sta						
ope			e if required.				the ge	nera	tor
hea	iter. I	f the heater	fails, the rela	y protects	the generato	or.			
									
									-
				NAME	H. Roth]	DATE	10-19-78
OPERATIN	G MODES						F	Rev	10-25-78
В	SHUTDOW TRANSITION WARM UP	N DN TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I-FEATHE	ITION T	O FEATH	ER	

SUBSYSTE	М		COMPONEN	Т		T	PAGE	104
NACELLE	_ EPS		POTENTI	AL TRANSFOR	MER (PT)		FME A N	6. 8.4.1
	OF COMPO		PROPORTIONAL	TO THE 0-41	60 VOLT OUTP	UT OF	THE G	FNFRATOR-
			ENERATOR PROTE					
		USED BY THE U	-	CITAL VELVI	3 AND THE GE	.IILIA I	01/11/10	
TRANSDU		FECTS :		foot			Α.	PPLICABLE
1	<u>-anstorm</u>	er is open-ci	rcuited, no ef	rect	·			RATING MODES
				~				-
2 T	ransform	er has short-	circuited, wind	ings				•
· · · · · · · · · · · · · · · · · · ·								G
3							-	
						-		
4							~	
							<u> </u>	
F.	AILURE FRE	,			FAILURE S	EVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC IV
1	25	1.1	400			-)	<u> </u>	****
2	· 75	1.1	133			-)	ζ	
							-	-
FAILURE	DETECTION	METHODS	<u> </u>		<u> </u>			
1 WT	S shutdo	wn		<u>.</u>				-
-				-				
2 WTS	S.shutdo	wn 1*	<u> </u>		-	•		
,		-		-				•
3		PECTUS ACTION //	E ABBLICABLE)					<u></u>
DISCUSSIC	M AND COR	RECTIVE ACTION (I	H, APPLICABLE!				_	
			•		9			-
		-		,	-	,		
Poten	tial tra	ansformers are	e utilized for	many functi	ions: 1) Co	ontrol	s, 2)	Voltage
			on devices, 4)					
 -			and 7) Synchr					
		· ·	ond // ognom					
)					·			
·	<u> </u>						 .	
3+ 74			circuit the WTS	will chut	down due to	0,000	-0vc1+	etion
1^11	P1 15	in a control	circuit the wis				7	DATE8/17/78
OPERATIN	G MODES		•	LINAME G	. TRUSK / H	KUTH		Rev. 9/25/78
В	SHUTDOW	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA H TRANS	ITION T	Re	v. 10/25/78-
	WARM UP		E EUWNO H TON	TO OF LINATE	I FEATH			·

78-K 6162-001

SUBSYSTE			COMPONEN	TRANSFORME	P (07)		PAGE	105 6 8 4 2
NACELLE			CORRENT	TRANSI ORIGINA	<u> (C1)</u>		FMEAN	6.8.4.2
	OF COMPO		SIGNAL PROPORTI	IONAL TO TH	F 0-433 AMP	GENER	ATOR O	IITPIIT I INF
CURRENT			D BY THE GENERA					
		TRANSDUCERS.	D BI THE GENERA	TION PROTEC	ITTE NELATO	AIIU I	TIE GEN	LINTON
FAIL URF N	AODES & EF	FECTS						PPLICABLE
			rent transform	<u>er secondar</u>	y winding:		OPE	RATING MODES
	output							<u>G</u> '
			<u>ndıvıdual</u> turn	s of the cu	rrent transf	former	·:	_
10	wer outp	out from CT						G
3			<u>-</u>					
			<u>-</u>					
4								-
			г					<u> </u>
F.	AILURE FRE		ļ <u>.</u>		FAILURE S	EVERIT	Υ	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE × 10 ⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL	CATASTROPHIC IV
1	25	1.1	400			,	X	
2	75	1.1	133			7	X	
			-					
FAILURE	DETECTION	METHODS	<u> </u>		·			<u> </u>
1 W7	rs shutd	∩wn	V			•		
2 W	S shutd	own						<u>-</u>
				-				
3							-	
DISCUSSIO	N AND COR	RECTIVE ACTION (IF APPLICABLE)					
			<u> </u>			<u>·</u>	•	
Curren	t transf	ormers are ut	illized for man	v functions	. 1) Contr		2) Vo	111200
			devices, 4)					
meters		itt-meter, /)	Ground fault	protection,	and 8) ווע	Teren	itiai p	rotection
circui	ts							
ļ								
							1	
<u></u>				NAME G	TRUSK/ H.	ROTH		DATE 8/18/78
В	SHUTDOW TRANSITIO	N DN TO WARM UP	E STANDBY	TO STANDBY	G OPERA H - TRANS	ITION T	Re	lev. 9/25/78 v. 10/25/78 er
c	WARM UP		F TRANSITION	TO OPERATE	I FEATHE	R 		

78 K-6162-001

SUBSYSTE	M		- COMPONEN	IT	-		PAGE -	106
NACELLE			VOLTAGE	TRANSDUCER				0 6.8.5.1
	OF COMPO	NENT MA OUTPUT ANA	LOC STONAL E	מרא דשב ה ז	15 VOLT OUTI	חוד הב	. v DO.	TENTIA!
				· · · · · · · · · · · · · · · · · · ·				
TRANSFO	RMER T	HIS SIGNAL IS	PROVIDED TO T	HE CONTROL	SUBSYSTEM AI	ND TO	A VOL	IMETER DISPLA
<u> </u>								
1 Op	en circl	it in the vo	ltage transduce	r. No out	out from tra	nsduc	r. OPE	RATING MODES
							•	G
2 Sh	ort circ	cuit between	ındivıdual turr	s of the vo	oltage trans	ducer		
			from transduce					-G
3	<u> </u>	71.1.200 OX 0F4 F	110	····	-			
<u>3</u>		· · · ·						-
								
4								
	AU UDE ERE	OUENCY		·	544.455.6	· · ·		
F/	AILURE FRE		MEAN TIME	 	FAILURE S	EVERII	<u> </u>	
FAILURE MODE NO	FAILURE MODE FREQ %	COMPONENT FAILURE RATE	BETWEEN FAILURE	MINIMAL	MARGINAL '		TICAL	CATASTROPHIC
	I TREG 70	×10 6 PER HOUR	(TEARS)	<u>'</u>				IV
1	25	1.1	400	-X			-	_
2	75	1.1	133	χ.	1.			
2	None.	vortage sign	al is for data	purposes o	. ,			
	N AND COR	RECTIVE ACTION (F APPLICABLE)		<u> </u>	~		
			·	-				, , , , , , , , , , , , , , , , , , ,
				······································	ı			
					•			
								
1 & 2.	Indepe	<u>ndant over vo</u>	<u>ltage protectio</u>	on in provi	ded.			
				٠ .				
			<u>-</u>		<u>.</u>	1		
						-	~	
							•	
		V.	ı	· - · · · · ·				
						·		
				NAME G	. TRUSK/ H.	ROTH		DATE 8/17/78
OPERATIN	G MODES			Tiname a	· INUSK/ II.	WOIII		Rev. 9/25/78
	G MODES SHUTDOW	N	D TRANSITION	I TO STANDBY	G Open	\TC	F	Rev. 10/25/78
В-		ON TO WARM-UP	E STANDBY	TO STANDBY	G OPERA H TRANS I-FEATH	T NOITIE	O FEATH	IER

SUBSYSTE			COMPONEN	T TRANSDUCE	D	PAGE	107
FUNCTION	OF COMPO	NE NT					6.8.5.2
			INALOG SIGNAL IS PROVIDED TO			OF A CURR	ENT
TRANS	FORMER.	THIS SIGNAL	12 SKOAIDED IO	AN AMMETER	DISPLAT.	 -	 -
FAILURE	ODES & EF	FECTS	system or amm	etan conco	zoro current		PPLICABLE
<u>1 U</u>	pen_crrc	uic. Concroi	system or anim	ter sense	zero currenc.	OPE	G RATING MODES
2 S	hort cir	cuited: same	e as #1.				
							G
3	 						
							
4	·				····		
Г.	AILURE FRE	QUENCY			FAIL URE SE	VERITY	· ····
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC IV
1	75	1.1	133	Х			
3	25	1.1	400	X	1		
4							
FAILURE	DETECTION	METHODS			·		
1 -2	Zero cur	rent displaye	ed at WTS site.	No remote	detection av	/ailable.	
7				· - · · · · · · · · · · · · · · · · · ·			
3							<u>-</u>
	CAUSE AND	CORRECTIVE ACTION	ON (IF APPLICABLE)		 		
Appro	ximate o	current can be	derived from	displayed o	r stored real	l power dat	a.
				·			
ļ					·		
						···	
							
! 							
							
-							
				NAME G.	TRUSK/H. ROTH		DATE 8/17/78 EV 10/13/78
В	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERAT H TRANSI I FEATHEI	E TION TO FEATH	

SUBSYSTE	М		COMPONEN	IT		P	AGE 108			
NACELL	NACELLE - EPS REAL POWER TRANSDUCER FMEANO 6.8.5.3									
	OF COMPO DES A 0-		NALOG SIGNAL OF	GENERATOR	KW OUTPUT BA	SED ON	INPUTS I	FROM		
POTEN	TIAL AND	CURRENT TRAN	SFORMERS. THIS	SIGNAL IS	PROVIDED TO	THE CO	NTROL SYS	STEM		
AND TO) A KW M	ETER DISPLAY.								
FAILURE N	odes & EF Output h	ғестs igh: WTS shu	ts down.				APP LIC. OPERATIN			
							G			
2	Output I	ow: WTS shut	s down.				G	-		
3							-			
				-						
4										
	AILURE FRE	OLIENCY			FAIL URE S	EVERITY				
	FAILURE	T	MEAN TIME		1 ALEGNES					
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL 1	CRITIC		ASTROPHIC IV		
1	100	1.1	100 -			Х				
	100	1.1	100		 	X				
3	<u></u>									
EALL LIDE	DETECTION	LMETHODS		_	· 					
)TO						
	WIS Shut	s down, zero	power output, E	sic indicate	es open.					
7				· · · · · · · · · · · · · · · · · · ·						
1					··-·			 		
4		000000000000000000000000000000000000000	OŇ (IF APPLICABLE)							
			i <mark>igh. System</mark> o	nerates at	reduced nowe	r level	s Dete	cted		
			ner units in fa		, caacca power	10,0,				
			Control system		owon data to	sot th	o rotor	h] ado		
		-	vill be initiate	<u>ea when den</u>	erator prote	LION S	ensors a	pproacii		
0	verstres	s limits.			····					
						 				
					 					
		,								
_ 				NAME G	TRUSK/H. ROTE		DATE	8/17/78		
OPERATIN	G MODES					<u> </u>	REV	10/13/78		
A	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY	TO STANDBY	G OPERA H TRANS		REV	\Y <i>}2</i> 5/7 1 8		

SUBSYSTE			COMPONE				PAGE	109
	LE - EPS		REACTI	VE POWER TR	ANSDUCER		FMEAN	6.8.5.4
	OF COMPO		HALOO CTONAL O	C OCHEDATOR	WAR OUTDUT	DACE	ON T	NOUTC FROM
			NALOG SIGNAL O					
POTEN	TIAL AND	CURRENT TRAN	SFORMERS. THIS	S SIGNAL IS	PROVIDED TO	A KV	AR MET	ER DISPLAY.
FAU LIRE N	MODES & FE	FECTS						PPLICABLE
1	Output h	igh: incorre	ct on-site dis	plays.				RATING MODES
								G -
2 - (Output 1	ow: incorrec	t on-site disp	lays.				
								G
3								
4								
F.	AILURE FRI	EQUENCY			FAILURE S	EVERIT	Υ	
FAILURE MODE NO		FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC
1	50	1.1	200	X				
2	50	1.1	200	Х				
3 4							- ···	
					<u> </u>			·
	DETECTION							
			vailable. KVA			compa	tible	with
7	voltage	, current, po	wer factor and	KW meter di	splays.			_
3								
4								
FAILURE (CAUSE AND	CORRECTIVE ACTIC	on(IFAPPLICABLE) I from other da	ta displave	d at site: \	voltae	ne. cu	rrent.
		ctor and real						
	power re		power.	· · · · · · · · · · · · · · · · · · ·		···-		
								
	_							<u> </u>
	<u> </u>		- 					
·								·
			•					
								
-				NAME G. T	RUSK/H. ROTH			DATE 8/17/78
OPERATING	MODES		-				<u> </u>	REV 10/13/78
8	SHUTDOWI TRANSITIO WARM-UP	N ON TO WARM-UP	D TRANSITION E STANDBY F TRANSITION		G OPERAT H TRANSI I-FEATHE	TION TO	O FEATH	ER

		 	MOD 2 Failure Mod	de and Effect:	s /:	Analysis			
SUBSYSTE	М		COMPONE					PAGE	
	E - EPS		GENERATO	R TEMPERATU	RE	TRANSDUCER		FMEAN	0 6.8.5.5
	OF COMPO		IOE DDODODTIONAL	TO TEMPEDAT		E 05 THE 05N	CD 4 TO	D LITHET	NOC AND
			ICE PROPORTIONAL	_			EKATU	K MINDI	NGS AND
SUPPL	IES THIS	DATA TO THE GE	NERATOR WINDING	OVER TEMPER	ΑI	URE RELAY.			
				 					
FAILURE N	MODFS&EF ansducer	FECTS is open-circui	t: Over tempera	ture relay	15	activated.			PPLICABLE RATING MODES
				_					G
₂ Tr	ansducer	is short-circu	nted: Over temp	perature rel	ay	is activate	d.	<u>† </u>	
				,					G
₃ Tr	ansducer	is shorted to	ground: Over te	emperature r	el	av mav or ma	v	†	
<u> </u>	t be act			· · · · · · · · · · · · · · · · · · ·				}	G
					_			-	
4									
E /	AILURE FRE	OLIENCY				FAİL ÜRE S	EVERI	L	
	FAILURE	r ————————————————————————————————————	MEAN TIME		7	TAILORES	- VENI		1
FAILURE MODE NO	MODE FREQ %	FAILURE RATE	BETWEEN FAILURE (YEARS)	MINIMAL	١	MARGINAL II	CR	ITICAL	CATASTROPHIC IV
			*	-	_			• 	ļ
11	10	1.1	1000	,	4			Χ	
2	80	1.1	125		1			X	
	10	1.1	1000			•		X	
JRE I	DETECTION	METHODS						_	
			power output from		о.	(WTS shutdy	וד משכ	nitlate	d prior to
det	aching ge	enerator output	from the line.)						
2									
3		•		_					
	N AND COD	RECTIVE ACTION (I	E APPLICABLES						
DI3C03510	AND CON				,				
			-			t	1	-	
			,			l.			
							,		1
-									
									
									
				<u>, </u>					
									_
		- 1							
		-							·
				NAME	Н.	ROTH			DATE9/28/78
PERATING			_		ĺ	i			REV 10/25/78
₿ -	SHUTDOWN TRANSITIC WARM UP	N ON TO WARM-UP	D - TRANSITION E STANDBY F - TRANSITION	,	ŗ	G-OPERA H TRANS	ITION	TO FĘATH	·ER

	M		COMPONE	NT			PAGE	110
NAC	ELLE -	EPS	ACCES	SORY POWER	TRANSFORMER		FMEAN	06.8.6
FUNCTION TRA	OF COMPOR	NENT 480 VOLTS TO	115/230 VOLTS	TO PROVIDE	ELECTRICAL	POWER	TO	
ACC	ESSORIE	S MOUNTED IN	THE NACELLE.					
FAILURE M			not start up o	shut down	via normal			PPLICABLE RATING MODES
con	trol sy	stem procedur	e.				В, С,	D, E, F,G,H
2 Sho	ort circ	uit: Same as	No. 1				B, C,	D, E, F,G,H
3				~				
								
4	_							
			T	~ - · · · · · · · · · · · · · · · · · · 			<u> </u>	
FA	AILURE FRE	QUENCY			FAILURES	EVERIT	r Y	·
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV
1	50	1.1	200				Χ.	
2	50	1.1	200			-	Χ	
3				 	 		_	
			<u> </u>	L.	 			<u> </u>
FAILURE	DETECTION	I WE I HODS						
1-2 7	ero pow	<u>er output ind</u>	icated at mann	ed substation	on			
2								
3	_							
4			·					
1			ON (IF APPLICABLE)				٠	
	_		30 Vac incapac		•			
			1 function fro					<u>utdown via</u>
	this mod	de will not r	esult in rotor	overspeed b	eyond design	n limi	ts.	
								<u>~</u>
<u> </u>								
				·				
-				NAME G. T	RUSK/H. ROTI	H	—	DATE 8/17/78
OPERATIN	G MODES							Rev 10/13/78
A B	SHUTDOW	N ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATH	TION 1	ГО FEATH	Rev 10/25/78

SUBSYSTE: NACFL	M LE - EP:	s [°]	COMPONEN 480 VO		BREAKER PAN	!	AGE MEAN	111 10 6.8.7.1
	ОГ СОМРО						MEAN	10 010111
			TION AND PROTEC	TION OF 480	VOLT ACCES	SORY		
POWER	WITHIN	THE NACELLE					,	
AILURE N	ODES&EF	FECTS Cult: WTS car	nnot start up o	r will go 1	to emergency			PPLICABLE RATING MODES
	hutdown		-					ALL
			as No. 1					
<u> </u>	HOT'L L.I	reur L. Same	35.100					- ALL
								ALL
3								
			<u></u>		_			·
4							-	
			,					
FA	AILURE FRE	EQUENCY			FAILURE S	EVERITY		,
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL . II	CRITI		CATASTROPHIC
1	75	1.1	133-			Х -	-	
2	25	1.1	400			X		
3		<u> </u>			 			ļ
		<u> </u>						<u> </u>
1-2 Z	ero pow	er output ind	<u>ıcated at manne</u>	<u>d substatio</u>	on.			
3	 -							
4						·		
FAILURE	CAUSE AND		ON (IF APPLICABLE)			_		,
		Battery wi	ll discharge if	maintenand	ce is not ef	fected.		
			· · · · · · · · · · · · · · · · · · ·					
	·—·					-		<u> </u>
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				NAME G.	TRUSK/H. RO	TH		DATE 8/17/78
PERATIN	G MODES							Rev 10/13/7
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	TO STANDBY	G OPERA H TRANS I FEATH	OT NOITIE		Rev 10/25/7

NACELLE - EPS 115/230 VOLT CIRCUIT BREAKER PANEL FM FUNCTION OF COMPONENT PROVIDES FOR THE DISTRIBUTION AND PROTECTION OF 115/230 VOLT ACCESSO POWER WITHIN THE NACELLE FAILURE MODES & EFFECTS 1 Individual circuit breakers open prematurely or fail to close. 2 Individual circuit breakers fail to trip when required 3 4 FAILURE FREQUENCY FAILURE FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL CRITIC.	ORY
PROVIDES FOR THE DISTRIBUTION AND PROTECTION OF 115/230 VOLT ACCESSO POWER WITHIN THE NACELLE FAILURE MODES & EFFECTS 1 Individual circuit breakers open prematurely or fail to close. 2 Individual circuit breakers fail to trip when required 3 FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FAILURE RATE FAILURE FREQUENCY FAILURE FREQUENCY FAILURE FAILURE FAILURE RATE FAILURE FREQUENCY	APPLICABLE
FAILURE MODES & EFFECTS 1 Individual circuit breakers open prematurely or fail to close. 2 Individual circuit breakers fail to trip when required 3 4 FAILURE FREQUENCY FAILURE FAILURE RATE FAILURE FAILURE RATE FAILURE FAILURE FAILURE RATE FAILURE FAILURE RATE FAILURE FAILURE FAILURE RATE FAILURE FAILURE RATE RETWEEN FAILURE MARGINAL CRITIC	
1 Individual circuit breakers open prematurely or fail to close. 2 Individual circuit breakers fail to trip when required 3 4 FAILURE FREQUENCY FAILURE FAILURE RATE MEAN TIME BETWEEN FAILURE MARGINAL CRITIC	
1 Individual circuit breakers open prematurely or fail to close. 2 Individual circuit breakers fail to trip when required 3 4 FAILURE FREQUENCY FAILURE FAILURE RATE MEAN TIME BETWEEN FAILURE MARGINAL CRITIC	
FAILURE FREQUENCY FAILURE FREQUENCY FAILURE SEVERITY MEAN TIME BETWEEN FAILURE MINIMAL MARGINAL CRITIC	OPERATING MODES
FAILURE FREQUENCY FAILURE FREQUENCY FAILURE SEVERITY MEAN TIME BETWEEN FAILURE MINIMAL MARGINAL CRITIC	ALL
FAILURE FREQUENCY FAILURE SEVERITY FAILURE FAILURE RATE RETWEEN FAILURE MINIMAL MARGINAL CRITIC	ALL
FAILURE FREQUENCY FAILURE SEVERITY FAILURE FAILURE RATE MEAN TIME RETWEEN FAILURE MINIMAL MARGINAL CRITIC	- 166
FAILURE FREQUENCY FAILURE SEVERITY FAILURE FAILURE RATE MEAN TIME MEAN TIME MEAN TIME MARGINAL CRITIC	
FAILURE FAILURE RATE MEAN TIME MINIMAL MARGINAL CRITIC	
FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL CRITIC	
MODE NO FREQ % × 10 ⁻⁶ PER HOUR (YEARS) I III	
1 50 1.1 200 X 1*	
2 50 1.1 200 X 1*	
3 4	
FAILURE DETECTION METHODS	
1 See FMEA sheets for individual items.	
2	
3	1
4	
FAILURE CAUSE AND CORRECTIVE ACTION (IF APPLICABLE)	
<pre>1* Critical if faulty breaker affects critical control systems, ot</pre>	therwise
minimal.	
	
3 1	
	
NAME B. TRUSK/H. ROTH	DATE7/17/78
OPERATING MODES	Rev 10/13/78
A SHUTDOWN D TRANSITION TO STANDBY G OPERATE B TRANSITION TO WARM UP E STANDBY H TRANSITION TO F C-WARM UP F TRANSITION TO OPERATE I FEATHER	

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SUBSYSTE			COMPONE				PAGE	114
NACELI	_E - EPS		4.16 K	V BUSES			FMEA N	o 6.8.8.1
	OF COMPO							
PROVI	DES A PA	TH FOR THE FL	OW OF 4.16 KV	POWER WITHIN	N THE GENERA	TOR AC	CESSO!	RY UNIT
FAILURE N	ODES & EF	FECTS		·····				PPLICABLE
<u>1 B</u> 1	uses are	short circui	ted: WTS shut	s down .				RATING MODES
								_G
A	bus 1s	open circuite	d: WTS shuts	down				•
								G
								_
3		~						
4						-		-
								
	AILURE FRE	QUENCY			FAIL URE S	EVERITY		
	FAILURE		MEAN TIME		11.120.120			1
FAILURE	MODE	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL		ICAL	CATASTROPHIC
MODE NO	FREQ %	X 10 PER HOUR	(YEARS)		11		11	l iv
1	25	2.3	66.7				X	
2	75	2.3	200				X	
3								<u> </u>
4								<u> </u>
FAILURE	DETECTION	METHODS						
1 W	TC 1c ch	ut down.			-			
	13 13 311	uc down.						
2								
3								
4								
FAILURE			ON (IF APPLICABLE)					
1 & 2	Diffe	rential prote	ction or groun	d protection	n will trip	the gei	nerato	or
	circu	it breaker.						
								
			···					
	 ,							
								
								
					רמווכע /ע מסדו			DATE 9/17/70
				NAME G.	TRUSK/H. ROTH	1		DATE 8/17/78
OPERATIN	G MODES				TRUSK/H. ROTE	1		DATE 8/17/78 REV 10/13/78
1 A	SHUTDOW	N N TO WARM UP	D TRANSITION E STANDBY	NAME G. T	G OPERA		}	REV 10/13/78

SUBSYSTE			COMPONEN	NT LT CIRCUITS		P	AGE .	115
	LE - EPS	F	MEA N	6.8.8.2				
	OF COMPO				·			_
PROVI	DES A PA	TH FOR THE FL	OW OF 480 VOLT	POWER WITH	IN THE GENER	ATOR AC	CESSO	DRY UNIT.
					 	_		
								
FAILURE N	nodes & ef circuit	rects is open circ	cuited:					PLICABLE RATING MODES
			·					A11
₂ A	circuit	: 1s shorted t	o ground: pro	tective cir	cuit breaker			
=	rips							A11
т.		its are short						
3 1	WO CIPCO	its are short	.eu.					A71
								A11
4			· · · · · · · · · · · · · · · · · · ·					
			T T					
F/	AILURE FRE	EQUENCY			FAILURE S	EVERITY		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL'	CRITIC		CATASTROPHI IV
1	50	1.1	200	-	:			-
2	25	1.1	400					
<u>3</u>	25	1.1	400					
	L	L				L		
FAILURE	DETECTION	METHODS						
1				, •				
2 -								
3	-							
4	<u>-</u>		-					
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)		-			
	See FM	A sheets for	individual ite	ms receivin	g 480 volt p	owe'r.		·
							-	
	-			-				
						<u>,</u>		-
								
			,					
					· · · · · · · · · · · · · · · · · · ·	<u></u>		
			•					
		-						
				NAME G.	TRUSK/H. ROT	Н		DATE 8/17/7
OPERATIN	G MODES		*				RI	
	SHUTDOW			N TO STANDBY	G . OPERA		RE	
	TRANSITION WARM UP	ON TO WARM UP	E STANDBY F TRANSITION	N TO OPERATE	H'TRANS I FEATH	SITION TO ER	FEATH	ĿН

SUBSYSTE		····	COMPONE			PAGE	116			
	LE - EPS		115/23	O VOLT CIRC	UITS	FMEAN				
	OF COMPO		.OW OF 115/230	VOLT WITHIN	THE GENERAT	OR ACCESSOR	Y UNIT.			
										
FAILURE N	nodes&ef A circui	ғест s t is open cir	cuit:	,			PPLICABLE RATING MODES			
ļ							A11			
2	A circui	t is shorted	to ground: pr	otective ci	rcuit	·				
	breaker	trips					A11			
3	Two circ	cuits are shor	rted:		-					
l 					····		A11			
4							•			
_		-0.15104								
<u> </u>	FAILURE FREQUENCY FAILURE SEVERITY *									
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL L	MARGINAL II	CRITICAL	CATASTROPHIC			
ļ	50	1.1	200							
2	25	1.1	400			 				
3	25	1.1	400				-			
4		-								
FAILURE	DETECTION	METHODS								
1	-						-			
2										
3					-					
4										
			ON (IF APPLICABLE)		115 (000		-			
*	See FML	A sheets for	<u>individual ite</u>	ms receivin	g 115/230 vo	oft power				
					 					
										
			· · · · · · · · · · · · · · · · · · ·							
										
				· · · · · · · · · · · · · · · · · · ·	•					
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			-			· · · · · · · · · · · · · · · · · · ·				
				NAME G. T	RUSK/H. ROTH		DATE 8/17/78			
OPERATIN	G MODES				-	R	EV 10/13/78			
В		N ON TO WARM UP	E STANDBY	I TO STÄNDBY		ITION TO FEATH	ER			
c.	WARM UP		F IHANSIIIUM	TO OPERATE	I FEATHI	- n				

SUBSYSTE	М		COMPONEN				PAGE	117	
NACELI			D.C. C	IRCUITS -			FMEAN	o 6.8.8.4	
FUNCTION			OU OF UNINTERD		DOUCD WITHIN	TUE	CENEDĂ:	TOD ACCECC	
			OW OF UNINTERRU	PITELE DE I	POWER WITHIN	Inc	GENERA	TOR ACCESS	
<u> OXRY</u>	UNIT (G	AU_)							
					· · · · · · · · · · · · · · · · · · ·				
FAILURE M	odes&er Open cir	FECTS Cuit in indiv	<u>vidual circuit:</u>	loss of i	ndividual			PLICABLE RATING MODES	
	function	1						A11	
			dividual circu	it: same a	s #1				
<u> </u>	-	<u>, y</u>	^	or same a	<u> </u>		,	All T	
3	 Open cir	cuit to the G	AU: loss of ge	enerator pr	otective		` .		
								All	
functions, aircraft warning lights and WTS shuts down. All									
4				- 			1		
							<u></u>		
F.	AILURE FRE	QUENCY -			FAILURE S	EVERIT	Υ		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE x 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		ITICAL	CATASTROPHIC IV	
1	1 75 1.1 133 - * X								
2	75	1.1	133	** - 1			X		
3	3 25 1.1 400 X								
4									
FAILURE	DETECTION	METHODS					'		
1 & 2	Not rem	notely detecta	able.						
34						-			
3	WTS shu	ıts down						-	
4			-						
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	·					
	See FME	A sheets for	individual, fun	ctions:					
	Ge	enerator prote	ective devices	(6.8.1, 6.8	.3.1 through	6.8.	3.8)		
	A ₁	ırçraft warnir	ng lights (6.9.	3)	-				
			(memory and fa		tdown circui	ts 7.	7.4 an	d 7.7.6)	
		<u> </u>	(momo.y ava ra		<u> </u>				
<u></u>									
<u> </u>									
l								<u>-</u>	
	·				·				
*	Failure	e severity cr	itical if WTS s	huts down v	ia fail-safe	shut	down c	ircuits.	
				-		-			
				NAME G.	TRUSK/H. ROT	——— ТН		DATE 8/17/78	
OPERATIN	G MODES			<u>~.</u>				REV 10/13/78	
A B	SHUTDOW	N ON TO WARM-UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS 1 FEATH	I NOITIS	-	REV 10/25/78 ER	

SUBSYSTE	M LE - EPS			COMPONEN		TC			PAGE	118
	OF COMPO			CONTROL	CIRCUI	12			FME A N	6.8.8.5
1		ATH FOR THE FL	.OW OF C	OMMAND,	CONTROL	AND	INSTRUMENT	ATION	SIGNAL	S WITHIN
THE G	ENERATOR	ACCESSORY UN	NIT.			<u>-</u>	.			
FAILURE N	ndividua	FECTS 1 path is ope	en circu	ited						PLICABLE ATING MODES
										F, G, H
₂ I	ndividua	l path is sho	orted to	ground						
										F, G, H
3										
									ĭ	
4					·····					
			_							
F.	AILURE FRE	EQUENCY		ļ			FAILURES	EVERIT	γ*	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN BETWEEN (YE	FAILURE	MINIMA I	ا	MARGINAL II		TICAL	CATASTROPHIC IV
1	75	2.3	66.	7						
2	25	2.3	200				···			
3			 					 -		
	DETECTION	METHODS	1			<u>+</u> .		L		
<u> </u>	DETECTION									
1			_						-	
2							<u>_</u>			
3										
	CALISE AND	CORRECTIVE ACTI	ON (1F APP)	LICABLE)					· · · · · · · · · · · · · · · · · · ·	
		sheets for 1			tions and	d 'fa:	ilure sever	itv		
1		through 6.8.5.								
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					NAME	G.	TRUSK/H. RO	TH	DE	DATE 8/17/78 V 10/13/78
OPERATIN	G MODES SHUTDOW	N	D T	RANSITION	TO STANDE	ΙΥ	G OPERA	TF		10/25/78
В		ON TO WARM UP	E \$	TANDBY	TO OPERAT			ITION T	O FEATHE	R

SUBSYSTE			119					
	CELLE -	FM	EANO 6	5.9.1				
FUNCTION								
PR(<u>DVIDES I</u>	LLUMINATION O	F NACELLE INTE	RIOR AREAS	USED FOR MAI	NTENANCE	AND	
REI	PAIR WHE	N THE NACELLE	IS OCCUPIED.					
-						_		
FAILURE M	iopes & ef	_{гестѕ} circuit brea	kers supplying	lighting	circuits trip	·		ICABLE ING MODES
- res	spective	lights extin	quish.					A
	nps burn							
2 <u>Lai</u>	iips burii	eu ouc						_
	-							Α
<u>3 119</u>	5/230 V	<u>power faılure</u>	: all lights	go out				
								Α
					•			
4			 	·				_
	AILURE FRE	OUENCY '	<u>, </u>		FAILURES	EVEDITY		
		T T T T T T T T T T T T T T T T T T T	145 114 5145		FAILONES	EVENIII		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITIC	AL C	ATASTROPHIC IV
1	50	57	4	· X -	1.			
2	40	57	5 _	X		<u></u>		
3	10	57	20	Х				
4		-						
2	ghts fai	l to illumina	te or extingui	sh. No re	mote detectio	n		
3			<u> </u>					
4								
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)					
	<u> </u>	<u> </u>	<u> </u>				<u> </u>	
		•			_			
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		·						
						<u> </u>		
			_					
				·				
								
					<u>.</u>			
						-	_	
	····	1		NAME G.	TRUSK/H. ROT	Н	DA	TE 8/17/78
OPERATIN	G MODES							10/13/78 10/25/78
A B	SHUTDOW	N ON TO WARM-UP	E STANDBY	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATH	ITION TO F		

SUBSYSTE		E - EPS	C	OMPONEN CONVEN	T HENCE OUT	LETS		PAGE	120 o 6.9.2
FUNCTION	OF COMPO								0 0.3.6
	MAKES	ACCESSORY POW	ER AVAIL	ABLE FO	R TEMPORAL	RY USE W	ITHIN T	HE_NACELL	E
	FOR AS	SEMBLY MAINTE	NANCE AN	D REPAI	R TASKS.				
								····	
FAILURE N	opes & ef	_{гестѕ} <u>cırcuit brea</u>	kers sup	plving	convenien	t outlet:	s trip:	A OPE	PPLICABLE RATING MODES
1	_	vaılable at o							Α
		ıt to specifi		: No po	wer avail	able at o	outlet.		
=									Α
3 11	5/230 V	power failure	: No por	wer ava	ilable at	any nac	elle		
l —		e outlet	•						Α
			· <u>-</u>				· · · · · · · · · · · · · · · · · · ·		
4					···				
F.	AILURE FRE	EQUENCY				FAI	LURE SEV	/ERITY	
FAILURE SALLURE BATE MEAN TIME								00171041	
FAILURE MODE NO	MODE FREQ %	x 10 ⁻⁶ PER HOUR	(YEAR		MINIMAL	MARGI	NAL	CRITICAL III	CATASTROPHIC
1	50	11.4	20		X	 			
2	25	11.4	40		Х				
3	25	11.4	40		Х				
4	L	<u></u>	<u> </u>						<u> </u>
FAILURE	DETECTION	METHODS							
1 -3 P	ortable	equipment fai	ls to fu	nction					
2									
3									
4		· · · · · · · · · · · · · · · · · · ·	-						
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLI	CABLE)		-			
			-						
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									<u> </u>
					NAME B.	TRUSK/H	. ROTH		DATE 8/17/78
OPERATIN	G MODES							ļ 1	Rev 10/13/78 Rev 10/25/78
	SHUTDOW	N ON TO WARM UP	E ST	ANDBY	TO STANDBY	н		ION TO FEATH	
	WARM UP		F TR.	ANSITION	TO OPERATE		FEATHER		

SUBSYSTE	М	•	COMPONEN	IT			PAGE	121	
NACELI	.E <u>– EPS</u>		AIRCRAI	T WARNING	LIGHTS		FMEAN	10	6.9.3
FUNCTION				, , , , , , , , , , , , , , , , , , ,					
COMPLI	LES WITH	FAA REQUIREM	ENTS TO PROVIDE	VISUAL WA	RNING OF OBS	TRUCT	ION TO	LOW	
FLYING	AIRCRA	FT.							
FAILURE M	ODES & EF	FECTS reaker is tri	pped: high-inf	tensity fla	shina white				ABLE NG MODES
			-	-			, 0,2	A11	
			ghts are exting					<u> </u>	
			e of three) hig						
ol	<u>structi</u>	on lights is	open circuit:	one HIFWO	is extinguis	hed.		A11	
3 L	amp malf	unctions (bur	ns out): indiv	vidual HIFW	10 light is				
extinguished. All									
4)		
7		· · · · · · · · · · · · · · · · · · ·							
	AILURE FRE	FOUENCY	- 1		FAIL URE 5	SEVERIT			
	FAILURE	T	MEAN TIME		1	T =		_	
FAILURE	MODE	PAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL	CR	CAT	TASTROPHIC	
MODE NO	FREQ %	X 10 - PER HOUR	(YEARS)		11			•	IV
1	2	1140	5	X					
2	1	1140	10	Χ	<u> </u>		``		
3	97	1140	.1	Х	ļ. <u></u>	 		<u> </u>	
4			<u> </u>		<u> </u>	 _		<u> </u>	
FAILURE	DETECTION	METHODS				۲۶			- .
1 -3	Alarm at	manned subst	ation. Visua	l observanc	re at site		. <u>-</u>		,
7	Train ac	manned Jubs t	,		,		 -	-	
7									
			•					-	
4									
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)		-				1
			·				-		
									-
			<u></u>						
									
	-								
			·						
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				NAME G	. TRUSK/H. RO	TH C	-	DATE	8/17/78
OPERATIN	G MODES	1	. , , , ,					REV	10/13/78
А	SHUTDOW	N	D TRANSITION	TO STANDBY	G OPERA	ATE		KŁŅ.	10/25/78
В		ON TO WARM UP	E STANDBY	TO OPERATE	H TRAN	SITION 1	O FEATH	IER	ı

SUBSYSTE			COMPONE				PAGE			
	SUBASSE		TOWER	STRUCTURE			FMEAN	o 7.1.1		
	OF COMPO		TO AND DESIGNATION							
1HE 10	WER SIR	UCTURE SUPPOR	TS AND PROVIDES	S MOUNTING I	PROVISIONS FO	OR THE	E YAW D	RIVE		
SYSTEM	i, ELECT	RICAL CABLES	AND NACELLE AC	CESS DEVICE.						
l										
	odes& er ructura		tower due to o	verload				PPLICABLE		
							L All	modes		
2										
3										
	,									
4							Į			
							L			
F.	AILURE FRI	EQUENCY			FAILURE S	EVERIT	TY			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV		
1	negl	igible						X		
2										
3										
4										
FAILURE DETECTION METHODS										
1 Insr	1 Inspect tower if overload condition occurs.									
2	CC COW	er in overtoad	u condition oct	euls						
}										
3					 _	. .				
4										
			ON (IF APPLICABLE)							
			<u>be safe life de</u>							
unles	s loads	greater than	the design lin	nt loads oc	cur. Struct	ural	analys:	15		
will	be perf	ormed using th	ne MOD-2 WTS st	ructural de	sign criteri	a.				
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	`									
	-									
										
<u> </u>								·		
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\		···						·		
				NAME J.	SHULTZ			DATE 8-14-78		
OPERATIN	G MODES									
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	O FEATHE	R		

SUBSYSTE	М		COMPONEN				PAGE			
	SUBASSEM		NACEL	LE ACCESS D	EVICE		FME A N	0 7.1 2		
	OF COMPO		PROVIDES_TRANSP	ΝΕΤΔΤΙΝΝ Ε Π	R TWO PERSON	IS/AND	OR MA	INTENANCE		
			ND AND THE TOP			13/1110	011 7 111	INTERNIOL		
Eduted	CMT DE IX	ALCA THE MACH	W AND THE TWO	VI(I LL., I VIII)						
FAILURE	ODES& EF	FECTS ting device ma	alfunctions					PPLICABLE RATING MODES		
<u></u>		<u></u>						tenance		
2 Po	wer lift	ting device ca	able brakes							
							Main	tenance		
3										
							_			
4										
F,	AILURE FRE	QUENCY			FAILURES	EVERITY	, 			
FAILURE MODE NO										
1										
2										
3					<u> </u>	 				
FALLURE	DETECTION	METHODS	<u> </u>		<u> </u>	<u> </u>		<u> </u>		
1 Per	10dic ma	aintenance and	d inspections							
3										
4			· 				·········			
	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)		····					
Use la	dder ba	ckup system ı	f lift malfunct	nons and re	pair lift.					
Replac	e damag	ed cables and	fittings Pla	n to use 11	ft with 2 ca	bles.				
						·				
										
				NAME J.	SHULTZ		1	DATE8-14-78		
OPERATIN	G MODES			·	* * * * 5 4		Rev	10/25/78		
В	SHUTDOW TRANSITIO WARM UP	N ON TO WARM-UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATH	SITION TO) FEATHI	ER		

SUBSYSTE		IDI V	COMPONEN			PAGE	124 10 7.1.3
	OF COMPO		LAU	DEK		FMEAN	10 /.1.3
			OF ENTERING A	ND EGRESSIN	G THE NACELL	E FROM THE	POWER
			AN ALTERNATE S'				
FAILURE N 1 Str	opes & ef uctura l	fεcτs failure due t	o overload.	_		OPE	PPLICABLE RATING MODES
failur	e		<u> </u>			mai	ntenance
2							
					·		
3			·	 	·····		
							···
4				·			
			· · · · · · · · · · · · · · · · · · ·	·			
F.	AILURE FRE	QUENCY	(FAILURE S	EVERITY	γ
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC
1		Negligible		Х			
2							
3 4			 				
FAILURE	DETECTION	METHODS			4		<u> </u>
				<u> </u>			
	lodic vi	sual inspecti	ons			·,	
2							
3							-
	CAUSE AND	CORRECTIVE ACTIV	ON (IF APPLICABLE)				
			adder and attac	hments will	be safe lif	e designed	- structural
analys	is will	be performed	using the MOD-	2 WTS struc	tural design	criteria.	
		<u> </u>		1			
							
							
					 		
l -					-		
ļ ———		·					
				<u></u>			
l							
				NAME .1	CUIU T7		DATEO 14 70
OPERATIN	G MODES			1	SHULTZ	Re	DATE 8-14-78 ev. 10/25/78
	SHUTDOW	N		TO STANDBY	G OPERA	TE	
В		ON TO WARM-UP	E STANDBY F TRANSITION	TO OPERATE	H TRANSI I FEATHE	ITION TO FEATH	ER

SUBSYSTE			COMPONEN				PAGE	
	SUBASSI		TOWER F	OUNDATION			FMEAN	7.1.4
FUNCTION	OF COMPO	NENT INDATION SIIDDO	ORTS AND PROVID	NES MOUNTING	PROVISIONS	FOR 1	THE TOW	IFR STRUCTURE
	UWER FUI	JNDATION SUFF	JAND TROVID					
			-					
FAILURE N	ODES & EF	rects failure of co	oncrete foundat	non due to	overload.			PPLICABLE RATING MODES
1 361	uc cui u i	1011010 01 01	, , , , , , , , , , , , , , , , , , , ,				_A11 n	
							- 1	ioucs
2 Str	<u>ructural</u>	<u>failure of a</u>	ttachment bolts	due to ove	rload or		-	•
	rosion.						A11 n	nodes
			of foundation		<u>load result</u>	<u>ıng i</u>	þ	
exc	essive_	system_tilt.					A11 r	nodes_
4				-	2			
'								
F	AILURE FRE	QUENCY			FAILURE S	SEVERIT	ΓY	
	FAILURE							
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CH	ITICAL III	CATASTROPHIC IV
1	No. 7 - 24 7 0							
2		Negligible Negligible					X X	
3		Negligible					X	
4							_	<u> </u>
FAILURE	DETECTION	METHODS						
1 Po	cioduc v	usual inspect	ions					
2	LIUQUCY	13uu IIISpect	. (0113	·		,		
3		·						
4								
·	CALICE AND	CORDECTIVE ACTIV	ON (IF APPLICABLE)	-				
		=	nless loads gr	eater than	the design 1	imit	loads	occur.
		-						
			be performed u					
Corr	osion pr	<u>revention fini</u>	<u>shes will be u</u>	sed and mai	ntenance per	rtorme	<u>a wnen</u>	requirea.
					-			
	_							
			•					
								
		-				·		
								
						<u>-</u>		
	· -						· · · · · · · · · · · · · · · · · · ·	
				NAME J. S	HULTZ			DATE 8-14-78
OPERATIN	G MODES						Re	ev. 10/25/78
	SHUTDOW	N ON TO WARM-UP	D TRANSITION E STANDBY	N TO STANDBY	G OPERA		TO FEATH	IER
	WARM UP			N TO OPERATE	I FEATH			

SU: SYSTE	M		COMPONE	NT			PAGE	126		
TOWER	TOWER - EPS TOWER-HIGH VOLTAGE CABLE FMEANO 7 2 1 1									
					TAR AUTAUT 6					
			OW OF HIGH VOL							
CABLE	_IRANSI	II ON _MECHANI SI	M_TO_THE_HIGH_V	OLTAGE JUNC	IION BOX AT	THE FO	OOT OF	THE TOWER.		
FAILURE !	10DES & EF	FECTS		- -			Δ.	PPLICABLE		
1 OP	EN CIRC	UIT: ONE OR I	MORE PHASES GO	TO ZERO VOL	TAGE; GCB OF	ENS,		RATING MODES		
BTC_ _ (BUZŢĮE (CONTACTOR) QP	ENS. WTS SHUTS	DOWN.				G		
2_SH	LORT_CLR	CUIT: POSSIBI	LE_PHASE <u>-TO-</u> PHA	SE_FAULT;_ G	CB_OPENS, B]	·c				
OPENS	, WIS_SI	HUIS DOWN						<u>'G</u>		
3 GP	OUNDED	CONDUCTOR M	<u>ASSIVE FAULT ON</u>	ONE CONDUC	TOR; GCB OPE	NS,		-		
BTC C	PENS, W	TS SHUTS DOWN	•					G		
4				 						
										
F.	AILURE FRI	EQUENCY			FAIL URE S	EVERIT	Υ	,		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL	CATASTROPHIC IV		
1	50	.8	286				Χ			
2	25	· <u>8</u>	578	······································			X			
3 4	25	.8	578				X			
FAILURE	DETECTION	METHODS	 							
1 GEN	IFRATOR !	POWER INDICAT	ION INDICATES Z	FRO POWER:	BTC POSITION	INDIC	ATES	"OPEN"		
			ATION INDICATES							
X ~ E	OTH ARE	"OPEN".								
4										
			ON (IF APPLICABLE)							
1 [<u> IFFEREN</u>	TIAL CURRENT I	PROTECTION RELA	Y WILL CAUS	E THE GCB TO	OPEN	OR AS	A BACKUP,		
	HE DIFF	ERENTIAL CURRI	ENT PROTECTION	CIRCUIT WIL	L CAUSE THE	BTC TO	OPEN			
2 0	ENERATO	R OR BTCU DIF	FERENTIAL CURRE	NT PROTECTI	ON OR GENERA	TOR O	/ER-CU	RRENT		
F	ŔOTECTI	ON CIRCUITS W	ILL CAUSE THE G	CB AND BTC	TO OPEN					
3 9	SAME AS	2 PLUS THE GR	OUND CURRENT RE	LAY WILL CA	USE THE GCB	TO OPE	<u>EN.</u>			
1										
I										
~			-							
			· ·							
				- [NAME	 			DATE		
ORCDATIN	C MODES			NAME G T	RUSK/H. ROTH			DATE 8/17/78 Rev. 9/8/78		
В	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	ITION TO	Re	v. 10/25/78		
	WARM UP		i indivatitor		FEATRE					

SUBSYSTE	М		COMPONEN	COMPONENT				PAGE 127			
	OWER - E		TOWER	TOWER TO BTBU HIGH VOLTAGE CABLE					.2.1.2		
	OF COMPO										
PROVI	DES AN U	NDERGROUND PA	TH FOR THE FLOW	OF HIGH V	<u>OLTAGE GENER</u>	ATOR (CURREN	T FRO	OM THE		
JUNCT :	ION BOX	INSIDE THE FO	OT OF THE TOWER	R TO THE BUS	<u>S TIE BREAKE</u>	R UNI	T LOCA	TED			
OUTSI	DE AND A	WAY FROM THE	TOWER.				•				
FAILURE M	odes& EF	FECTS uit: one or	more high volta	ige power p	hases			PPLICA RATIN	ABLE G MODES		
q(o to zer	o volts: BTC	opens. WTS shu	its down				G			
			le phase-to-pha		e-to-neutral						
		C opens, WTS	•	•				G			
	=		assive fault or	one high	voltage cond	uctor					
	-	, WTS shuts d	-			4000.		G			
	ic opens	, 113 3114 C3 Q	OWI								
4	·····										
F,	AILURE FRE	QUENCY			FAILURE S	EVERIT	Υ .		_		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL		TICAL	CAT	ASTROPHIC IV		
1	50	.4	571			X		+			
2	25	.4	1143			X		1			
3	25	.4	1143			X		-			
4			,					<u> </u>			
FAILURE	DETECTION	METHODS			-						
1-3	WTS sh	ut down							-		
2											
3				· · · · · · · · · · · · · · · · · · ·			-				
4			-								
FAILURE	CAUSE AND	CORRECTIVE ACT	ON (IF APPLICABLE)								
1-3		•	tial current p	otection re	elay will ca	ise tl	ne BTC	to	pen.		
	As a b	ackup: gener	ator over-cur	rent or grou	und protecti	on rel	lay ma	V	- -		
			manual disconr								
					oc open.						
		· · · · · · · · · · · · · · · · · · ·									
											
	· · · · · · · · · · · · · · · · · · ·										
											
·											
				NAME G.	TRUSK/H. ROT	4		DATE	8/17/78		
OPERATIN	G MODES										
								ĸev	10/13/78		

SUBSYSTEM COMPONENT BTBU TO TRANSFORMER				PAGE 1					
	ER - EPS			HIGH	VOLTAGE CA	BLE		FMEAN	7.2.1.3
FUNCTION PRO		NENT NUNDERGROUND	PATH FO	OR THE E	IOW OF HIG	H VOLTAGE GEN	JFRATN	י ום דווח פו	IT CUDDENT
l.		JS TIE BREAKER				-			TT COUNTRY .
	NSFORMER		<u> </u>	<u> </u>	W-W1	VI TIL FUNER	DUITU	· L	
FAILURE M	ODES & EF		more had	nh volta	de nomer in	hases go to a	2000		PLICABLE
vol	ts: BTC	C opens, WTS s	shuts do	own, acc	essory pow	er is distrib	outed	G	ATING WODES
2 Shor fau	rt circu lt; BTC	nan 3-phase. uit: possible opens, WTS sh	<u>phase</u> nuts dow	-to-phas wn, acce	e or phase ssory powe	-to-neutral r is distribu	ited	G	
		h an 3-phase. onductor: Mas	ssive fa	ault on	one high v	oltage conduc	tor		
BTC	opens.	WTS shuts dow	vn, acce	essory p	ower_is dı	stributed at		G	
4_oth	er than	3 phase.							
			 -					L	
F/	AILURE FRE	EQUENCY				FAIL URE S	EVERIT	-Y	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN	N TIME N FAILURE (ARS)	MINIMAL	MARGINAL II	CRI	ITICAL III	CATASTROPHIC IV
1	50	.4	570					Χ	
2	25	.4	1140					Χ	
3	25	.4	1140	·			 	X	
ļ	shut do	N METHODS							
3									
4									
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APP	LICABLE					
1-3	For ge	enerator prote	ction s	ee FMEA	7.2.1.2	· · · · · · · · · · · · · · · · · · ·		-	
1-3	For ac	cessory power	utiliz	ation e	quipment p	rotection (TB	A)		·
	see a1	so FMEA 7.2.2	2.1					·-	
l									
		•							
							-		
[- 									
 -						· · · · · · · · · · · · · · · · · · ·			
			 -					 -	
	_				- [т.	
					NAME G.	TRUSK/H. ROT	<u>H</u>		PATE 8/28/78
OPERATING	G MODES		_					Re	Rev 10/13/78 ev. 10/25/78
В	- SHUTDOW TRANSITION WARM UP	IN ON TO WARM UP	E S	TANDBY	TO STANDBY	G OPERA H TRANS I FEATHE	TION T	O FEATHE	

SUBSYSTE	M		COMPONE	NT			PAGE	129 ·
TOWE	R - EPS		- AERIA	AERIAL HIGH VOLTAGE CABLE				7.2.1.4
FUNCTION	OF COMPO	VENT .						
		C-)acre	L CONDUCTORS F	OR THE FLOW	OF GENERATO	R POW	FR	
							F17	
<u>FROM</u>	THE OUT	PUT STOE OF T	HE POWER TRANS	FURMER IU I	HE READE 210	E OF		
THE	FUZED MA	NUAL DISCONNE	CT_SWITCH.					
FAILURE N	ODES & EF	FECTS	: one or more	high volta	aa nawan nha	505		PLICABLE
1 C	o to zer	o volts: BT(copens, WTS sh	uts down. a	ge power pha	962_	OFER	
			r than 3-phase					<u>G</u>
			t: possible p					
			opens, ATS sh		ccessory pow	er		G
			r than 3-phase			4		
			massive_fault lown; accessory				r	-
		n 3-phase.	iown, accessory	power 15 d	13 CF IDUCEU a	<u> </u>		G
4	-	in o phase.						
						_		
F.	AILURE FRE	QUENCY			FAILURE S	EVERIT	ΓY	
	FAILURE		MEAN TIME		<u> </u>	·		1
FAILURE	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL	- CR	ITICAL III	CATASTROPHIC
MODE NO	FREU 76	X 10 TENTIOON	(TEARS)					· IV
1	50	.4	571			х		
2	25	.4	1143			<u>x</u>	<u>-</u>	
3	25	.4	1143			X		
4				L	<u> </u>	ļ		<u> </u>
FAILURE	DETECTION	METHODS				ı		
1-3 W	TS shuts	down						
2						·		
3		, ,	-1					,
4								
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	1				
			ction, see FME	A 7 2 1 2				
1-3			utilization e		otection (TR	A) se	e EMFA	7 2 2 1
						,,, ,,,	- I FILM	7.2.2.1.
								
	-							
		•	-					
-								
					<u> </u>			
			, , , , , , , , , , , , , , , , , , ,					
				. —	-			
				NAME G.	TRUSK/H. ROT	——— Н		DATE 8/17/78
OBERATIO	IC MODES							
OPERATIN			D ====================================	N TO STANDBY	C 0050	\TC	Re	evision: 10/16/78
A B	SHUTDOW TRANSITI	IN ON TO WARM UP	E STANDBY	N TO STANDBY		NOITIE	TO FEATH	ER
c	WARM UP		F TRANSITIO	N TO OPERATE	I FEATH	ŁR	Re	ev. 10/25/78

SUBSYSTEM COMPONENT ACCESSORY POWER FEEDER PAGE 130									
TOWER	- EPS		TO THE	TOWER JUNCT	ION BOX		FMEANO 7.2.2.1		
	OF COMPO		H FOR THE FLOW	OF NECESSA	RY POWER FRO	M THE	BUS TI	E	
l ———			ORY POWER JUNC						
							TOTAL TOTAL		
							1		
	odes& er pen circ	rects uit: accesso	ry power is di	stributed a	<u>t other than</u>			PPLICABLE RATING MODES	
3.	-phase.						F.	<u>G, H</u>	
2 SI	nort cir	cuit: fused	manual disconn	ect may fus	e and access	ory]		
po	ower dis	tributed at o	ther than 3-ph	ase			F,	G, H	
3 G1	rounded	conductor f	used manual di	sconnect fu	ses and				
a	ccessory	power distri	buted at other	than 3-phas	se		F,	G, H	
4									
<u> </u>									
F.	All LIRE ERE	QUENCY			FAIL URE S	EVERIT	L		
ļ	FAILURE FREQUENCY FAILURE SEVERI FAILURE FAILURE RATE MEAN TIME								
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL	CATASTROPHIC	
WIODE NO	THEU N		(12/10)	·	<u> </u>			IV	
- 1	50	.13	1800				X		
2	25 25	.13	3600 3600			_ 	X		
3 4	25	.13	3000				Χ		
					<u> </u>				
FAILURE	DETECTION	METHODS		····					
1-3 WTS	S shut d	own.							
2	<u></u>								
3				 					
<u> </u>									
4		CORDECTIVE ACTIV	ON (IT ARRI ICARI E)						
FAILURE	CAUSE AND	CORRECTIVE ACTION	ON (IF APPLICABLE)						
									
									
									
	If powe	r phase fault	ed is supplying	g the contro	ol system, W	TS wil	11 go 1	nto	
	emergen	cy shutdown;	one of the o	other two ph	nases, the W	rs wil	ll prob	ably	
	shut do	<u>wn.</u>							
	-			NAME G. T	TRUSK/H. ROTI	ł		DATE 8/17/78	
OPERATIN	G MODES						R	EV 10/16/78	
В	SHUTDOW! TRANSITIO WARM UP	N DN TO WARM UP	E STANDBY	I TO STANDBY I TO OPERATE	G OPERA H TRANS I FEATHE	TION T		v. 10/25/78 ER	
									

TOWER -	M EPS			MACELLE	RY POWER FEE	DER TO	PAGE FMEAN	131 0 7.2.2.2
FUNCTION PROVIDE	OF COMPO	NENT FOR THE FLOW	OF NACELLE ACC	ESSORY POW	ER FROM THE	JUNCTI	ON BOX	AT THE
BASE OF	THE TOV	ER TO THE CAR	BLE TRANSITION	MECHANISM	AT THE YAW B	EARING		
FAILURE N	nodes& EF	FECTS	-		·			PPLICABLE RATING MODES
<u> </u>								F,G,H
2 Sho	<u>rt Circ</u>	uit						² ,G,H
3 Gro	unded Co	onductor						,G,H
4		-						-
F	AILURE FRE	EQUENCY			FAILURE	SEVERIT	Υ	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL t	MARGINAL II		IŢICAL	CATASTROPHIC IV
1	50	.15	>1500				Х	
2	25	.15	>3000		ļ <u></u>			
3 -	25	.15	>3000				X	
FAILURE	DETECTION	METHODS	-			 -		†
1-3 WT	S shutde	own.		,	-			n e
2				÷.				
3					, _	;		
4	OALIOE AND	CORDECTIVE ACTI	ON (15 ABBLICABLE)					
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)					
San	ne as FM	EA 7.2.2.1						
		-						
				1	· .			
				-	·			
					. 1			
-	· · · · · · · · · · · · · · · · · · ·							
_	<u>-</u>				•			
				NAME G. T	RUSK/H. ROTI			DATE 8/17/78
	SHUTDÓW			TO STANDBY	G OPER	ATE	Rev.	10/16/78 10/25/78
В		ON TO WARM UP	E STANDBY	TO OPERÀTE	H TRAN	ISITION T	O FEATH	IER

SUBSYSTE TON	м IER – EP:	BLE TO	PAGE FMEAN	132 _o 7.2.2.3				
	OF COMPO							
PROVIC	E AN UNI	DERGROUND PAT	H FOR THE FLOW	OF ACCESSO	RY POWER FRO	M THE	BUS TI	E CIRCUIT
BREAKE	R UNIT	TO THE CONTRO	L SYSTEM'S TOWE	R CONTROL	UNIT LOCATED	INSI	E THE	BASE OF
THE TO	WER.							
FAILURE N	odes& er pen cir	rects cuit: loss o	f capability to	communica	te with nace	11e	OPE	PPLICABLE RATING MODES
	control	system.					Mai	ntenance
2 (Short cı	rcuit: Same	as #1				Mair	ntenance
3 (Grounded	Conductor.	Same as #1					
							Mair	ntenance
4					<u> </u>			
F,	AILURE FRE	EQUENCY			FAILURE S	SEVERIT	Υ	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL		TICAL	CATASTROPHIC IV
1	50	.13	1800	Χ				<u> </u>
2	25 25	.13	3600	X		<u> </u>		
3 4	25	.13	3600	X		ļ		
% 1-3 3 4		: Inability	to manually ope	erate the W	TS		-	-
В	SHUTDOW	N DN TO WARM UP	E STANDBY	NAME G.	TRUSK/H. RO	ATE SITION T	Re	DATE8/17/8 Rev 10/16/8 ev. 10/25/78

TOWER	=		COMPONEN					
	- EPS		THE L	IFT SYSTEM			FMEAN	07.2.2.4
	OF COMPO		FOR THE FLOW O	E ACCESSORY	, DUMED EDUM	TUE D	IIC TI	DDEAVED
			FOR THE FLOW O			THE D	03 11	DREAKER
ONT! IC) IHE FI	FI STSTEM LUC	ATED IN THE BAS	C OF THE TO	WER.	<u>'</u> ,		
EAN LIBEA	ODES & EF	EECTS .	···					00.104015
1 Ope	en Circu	it: Elevator	will not opera	te	· · · · ·	}		PPLICABLE RATING MODES
							Mai	nt <u>enance</u>
			r protective ci	rcuit break	er trips,			
		ill not opera					<u>Mai</u>	<u>ntenance</u>
			<u>evator protecti</u>	ve circuit	breaker tri	os,		
el	<u>evator w</u>	<u>ill not opera</u>	te				Ma 1	<u>ntenance</u>
4								
					-			
	AILURE FRE		,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	 _	FAILURE S	EVERIT	Y —	·
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL .	MARGINAL II		TICAL	CATASTROPHIC IV
1	50	. 15	- >1500 -	X				
2	25	15	>3000	X				
3	25	.15	>3000	X ,			_	
	DETECTION		not operate, ass	ociated ci	rcuit breake	r is t	rippe	d `
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d `
1-3 On	-site el	evator does n		ociated ci	,		rippe	d \
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rıppe	d `
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d \
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d `
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d \
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d \
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,		rippe	d \
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,			d .
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	,	ail		DATE 8/17/7
1-3 On	-site el	evator does n	ON (IF APPLICABLE)	ociated ci	; th safety r	ail	Rev	

SUBSYSTE TOWER	M - EPS	DER TO		134 o 7.2.2.5				
FUNCTION PROVICE	OF COMPO DE A PAT	NENT H FOR THE FLO	W OF ACCESSORY	POWER FROM	THE BUS TIE	BREA	KER UNI	T TO THE
ELECTE	RICAL FA	CILITIES LOCA	TED AT THE FOOT	T OF THE TO	VER			
								
FAILURE N	odes&er	ғестя <u>it: lights or</u>	utility outle	ts not func	tıonal			PLICABLE SATING MODES
							Main	<u>tenance</u>
2 Sho	ort Circ	uit protecti	ve circuit bre	aker trips	and lights o	<u>r</u>		
		tlets not fun			 		Main	tenance
<u> </u>			ctective circu	it breaker	trips and li	ghts		
or	utility	outlets not	functional				Main	<u>tenance</u>
4		· · · · · · · · · · · · · · · · · · ·				——		
F	AILURE FRE	EQUENCY		·	FAILURE S	EVERIT	Y	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL 11	CR	ITICAL III	CATASTROPHIC IV
1	50	.15	>1500	Х				
2	25	.15	>3000	Х				
3	25	.15	>3000	- X		 _		
4	L		<u></u>		<u> </u>	l		
FAILURE	DETECTION	METHODS						
	ne remot							
1-3 On	Site:	<u>Lights</u> out or	electrical ou	tlets not f	unctionin g			····
3								
4							<u> </u>	
FAILURE	CAUSE AND	CORRECTIVE ACT	ON (IF APPLICABLE)					
		· · · · · · · · · · · · · · · · · · ·			· · · · · · · · · · · · · · · · · · ·			
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<u> </u>			-11	[C T	DUCK /U DOTU		T.	24-50/11/70
0055	6 M6555			INAME G. I	RUSK/H. ROTH			DATE8/11/78
В	SHUTDOW	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	Rev. Rev. TO FEATHE	10/16/78 10/25/78 :R

SUBSYSTE TOWER -				PONENT ACCESSORY POWER CABLE TO PAGE 135 E POWER OUTPUT TRANSFORMER FMEANO 7 2 2 6					
	OF COMPO	MENT		ITE .FUW	EK OUTFUT	I KANSI OKIILK		FME A N	0 7.2.2.6
		ERGROUND PART	FOR THE	FI OW O	F ACCESSOR'	Y POWER FROM	THF F	BUS TIE	F BREAKER
TO THE	HIGH VO	LTAGE POWER O	UTPUT TRA	ANSFORM	ER				
 -	 · - 								
FAILURE M	ODES& EF	FECTS WTS shut	s down,	accesso	ry power d	ıstrıbuted a	t		PPLICABLE RATING MODES
		3-phase.							A11
		uit: Same as	#1. fus	ed manu	al switch	for accessor	·V		
-		be fused open					-		A11
		onductor: Sa			<u> </u>				
3 010	Junueu C	onductor: Su	, inc us #E					}	A11
									
4					·				
	AILURE FRE	EQUENCY	 			FAILURE:	SEVERIT		
<u>`</u>	FAILURE	Γ	MEAN T	TIME -	·	7,7,120,12	1	<u> </u>	
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN F	AILURE	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTROPHIC
1	50	.15	>150	<u></u>		-	 	-X -	
2	50 25	.15	>300		-	 	 	- Ŷ	
3	25	.15_	>300	0				X	
4			t~						
FAILURE	DETECTION	METHODS		-		-			•
1 WT:	S Shut D					-			-
2	· · · · · · · · · · · · · · · · · · ·	~				•	-		
3	· · · — · ·			<u></u>					
4	·								
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APP L	ICABLE)					
1-3 D1	fferenti	al.protection	will tr	ip the	BTC if WTS	in "Operate	" mod	е.	
			<u>-</u>						*
	-								
			<u> </u>		•				
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	-		-				-	-	
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						- ,		 	
					NAME G. T	RUSK/H. ROTH	<u> </u>	Day	DATE 8/17/78 10/16/78
OPERATING			~	A 410-T- 0	TOSTANGE	0 000	· *F	Rev Rev.	10/25/78
В	SHUTDOW TRANSITION WARM UP	N QU-MRAW QT NC	E ST	ANDBY	TO STANDBY TO OPERATE	G OPERA H TRAN: I FEATH	T NOITIE	O FEATH	ER_

SUBSYSTE TOWER -					IPTABLE POWER R JUNCTION E		7 0 0 7
FUNCTION PROVIDE	OF COMPO AN UND	NENT ERGROUND PATH	FOR THE FLOW C	F UNINTERRU	JPTABLE (DC)	POWER FROM	1 THE BUS TIE
BREAKER	TO THE	JUNCTION BOX	LOCATED INSIDE	THE BASE C	F THE TOWER.	·	
FAILURE M 1 Ope	odes&er n Circu	rects it: No power	to operate prot	ection devi	ces in BTCU.	ОР	APPLICABLE ERATING MODES
							F, G
2 Sho	ort Circ	uit: Same as	#1				F, G
₃ Cor	nductor	Grounded: Sa	me As #1				
		 -					F, G
4							•
F	AILURE FRI	EQUENCY			FAILURE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL	CRITICAL	CATASTROPHIC
1	50	. 15	>1500			*	
3	25 25	.15	>3000 >3000			*	_
4							
FAILURE	DETECTION	METHODS					
1	·						
1-3		WTS shutdown	•	1		-	-
3		· 			<u> </u>	· · · · · · · · · · · · · · · · · · ·	
4	041105 4110		ON (IF APPLICABLE)			·	
			design of cabl	e_run & car	eful fabrica	tion techn	inues seuni
			this failure i				
			insformer low o				
		protection.				·	·—
Utılit	y transi	former is prot	ected against	explosion a	nd fire. Fu	sed manual	disconnect
may fu	se open	under certair	fault condition	ons.			
		····					
					·		
					٠		
J ——		····	<u>. </u>	NAME G	TRUSK/H. ROT	 H	DATE8/17/78
OPERATIN	G MODES				TROOMY II. ROT	Rev.	10/16/78
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHE	TION TO FEXT	10/25/78 Held 27/78

SUBSYSTE TOW	м ER – EPS	,	CABLE TO	COMPONENT UNINTERRUPTABLE POWER CABLE TO THE TOWER CONTROL UNIT				PAGE 137 FMEA NO 7.2.2.8		
FUNCTION	OF COMPO	NENT								
			TH FOR THE FLOW DL SYSTEMS TOWER							
		- THE CONTRO	JE SYSTEMS TOWER	R CUNTRUL U	NII MOUNTED	TNOTO		DASE OF THE		
TOWER	ODES & FE	FECTS			-		Δ.	PPLICABLE		
<u>1 Op</u>	en circu	it. Loss of	stored data				OPE	RATING MODES		
Ch		cuit. Same as	- #1				Maint	enance		
2 311	ort circ	Juit Same as	> π ι							
	nductor	Grounded Sa	ame as #1		· · · · · · · · · · · · · · · · · · ·		Maint	enance		
3 CO	nauc tor	di odilaca se	2.110 43 #1							
							Maint	enance		
4		-						-		
F.	AILURE FRE	QUENCY			FAILURE S	ĖVERIT	 Y			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	,MARGINAL	CRI	TICAL	CATASTROPHIC IV		
1	50	.13	- 1800	Χ -	- 1-			-		
3	25 25	.13	3600 3600	X	 	,		-		
4	25	. 13	3000	<u>, </u>				 		
FAILURE	DETECTION	METHODS								
1 2	Remotel									
½ 1-3 <u>*</u>	Kellio ce i									
<u> </u>	-				-					
4		-						•		
			ON (IF APPLICABLE)							
			s lost, mainten							
			identification		Shooting pro		es are			
to	isolate	and identity	source of malf	unctions.						
										
 										
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ļ ——										
										
				NAME G.	TRUSK/H. RO	TH		DATE 8/17/78		
OPERATIN	G MODES				•			Rev 10/1///8 v. 10/25/78		
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATHI	ITION T	_			

	SUBSYSTEM COMPONENT UNINTERRUPTABLE POWER TOWER - EPS FEEDER TO THE NACELLE								.9
FUNCTION	OF COMPO	NENT FOR THE FLOW	OF NACELLE UNI	NTERRUPTABL	E (DC) POWER	FROM	THE J		вох
			THE TOWER TO TH						
FAILURE M	odes&er	FECTS						PPLICABLE	DES
								A11	
2 Sho	rt Circ	uit: Same as	#1					A11	
3 Con	ductor (Grounded						A11	
4								····	
F	AILURE FRE	EQUENCY			FAILURE S	EVERIT	Y *	<u> </u>	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II		TICAL	CATASTRO	OPHIC
1	50 25	.15	>1500 >3000	*			X		
3	25	.15	>3000			<u> </u>	X		
4			-				.^		
1-3 W7	S shutd	own.							
4									
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)						
	ne as FM	EA's 6.6.2.3	& 6.6.2.10						
									
									_
	<u> </u>			NAME G. T	RUSK/H. ROTH	- -		DATE 8/1	17/78
В	SHUTDOW	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	Rev.	10/16/78 10/25/78 ER	

SUBSYSTE		~	COMPONEN	THE NACELLE	IL CADEL	PAGE	139
i	OWER EP	<u> </u>	10 1	THE NACELLE		FMEA	NO7.2.3.1
PROVID	OF COMPOSE A PATI	NENT H FOR THE FLO	W OF CONTROL SY	STEM COMMAN	NDS AND DATA	FROM THE	TOWER CONTROL
UNIT I	NSIDE T	HE BASE OF TH	E TOWER TO THE	CABLE TRANS	SITION MECHAN	HT TA MZIV	E YAW BEARING
FAILURE N	odes&er ire is	FECTS open circuit				OF	APPLICABLE PERATING MODES
							All
2 k	<u>lires sh</u>	ort circuited					A11
3 V	lire sho	rted to groun	d				
							A11
4				· · · · · · · · · · · · · · · · · · ·			
F	AILURE FRE	QUENCY			FAILURE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL III	CATASTROPHIC
1	50	15	>1500			Х	
2	25	.15	>3000			Х	
3	25	.15	>3000		ļ	Х	
4	L	l	<u> </u>	<u></u>	<u> </u>	<u> </u>	
FAILURE	DETECTION	METHODS		···			
1 -3 WT	S shutde	own.					· ·
2						 	
4							
	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)				
FAILURE	CAUSE AND	CORNECTIVE ACTI	ON (IF AFFEICABLE)				
Saı	me as FM	1EA 6.6.3.5		-			
				····			
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	 .					<u>.</u>	
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			,	NAMEG. TR	USK/H. ROTH		DATE 8/17/78
OPERATIN			D	N TO STANSON	C 0055	**	Rev. 10/16/78 Rev. 10/25/78
В	TRANSITION WARM UP	ON TO WARM UP	D TRANSITION E STANOBY F TRANSITION		G OPERA H TRANS I FEATH	SITION TO FEA	THER

	UBSYSTEM COMPONENT PAGE 140									
TOW	TOWER - EPS CONTROL CABLE TO THE BTB UNIT 7.2.3.2									
	OF COMPO									
PROVID	<u>E AN UND</u>	ERGROUND PATH	FOR THE FLOW	OF CONTROL	SYSTEM COMMA	NDS A	ND DATA	A FROM THE		
TOWER	CONTROL	UNIT LOCATED	INSIDE THE BAS	E OF THE TO	WER TO THE B	US TI	E BREA	KER UNIT.		
		_								
FAILURE N	MODES&EF	гестs uıt: BTB doe	s not trip on	WTS shutdow	vn command, s	ynch-		PPLICABLE RATING MODES		
r	onizer d	annot be enab	oled, utility b	us tie or p	oower status	is no	t i			
	vaılable		_			,				
<u> </u>	hort cir	cuit: same a	is #T					F.G.		
	3 Grounded conductor: Same as #1									
3 Grounded conductor: Same as #1										
ļ	r.u.									
4										
					·=··					
F.	AILURE FRE	EQUENCY	j		FAILURE S	EVERIT	Υ			
FAILURE MODE MODE FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL (YEARS)								CATASTROPHIC IV		
1	50	.6	400	Х		<u> </u>				
2	25	.6	800	Х						
3	25	.6	800	<u> </u>						
4	<u> </u>				<del></del>					
FAILURE	FAILURE DETECTION METHODS									
1-3 No	ne remot	telv					······································			
<del></del>	On-site		stored data	···						
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X		<del> </del>		<del></del>			<del></del>			
L	041165 4415	CORDECTIVE ACTI	ON (IF APPLICABLE)							
			the EPS will tr	in the BTC	as a result	of re	verse	power		
		shut down.	<u> </u>	<u></u>				<del>'</del>		
<del></del>	M12 12	Shut down.		· · · · · · · · · · · · · · · · · · ·						
<u> </u>				•••••						
A1	so see	FMEA 7.7.41 t	hrough 7.7.44							
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l										
				NAME G.	TRUSK/H. RO	TH	To	DATE 8/17/78		
OPERATING	G MODES							ev 10/17/78		
A B	SHUTDOW	N DN TO WARM UP	E STANDBY	TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO	Re	v. 10/25/78		

SUBSYSTE				COMPONEN			PAGE	141
TOW	ER - EPS	5		CABLE	TRANSITION	I MECHANISM	FMEA	NO 7.3.
FUNCTION	OF COMPO	NE NT					· · · · · · · · · · · · · · · · · · ·	
		MEANS OF TRANS	FFRRIN	G POWER	IAND SIGNAL	ELECTRICAL C	ווותק FD	ΩM
					-		-	
THE	NACELLI	E TO TOWER ARC	JUND THI	F AAM RE	ARING THUS	ALLOWING THE	NACELLE T	0
ROT	ATE IN F	RELATION TO TH	IE TOWE	R.				
FAILURE N	ODES & EF	FECTS						APPLICABLE
<u> 1 Ope</u>	n circui	ts or high in	pedance	e			OPI	RATING MODES
								. ALL
								•
2 Con	<u>auctive</u>	path between	brushe	S			<del></del> )	
			1					·
3 Con	ductavo	path to case					,	
3. COII	uuc Live	hurir co caze					<del></del>	
4		-						
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			,	<del></del>		FAILURE SE	VEDITY -	<b>&gt;</b>
- F.	AILURE FRI	EQUENCY				FAILURE SE	VEHITY	<u> </u>
FAILURE	FAILURE MODE	FAILURE RATE		N TIME N FAILURE	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
MODE NO	FREQ %	× 10 ⁻⁶ PER HOUR		ARS)	ı	11	III	IV
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1	98	37.6	3.1			<del>                                     </del>		<del></del>
2	1	37.6	303	<u> </u>		·		<del></del>
3	<u> </u>	37.6	303	$\square$				<del></del>
4				1		]]		
FALLURE	DETECTION	METHODS 🍃				•		
ALLONE		VIVIE 111003						
1							_	
2								
							<del></del>	
3								
4		•						
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APE	LICABLE)	_ `			
$\triangleright$		or all signal		1		-		
	iotai i	Ai aii ziānai						
$\triangleright$	•	See FMEA's 6.6	. 1 1	5612	6621 th	rough 6 6 2 1	O for fai	luro
	4				_	· vugii v · v · c · i · i	<del>0 101 101</del>	1 U1 C
		severity and i	fault d	etection	methods.			<del></del>
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		<del></del>						•
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			•		NAME G. T	RUSK/H. ROTH		DATE 8/17/78
OPERATIN	G MODES	<del></del>						Rev 10/16/7
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	SHUTDOW	IN ON TO WARM UP	E	STANDBY	N TO STANDBY		IE ITION TO FEAT	
	WARM UP				N TO OPERATE	I FEATHE	R	(

SUBSYSTE			COMPONEN				PAGE 1	142
TOWER	- EPS		ELECTRI	CAL PATH AC	ROSS YAW BEA	RING	FME A NO	7.4.1
	OF COMPO							
PROVI	DE A PAT	H FOR THE FLO	W OF LIGHTNING	CURRENT TH	ROUGH THE YA	W BEAR	ING.	
								-
EAU LIRE M	ODES & EF	FECTS					AP	PLICABLE
1 H	igh resi	stance.				}		ATING MODES
						1		<u> A11</u>
2						- 1		
3								
4						1		
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	AILURE FRE	OUENCY			FAIL URE S	EVERITY	,	<del></del>
F.		T	MEAN TIME		1.31201123			
FAILURE	FAILURE MODE	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL		ICAL	CATASTROPHIC
MODE NO	FREQ %	× 10 - PEH HOUR	(YEARS)		11	_ '	11	IV
1	100	1.1	100	X				
2								
3		<u></u>						
4		<u>L</u>			<u> </u>			
FAILURE	DETECTION	METHODS						
Inc	pection							
	pección				<del></del>			·
2								
3					·····			- <del></del>
4								
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)					
Yaw	bearing	ıs massive a	nd offers a ve	ry low resi	stance path	to hig	h curr	ents
res	ultina d	— Iuring lightni	na strokes.					•
			<u>g</u>		<del></del>			
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				NAME G.	TRUSK/H. ROTH	<u> </u>	<u> </u>	DATE 8/17/78
OPERATIN	G MODES						R	EV 10/17/78
A	SHUTDOW	N ON TO WARM-UP	D TRANSITION E STANDBY	N TO STANDBY	G OPERA	TE ITION TO	) FEATHE	B
	WARM UP	OIT TO TEATINGOE	F TRANSITION	N TO OPERATE	I FEATHE			
I								

MODE NO FREQ % 10° PER HOUR (YEARS) I II III III IV  1 100 1.1 100	SUBSYSTE	м - EPS		GENER	ATOR LIGHTI	NG ARRESTORS	: 1	GE 143 MEA NO	7.4.2			
GENERATOR WINDINGS TO THE STRUCTURAL GROUND PATH OF THE SYSTEM. (THESE ARRESTORS ARE  IN THE GENERATOR TERMINAL BOX).  FAILURE MODES & EFFECTS:  1	FUNCTION	OF COMPO	NENT IMPEDANCE PAI	TH FOR THE FLOW	OF LIGHTNI	NG INDUCED C	URRENT F	ROM TH	IE			
IN THE GENERATOR TERMINAL BOX).  FAILURE MODES & EFFECTS 1 OPEN CITCUIT: No protection against lightning surge currents.  APPLICABLE OPERATING MODES All   APPLICABLE OPERATING MODES All   FAILURE FREQUENCY  FAILURE MODE MODES & FAILURE RATE BETWEEN FAILURE WINNIMAL RANGINAL RITURL RATE WEEN FAILURE RETWEEN FAILURE WINNIMAL RANGINAL RITURL RATE WEEN FAILURE RETWEEN FAILURE WINNIMAL RANGINAL RITURL RATE WEEN FAILURE WINNIMAL RANGINAL RITURL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RANGINAL RATE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WINNIMAL RATE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILURE WEEN FAILUR												
1 Open circuit: No protection against lightning surge currents.  All  FAILURE FREQUENCY  FAILURE FREQUENCY  FAILURE FREQUENCY  FAILURE FAILURE FAILURE RATE MEAN TIME BETWEEN FAILURE (YEARS)  1 100 1.1 100				<del></del>		-						
FAILURE FREQUENCY  FAILURE FREQUENCY  FAILURE FAILURE RATE MODE MODE MODE FRED W 10 ⁴⁵ PER HOUR 11100  1 100 1.1 100  2 3 4	FAILURE N	odes&er Open cir	FECTS Cuit: No pro	tection agains	t lightning	surge curre	nts.					
# FAILURE FREQUENCY  FAILURE FAILURE FAILURE FAILURE RATE MODE NO FORCE % 10-6 PER HOUR FAILURE WEEN FAILURE (YEARS)  1 100 1.1 100								Α	.11			
FAILURE FREQUENCY  FAILURE MODE NO FREG % TO FER HOUR PATE WODE NO FREG % TO FER HOUR PER HOUR HEAT WARRY IN THE BETWEEN FAILURE MINIMAL HARGINAL CRITICAL CATASTROPH IN THE WODE NO FREG % TO FER HOUR HEAT WARRY IN THE WODE NO FREG % TO FER HOUR CYCARS)  1 100 1.1 100	2	<del>_</del>			_			•				
FAILURE MODE NO REACH TIME FAILURE RATE MODE NO TEAMS TIME BETWEEN FAILURE MINIMAL MARGINAL CRITICAL CATASTROPH (YEARS)  1 100 1.1 100 X  2 3 4	3	···										
FAILURE MODE NO REACH TIME FAILURE RATE MODE NO TEAMS TIME BETWEEN FAILURE MINIMAL MARGINAL CRITICAL CATASTROPH (YEARS)  1 100 1.1 100 X  2 3 4	4	4										
FAILURE MODE NO FREQ % 10-6 PER HOUR NOTE (YEARS)   MINIMAL NARGINAL CHITICAL CATASTROPH (YEARS)   1 100 1.1 100   X   X   X   X   X   X   X   X   X	F	FAILURE FREQUENCY FAILURE SEVERITY										
TABLE DETECTION METHODS  1 WTS shutdown  2  3  4  FAILURE CAUSE AND CORRECTIVE ACTION (IF APPLICABLE)  If lightning surge currents reach the generator winding, because the arrestor is open circuit, insulation damage can occur leading to an internal fault. Backup protection is provided by differential protection and ground current protection.  Careful attention to lightning arrestor installation should be sufficient to preclude this failure mode.  NAME G. TRUSK/H. ROTH DATE 8/17/7  OPERATING MODES Rev 10/17/		MODE		BETWEEN FAILURE		l e		AL CA	ATASTROPHIC IV			
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protection is provided by differential protection and ground current protection.  Careful attention to lightning arrestor installation should be sufficient to preclude this failure mode.  NAME G. TRUSK/H. ROTH  DATE 8/17/7  OPERATING MODES  A SHUTDOWN  D TRANSITION TO STANDBY  G OPERATE												
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preclude this failure mode.    NAME G. TRUSK/H. ROTH   DATE 8/17/7	\				<del></del>							
OPERATING MODES Rev 10/17/  A SHUTDOWN D TRANSITION TO STANDBY G OPERATE					· · · · · · · · · · · · · · · · · · ·				-			
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OPERATING MODES Rev 10/17/  A SHUTDOWN D TRANSITION TO STANDBY G OPERATE												
OPERATING MODES Rev 10/17/  A SHUTDOWN D TRANSITION TO STANDBY G OPERATE												
A - SHUTDOWN , D TRANSITION TO STANDBY - G OPERATE				<del></del>	NAME G.	TRUSK/H. RO	ГН					
B TRANSITION TO WARM-UP E STANDBY H TRANSITION TO FEATHER C WARM UP F TRANSITION TO OPERATE I FEATHER	A B	SHUTDOW		E STANDBY		H TRANS	ITION TO F	_	10/1//8			

	SUBSYSTEM COMPONENT PAGE 144										
TOWER	TOWER - EPS TRANSFORMER LIGHTNING ARRESTORS FMEANO 7.4.3										
	OF COMPO										
PROTECT	THE TR	ANSFORMER WIN	DINGS BY PROVI	DING A LOW	IMPEDANCE PA	TH TO	EARTH	GROUND			
FOR LIC	HTNING	INDUCED CURRE	NT. (THESE AF	RESTORS ARE	LOCATED IN	THE T	RANSFOR	MER			
TERMINA	AL BOX).										
FAILURE N	odes& er pen cir	FECTS Cuit. No pro	tection agains	t lightning	surge curre	nts.		PLICABLE RATING MODES			
							L	All			
2											
3											
								<u>-</u>			
4						<del></del> -					
F.	AILURE FRE	EQUENCY			FAIL URE S	EVERIT	<u> </u>	-			
FAILURE MODE NO								CATASTROPHIC IV			
1	100	1.1	100				Χ				
2					ļ	<u> </u>					
3		<del> </del>		ļ	<del>                                     </del>			-			
	L	L		<u> </u>	<del></del>	<u> </u>					
FAILURE	DETECTION	METHODS		·····-							
1 W	TS Shut	down									
2				-							
3							-				
4											
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)								
If lig	ntnıng s	urge currents	reach the tra	nsformer wi	ndings, beca	use t	he arre	stor 1s			
open c	ircuit,	insulation da	mage or flasho	over can occ	ur leading t	o an	interna	l fault.			
Backup	protect	ion is provid	led by differer	ntial protec	tion.						
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				······	<del></del>						
			^		<del></del>						
			<del>-</del>								
			<del></del> -								
				NAME G.	TRUSK/H. ROT	Ή		DATE 8/17/8			
OPERATIN	G MODES						, .a.	Rev. 10/17/8 ev. 10/25/78			
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E STANDBY	ON TO STANDBY	G OPERA H TRANS I FEATHI	ITION T					

I	SUBSYSTEM COMPONENT PAGE 145 TOWER - EPS EARTH GRID FMEANO 7.4.4									
FUNCTION PROVI	OF COMPO	NENT ISFACTORY ELE	CTRICAL CONNEC	TION WITH T	HE EARTH TO	PROVIDE A C	URRENT .			
PATH	FOR LIGH	ITNING AND ELE	CTRICAL FAULT	CURRENTS.						
FAILURE N	odes&er pen circ	_{recтs} uit possible:	erratic rela	y operation	, possible		PPLICABLE '			
h	igh pote	ntıal between	structures and	d earth.			A11			
<u>2 H</u>	igh resi	stance circui	t: same as #1	•						
							A11			
3										
-	4									
F	AILURE FRE	EQUENCY			FAILURE S	EVERITY	- ,			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II	CRITICAL III	CATASTROPHIC IV			
1	25	1.1	400			- х				
3	75	1.1	133	<del></del>		X				
4										
FAILURE	FAILURE DETECTION METHODS									
1 -2	None rem	notely.				-				
	On-site:	erratic rel	ay operation.	<u> </u>			··· - ····			
3		·			<del></del>	<del></del> -				
	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	<del></del>	<del> </del>	- I	<del></del>			
			, lethal potent	ial dıffere	nces can occ	ur between	equipment			
			connection is e							
			otective relay		•					
		···	k hazards to p							
			e taken to ass nce is at safe	<del></del>	ounds are pr	operly inst	arred and			
	ear cii/ gi	Ound Testscar	ice is at saire	TEVETS.						
			ı		****					
	If site	e is occupied.	- O&M Manual wi	ill prohibit	t maintenance	during sto	rms.			
$\triangleright$			pections. Wit							
	100,000	) years betwee	en failure.			-				
	<del></del>			NAME G. T	RUSK/H. ROTH		DATE 8/17/78 REV 10/17/78			
В	SHUTDOW TRANSITIO	'N ON TO WARM UP	E STANDBY	N TO STANDBY		R TE SITION TO FEATH	ev. 10/25/78			
l c	WARM UP		F TRANSITION	TO OPERATE	I FEATH	ьн				

SUBSYSTE	м - EPS		COMPONEN	TION TO EAR	TH CDIN	PAGE	7 1 5
	OF COMPO	NENT '	CONNEC	ITON TO EAR	ווו שגוט	FME A	NO /.4.5
			W OF LIGHTNING	INDUCED CU	RRENTS AND	ELECTRICAL	FAULT
CURRE	NTS IN T	HE WTS STRUCT	URE TO THE EAR	TH GRID TO	ALLOW THEIR	SAFE DISSI	PATION.
· · · · · <u>-</u> ·							
FAILURE N	nodes& er ne as FM	FECTS EA 7.4.4		<del></del>		OF	APPLICABLE PERATING MODES
							A11
2							
<del></del> .	- <del></del>			· <del></del>			
3							
				·			
4							
F	AILURE FRI	EQUENCY			FAILURE	SEVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
1	100	1 1	100			<del> </del>	_
3							
4							<del> </del>
FAILURE	DETECTION	METHODS				<del></del>	-·-
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FAILURE	CAUSE AND	CORRECTIVE ACTIONS FMEA 7.4.4.	ON (IF APPLICABLE)				
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						<del></del>	<del></del>
				NAME G.	TRUSK/H. R	ОТН	DATE8/17/78
	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY		G OPER H TRAN	r	REV 10/17/78 Rev. 10/25/78
С	WARM UP		F TRANSITION	TO OPERATE	I FEATH		

SUBSYSTE	M IER – EP:	c	COMPONEN	ENCLOSURE			PAGE	147		
			. 1 5150	LINCLOSURE			FME A N	o 7.6.1.1		
	OF COMPO		JOUETNE A MOUN	ITTNC DACE A	ND A MEANS C	ال دمين	./	_		
			HOUSING, A MOUN							
ACC	ESS TO	ALL THE EQUIPM	MENT AND WIRING	PACKAGED W	ITHIN THE BU	IS TIE	BREAK	ER UNIT.		
FAILURE M	odes & EF	FECTS leaks water o	r sand/dust int	o enclosure	·•			PPLICABLE - RATING MODES		
<u></u>		· ·	-					ALL		
			-					7,12.5		
2		<del></del>			<del></del>	<del></del>		-		
				<del></del>						
3					· · · · · · · · · · · · · · · · · · ·					
4										
FAILURE FREQUENCY - FAILURE SEVERITY										
	FAILURE	FAILURE RATE	MEAN TIME BETWEEN FAILURE	MINIMAL	MARGINAL	00.				
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	(YEARS)	I	II		TICAL	CATASTROPHIC IV		
1	ļ	Negligible		X	-					
<u></u>		Meditainie		,						
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FAILURE	DETECTION	METHODS	-			-				
1 Ins	nootion		-		-					
	pection			_						
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			on(IF APPLICABLE) arts to minimiz				4 a . b			
<del></del>					-		LS Dy	<del> </del>		
			d drip proofing					~		
wea	ther-pr	oofing or enc	losure and drai	inage will p	<u>reclude elec</u>	trica	<u>l</u>			
fai	lures d	ue to water a	nd particulate	damage.				<u> </u>		
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				NAME G.	TRUSK/H. ROT	Н		DATE 8/17/78		
OPERATIN	G MODES		<del></del>					Rev 10/17/78		
	SHUTDOW		D TRANSITION	N TO STĄNDBY	G OPERA					
	TRANSITI	ON TO WARM UP	E STANDBY F TRANSITIO	N TO OPERATE	H TRANS I FEATHI		U FEATH	ĿН		

SUBSYSTE	М		COMPONE	NT			PAGE	148	
TOWER	-EPS		BUS T	IE CONTACTOR	(BTC)		FME A N	0 7.6.1.2	
	OF COMPO		ED, HIGH VOLTA	GE, HIGH CUR	RENT, ELECTR	RICAL	SWITCH	TO PERMIT	
THE F	REQUENT	CONNECTING AN	ND DISCONNECTI	NG OF THE WT	S ELECTRICAL	- POWE	R OUTP	UT TO THE	
	_	SMISSION LINE.						<u> </u>	
FAILURE 1	AODES & EF	FECTS OPEN: WTS CA	NNOT BE CONNE	CTED TO THE	UTILITY			PPLICABLE RATING MODES	
TRANS	MISSION	LINE.	····	<del></del>	<del></del>			<u>F.</u> G,H	
2 BT	C FAILS	CLOSED: GCB	WILL OPEN, WT	S SHUTS DOWN	•			,	
								F,G,H	
			POSSIBLE PH		FAULT: GCB				
OPENS	. BTC OF	PENS (IF POSSI	BLE), WTS SHU	TS_DOWN.				F,G,H	
			TO GROUND: M						
	CONDUCTOR: GCB OPENS, BTC OPENS ( IF POSSIBLE), WTS SHUTS DOWN. F,G,H  FAILURE FREQUENCY FAILURE SEVERITY								
<u> </u>	FAILURE	T	MEAN TIME		TAILONE			T -	
FAILURE MODE NO	MODE	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL III	CATASTROPHIC IV	
1	20	2.28	100 -	<del> </del>		,	X	<del> </del>	
2	30	2.28	167			<del></del>	X		
3 4	30 20	2.28	167 100				<u>Κ</u> 	<del> </del>	
	DETECTION		100	<u> </u>	<u> </u>		^		
1 GFN	EDATOD E	ONLED INDICATI	ON INDICATES 2	ZEDO DOWED 1	DTC INDICATE	C ODE			
			DISCONNECT SIGN	-			Y		
			ATION INDICATE				TCATE	ODEN	
4					<del>'9 010 MIN U</del>	<del>00 1116</del>	<del>/IU//IE</del>	-VPEN.	
1			ON (IF APPLICABLE)						
			TC IS COMMERCE		BLE AND IN E	XIENSI	VE USI	= BA THE	
			SE VERY DEPENDA		NOT ODENED		77 011		
2 P	KUTECTIV	E CIRCUITS IN	IP THE GCB IF	THE RIC HAS	NOT OPENED	AFTER	IT SHI	JULD.	
<u> </u>						•			
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			<del></del>		<del>-</del> .				
<del></del>	<u> </u>								
		<del></del>							
					<del></del>				
				NAME G. TE	RUSK/H. ROTH			DATE 8/17/78	
OPERATIN	G MODES			<u> </u>	ZOSIVIII KUIT	<del></del>	Re	ev. 9/8/78	
В	SHUTDOW TRANSITIO WARM UP	N ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION TO		v. 10/,25 <u>/,7</u> 8	
			<del></del>						

SUBSYSTEM COMPONENT								PAGE	149
TOWER - EPS SYNCHRONIZER								FME A N	o 7.6.1.3.1
FUNCTION	OF COMPO	NENT		- 54465 55		-DC OF TH	5 A5W		OUTDUT AND
		N VOLTAGE AMP	<del></del>						
THE U	TILITY ]	RANSMISSION L	INE ARE WI	THIN ACCEPT	ABLE, P	RESET LIM	ITS A	ND PRO	VIDE A -
SIGNA	L TO-CLO	SE THE BUS TI	E CONTACTO	IR.					
FAILURE M	ODES& EF	FECTS )PERATE: WTS	IS NOT CON	NECTED TO I	ITII ITY	TRANSMISS	TON		PPLICABLE RATING MODES
<u> </u>		MILIMINE HIS	-1-1-11(11-11(11)	<u>.,,,</u>		1110110110	-		F,G,H
		TO SYNC TOO EA	ARIY. MECH	IANTCAL DAM	GE POSS	TRIF.	-	<del></del>	, , , , , , , , , , , , , , , , , , , ,
2 01	LIVITES	10 31110 100 Li	1,200						F,G,H
	EDATEC 3	TO CYNC TOO L	ATE. MECUA	NITCAL DAMA	er nocci	DIE			1 9 0 9 11
<u>3 OP</u>	ERATES	TO SYNC TOO LA	ALE: MECHA	INICAL DAMA	E PUSSI	BLE.			-
		<del>-</del>						<b></b> -	F,G,H
4					<del></del>			1	
		<u> </u>	, — — —					L	
F/	AILURE FRE	QUENCY		_	<del></del>	FAIL URE S	EVERIT	γ ————	·
FAILURE MODE FAILURE RATE BETWEEN FAILURE MINIMAL MARGINAL (YEARS)								ITICAL III	CATASTROPHIC IV
1-3	100	. D	-				Х		
2									
3 4	· <del>- · · · ·</del>			-					
FAILURE DETECTION METHODS									
1 GENE	RATOR P	OWER INDICATO	R INDICATES	S ZERO POWE	R, BTC I	NDICATES	OPEN.		
2 &3 IN	EXTREM	E OUT-OF-SYNC	BTC CLOSUF	RE, MECHANI	CAL DAMA	GE MAY O	CCUR 1	O THE	GENERATOR OR
	RIVE TR				<del>.</del>				
4				r					
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICA	BLE)					·
_ <b></b> _s	vnchron	izer is redun	dant, failu	re of one	circuit	results i	in_dis	abling	
l s	vnchron	ızer. Resulta	ant failure	e rate is n	egligabl	e.		,	
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					<del></del> .		<del></del>		<del></del>
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l					·	<del> </del>			
*_F	AILURE	SEVERITY MAY	BE CATASTRO	OPHIC IF	MECHANI	CAL FAIL	JRE RE	SULTS.	·
				NAME	G TRUS	SK/H. ROTI	4		DATE 8/17/78
OPERATIN	G MODES				- MA I RUA	311/11	<u> </u>	F	Rev. 9/8/78
В	SHUTDOW TRANSITIE WARM UP	N ON TO WARM UP	E STAN	SITION TO STAN DBY SITION TO OPER		G OPERA H TRANS	SITION		v. 10/25/78

	SUBSYSTEM COMPONENT PAGE 150									
TOW	ER - EPS		DIFFE	RENTIAL PRO	TECTION RELA	ΙΥ	FMEAN	o 7.6.1.3.2		
	OF COMPO									
MONITOR	S THE DI	FFERENTIAL CL	JRRENT FLOW IN	THE WTS POW	<u>ER OUTPUT CI</u>	RCUIT	ZONE	FROM THE		
CABLE T	RANSITIC	N MECHANISM 1	TO THE FUSED MA	NUAL DISCON	NECT SWITCH	AND P	ROVIDE	S A SIGNAL		
TO OPEN	THE BUS	TIE CONTACTO	OR WHEN THE DIF	FERENTIAL C	URRENT EXCER	DS A	PRESET	I IMIT THUS		
TWOUGHT	PARE 2-8NE 4	ALGERICAL FAL	JLT WITHIN THE	PROTECTED Z	ONE.	00 /1		PPLICABLE		
<u> 1 Ope</u>	n_circui	t in sensing	wires: BTC tr	ips or cann	ot-be-closed	L	OPEF	RATING MODES		
								G '		
₂ Tri	p settin	g is too low:	BTC will tri	p too often	on unbalanc	ed				
	ds or tr	ansients.						G		
			fault cumments	may contin	uo to flow					
3 Trip setting too high: fault currents may continue to flow.										
	G									
4										
F	AILURE FRE	QUENCY			FAIL URE S	EVERIT	Υ			
	FAILURE	FAILURE RATE	MEAN TIME							
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV		
			12.7		<del> </del>		<u> </u>			
1 2	50 25	21	11.1	- · · · · · · · · · · · · · · · · · · ·			<u>Х</u> Х			
3	25	21	22.2		<del> </del>		X	<del> </del>		
4							<del>.</del>			
SALVADE DETECTION METUODS										
FAILURE	FAILURE DETECTION METHODS									
1 WTS	shut do	wn								
2 WTS	shut do	wn								
3 WTS	shut do	own								
4	<u> </u>									
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)		<del></del>	·				
1.			non senses dif	ferential c	urrent in on	en nh	- 42s	Trouble-		
			will reveal so		•					
	SHOOLII	y procedures	will reveal so	urce of tro	ubie, repair	as II	ecessai	ту		
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differential protection relay as necessary.										
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				NAME G.	TRUSK/H. RO	TH	1	DATE 8/17/78		
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SUBSYSTE	М		COMPONEN			PAGE	151		
TOWER			GENER	ATOR VOLTME	TOR VOLTMETER FMEANO 7.				
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SUBSYSTE	М		COMPONEN				PAGE	154			
TOWER			LINE	AMMETER			FMEAN	o 7 6.1.4.4			
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SUBSYSTE TOW		PAGE 155 FMEANO 7.6.1.4.5					
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AILURE M	opes & EF ter does	FECTS not indicate	e: No direct r	eading of p	oower deliver	ed	APPLICABLE OPERATING MODES
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	ter indi ading	cates high or	low: incorrec	<u>t' generator</u>	output powe	er	G ,
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				NAME G	TRUSK / H.	ROTH	DATE 8/17/8
OPERATIN	G MODES					-	Rev. 10/18/8
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	E \$TANDBY	N TO STANDBY	G OPERA H TRAN: I FEATH	SITION TO	Rev. 10/25/78

SUBSYSTE TOW	м ER - EPS	5	COMPON	ENERATOR POW	ER FACTOR M	ETER	PAGE FMEAN	156 10 7.6.1.4.6
FUNCTION	OF COMPO	NENT ONTINUOUS DISE	PLAY OF THE PO	OWER FACTOR	OF CURRENT	BEING [	<del></del>	
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I —		not indicate		reading of p	ower factor			PPLICABLE RATING MODES G
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F.	AILURE FRE	EQUENCY			FAILURE	SEVERIT	ry	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILUR (YEARS)	E MINIMAL	MARGINAL 11	CR	ITICAL III	CATASTROPHIC IV
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		<u> </u>		NAME G	. TRUSK/H. F	ROTH		DATE 8/17/8
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SUBSYSTE TOWE	M R - EPS		C	OMPONEN GENER	t ATOR KILO	WATT- HOU	R METER	PAGE ]	76747
FUNCTION	OF COMPO	NE NT	CUAL DIG	CDLAV OF		UMUL ATED	VII OLIAT		
	THE GENE	CONTINUOUS VI	SUAL DIS	SPLAT U	T THE ACC	UNULATED	KILUWAI	1-HOUKS D	
B1	THE GENE	.RATUK							
FAILURE M	ODES & EF	FECTS es not operate	. meter	r readii	nas are 1	ncorrect.	(		PPLICABLE RATING MODES
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2 M	eter inc	licates high c	or low:	meter	readings	are incor	rect.		G
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F.	AILURE FRE	QUENCY				FA	ILURE SEVI	ERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	F'AILURE RATE × 10 ⁻⁶ PER HOUR	MEAN BETWEEN (YEA	FAILURE	MINIMAL	MARG		CRITICAL	CATASTROPHIC
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					NAME H	. ROTH/G.	TRUSK		DATE 8/17/8
OPERATIN	G MODES								. 10/18/8
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SUBSYSTE TOWER	м - EPS			COMPONEN		- HO	UR METER		PAGE	58 o 7 6.1.4.8
FUNCTION	OF COMPO									
		ONTINUOUS VIS	JAL DISP	LAY OF	THE ACC	JMUL	ATED KILOWA	\TT -	HOURS D	ELIVERED BY
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<u>2</u> M	leter in	dicates high	or low:	incorr	ect pow	er u	sed/delive	red		
	lisplaye	d on meter						<del></del>	ļ	A11
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		CUENCY		<del></del>			FAILURE	CEVED!	<u></u>	
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FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN I	FAILURE	MINIMA	ıL.	MARGINAL II	CR	IITICAL III	CATASTROPHIC
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8	SHUTDOW	N DN TO WARM UP	E ST	ANDBY	TO STAND		G OPER H TRAN I FEATH	SITION	Rev	. 10/18/8 10/25/78

SUBSYSTE	M TOWER -	EPS.	COMPONE	NT IAL TRANSFO	ORMER PAGE 159			159 10 7.6.1.4.9		
FUNCTION	OF COMPO	NENT						-		
			NAL PROPORTION							
			S SIGNAL IS US	ED BY THE S'	YNCHRONIZER,	VOLT	METER /	AND THE		
	AGE TRAN		·	· · · · · · · · · · · · · · · · · · ·		<del></del>	r			
1 S	econdary	or primary w	<u>inding is open</u>	circuited:	No output			PPLICABLE RATING MODES		
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FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL I	MARGINAL 11	CR	ITICAL III	CATASTROPHIC		
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FAILURE	DETECTION	METHODS					<del></del>	<u> </u>		
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4 EAU UBE	CALICE AND	CORDECTIVE ACTI	ON (IF APPLICABLE)					<del></del>		
			insformers asso	ciated with	control or	prote	ctive	relaying		
		in WTS shutdo				· .	·			
V	oltage 1	ransducer (vo	ltage regulato	r) See	FMEA 6.8.2.	1				
		uency Protect			FMEA 6.8.3.					
		ge Protection		Soo	FMEA 6:8.3.	1				
1	ynchroni	•	<del></del>		FMEA 7.6.1.					
		zation Check			FMEA 7.6.1.		-			
		tor Protection	on .	<u> </u>	FMEA 6.8.3.					
i —	Power Factor Control See FMEA 6.8.2.2									
For Metering Errors See FMEAS: 7.6.1.4.1, 7.6.1.4.2, 7.6.1.4.5 through 7.6.1.4.8										
			-	NAME G. T	RUSK/H. ROTH	<u> </u>		DATE 8/17/78		
1	OPERATING MODES Rev. 10/18/78									
В	A SHUTDOWN D TRANSITION TO STANDBY G OPERATE Rev. 10/25/78 B TRANSITION TO WARM-UP E STANDBY H TRANSITION TO FEATHER C WARM UP F TRANSITION TO OPERATE I FEATHER									

SUBSYSTE	M OWER - E	EPS	COMPONEN	NT TRANSFOR	MĘR		PAGE 1	160 o 7.6.1.4.10		
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		NT TRANSDUCER		77.12						
	MODES & EF		S OPEN CIRCUIT	· NO OUTPUT	STGNAL			PPLICABLE RATING MODES		
	LL.UIUAL.		3 DI LIK EINCOIT	<u> </u>	JIMING.			,G,H		
2 S	HORT BET	WEEN SECONDAR	RY WINDINGS: IN	CORRECT TUR	NS RATIO.					
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F	AILURE FRI	EQUENCY			FAILURE SE	VERIT	Y			
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC IV		
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3	80	1.1	125			×	(			
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FAILURE	DETECTION	METHODS								
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will r	esult ir	n WTS shutdowr	1.							
	Re	everse Power F	Protection	See FMEA	6.8.3.4					
]	Di	ifferential Pr	rotection	See FMEA	6.8.3.6 8	7.6.	1.3.2			
	Po	wer Factor Co	ontroller	See FMEA	6.8.2.2		<del></del>			
<u> </u>			tion_Protection		6.8.3.9					
			ent Protection		6.8.3.3			<del></del>		
		round Fault Pr		See FMEA	6.8.3.5			<del></del>		
For Me	tering L	rrors See FML	AS: 7.6.1.4.3	unrougn /.b	.1.4.8					
		· · · · · · · · · · · · · · · · · · ·					,			
<u> </u>	_ <del></del>		<del></del>	NAME G.	TRUSK/H. ROTH	 	10	DATE 8/17/78		
OPERATIN	G MODES						F	Rev 10/18/78		
В	SHUTDOWI TRANSITIO WARM UP	N DN TO WARM UP	E STANDBY	TO STANDBY	G OPERAT H TRANSI I FEATHER	rion to		v. 10/25/78 ER		

SUBSYSTEM COMPONENT GENERATOR TOTAL RUNNING HOURS FMEANO 7.6.1.4.11										
FUNCTION	OF COMPO	NE NT		L		<del></del>	,		o 7.6.1.4.11	
PROV	IDES A C	CONTINUOUS VIS	SUAL DI	SPLAY OF	THE TOTAL	ACCUMULATED	HOURS	OF OF	ERATION OF	
THE	GENERATO	OR				· · · · · · · · · · · · · · · · · · ·				
					···					
FAILURE N	odes& er es not i	rects run or quits i	running	: No di	rect displa	y of correct	t		PPLICABLE RATING MODES	
ge	nerator	running time.			<del> </del>	·			G	
2 Ac	cumulate	e time too fa	st or s	low: in	correct dis	play of gene	era-	-^ ;	Ī	
to	r runni	ng time.							G	
3										
,			,							
4									:	
			<u></u>							
F,	AILURE FRE	<u> </u>	MEA	N TIME		FAILURE S	EVERIT	Υ	<del></del>	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN	N FAILURE EARS)	MINIMAL	MARGINAL II		TICAL	CATASTROPHIC IV	
1-2	100	6.8	16	.7-	Х			<del></del>		
2		-								
3									<del>                                     </del>	
FAILURE	DETECTION	METHODS		1		<del></del>	l	-		
		d calculation								
2	July 411	d carcaracton.	<del> </del>		<u> </u>				· · · · · · · · · · · · · · · · · · ·	
3			- <del> </del>		<del> </del>					
4								-		
FAILURE	CAUSE AND	CORRECTIVE ACT	ON (IF APP	LICABLE)	<del></del>					
		ing continuit		tential	transforme	r, repair if	neede	ed;		
re	eplace c	lock if requi	red.						<del></del>	
									-	
			<del></del>		<del></del>		<del></del>			
		-	<del>-</del> .			······a			<del>-</del>	
						<del></del>		<u>-</u>		
				· · · · · · · · · · · · · · · · · · ·						
			<del></del>		<del></del>	<del></del>				
ļ <del></del> -			·				<del></del>			
			· · · ·		NAME S	TDUOY ( 5:	O.T.:		DATE 0 (3.7.10	
OPERATIN	G MODES				NAME G.	TRUSK / H. R	UIH		DATE 8/17/8 Rev.10/18/8	
A	SHUTDOW				TO STANDBY	G OPERA			Rev. 10/25/78	
	TRANSITION WARM UP	ON TO WARM UP		STANDBY TRANSITION	TO OPERATE	H TRANS I FEATH		O FEATH	IER	

SUBSYSTE			COMPONE		101 50		PAGE	162		
TOWER	- EPS		BIC	PERATING CY	CLE2		FMEAN	o 7.6.1.4.1		
FUNCTION	OF COMPO	NENT								
PROVI	DES A CO	<u>NTINUOUS VISU</u>	JAL DISPLAY OF	THE NUMBER	OF OPERATING	CYCL	ES ON	THE BUS TIE		
BREAK	ER. THI	IS IS MANDATOR	RY DATA REQUIRE	D FOR BTC P	REVENTATIVE	MAINT	ENANCE	•		
·										
FAILURE	ODES & EF	FECTS	nt: operating	avala data	for the DTC			PPLICABLE		
			it: operating	cycle data	Tor the Bit	12	OPE F	RATING MODES		
	ncorrect	<u> </u>		<del></del>				F,H		
2 M	isses cy	cle counts.	Operating cycl	<u>le data for</u>	the BTC is					
_1	ncorrect	·						F,H		
3										
				,		•				
4				·						
FAILURE FREQUENCY FAILURE SEVERITY										
	FAILURE	<u> </u>	MEAN TIME		T					
FAILURE MODE NO	MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL		TICAL	CATASTROPHIC		
<u></u>								ļ <u>.</u>		
1 &2	100	6.8	16.7	X	<del> </del>	<del></del>				
3				<del> </del>	<del> </del>					
4								<u> </u>		
FAILURE DETECTION METHODS										
			<del> </del>	<del></del>	·····		<del></del>			
1 & 2	Visual									
2							<del></del>			
3										
4					- <del></del>					
			ON (IF APPLICABLE)							
_Opera	ting cyc	le data is us	sed for mainter	nance purpos	es, maximum	<u>tıme</u>	interv	al to		
BTC c	ontact	inspection and	l refurbishment	will also	be used.					
l ———					<del></del>			<del></del>		
					<u>.</u>		<del></del>			
								<del></del>		
							-			
			····	NAME	G TRUSK/H.	ROTH		DATE 8/17/8		
OPERATIN	G MODES				- 11.0010/11.					
A B	SHUTDOW	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T		v. 10/18/8 /. 10/25/78 ER		

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163-166 Missing

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TO			COMPONE		•	4	PAGE	167
	WER - EP	'S	4.16	kV TO 480 V	OLT TRANSFOR	MER	FMEAN	o 7.6.1.5.1
UNCTION	OF COMPO	NENT			<del></del>			-
PRO	OVIDES A	LL OF THE ACC	CESSORY POWER U	SED IN THE	WTS			,
								<del> </del>
							<del>-</del>	
AILURE N	ODES & EF	FECTS			W			PPLICABLE
<u>1_Upi</u>	en circu	<u>nt in primary</u>	or secondary.	winaings:	No output or		OPE	RATING MODES
								ALL
2 Inte	ernal sh	ort circuit:	input fuzed <u>m</u>	anual switc	<mark>h fuses open</mark>	<u>,                                     </u>		
No o	output.						-	ALL
		ound fault:	<u>input fuzed ma</u>	nual switch	fusos opon			
			•		. ruses open	•	k.	
<u>no</u> (	output.	<del></del>	<del> </del>					ALL
4								İ
F	AILURE FRE	QUENCY			- FAILURE S	EVERIT	Y	
	FAILURE	FAILURE RATE	MEAN TIME		<i>-</i> "			
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL		TICAL III	CATASTROPH
			<u> </u>	·				
1	50	1.1	200	<del></del>	ļ		Χ	
2	25 - 25 -	1.1	400				X	ļ
3	25	1.1	400	<del> </del>			Χ	ļ
4								
					<u> </u>			<u> </u>
FAILURE	DETECTION	METHODS		<u> </u>	<u>,</u>		<del></del> -	<u></u>
				-				
1-3 W		METHODS ut down-						
1-3 W								
1-3 W								
1 - 3 W7 2								
1 – 3 W7 2 3	TS 1s sh	ut down-						
1 - 3 W	TS 15 Sh	ut down	ON (IF APPLICABLE)			funct	zions	
1 - 3 W	TS 15 Sh	ut down				funct	zions	
1 - 3 WT 2 3 4 FAILURE 6	CAUSE AND	ut down- corrective Acti y power avail	ON(IF APPLICABLE) able for house	keeping and	maintenance			
1 - 3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1 - 3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			-
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1-3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1 – 3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1 – 3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2	maintenance			
1 – 3 WT 2 3 4 FAILURE 6 No a	CAUSE AND ACCESSOR	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2 7.6.1.7.5	maintenance	.9.1-6		
1-3 WT 2 3 4 FAILURE 6 No a See 7.2.	CAUSE AND ACCESSOR also FM	corrective active power avail	ON(IF APPLICABLE) able for house 8.7.1 and 6.8.	keeping and 7.2, 6.8.8.2 7.6.1.7.5	maintenance 2-6.8.8.4, 6	.9.1-6	5.9.3,	DATE 8/17/7 Rev 10/17/
1-3 WT 2 3 4 FAILURE ( NO &  See 7.2.	CAUSE AND ACCESSOR also FM	corrective active power avail EAS 6.8.6, 6.	on(IF APPLICABLE) able for house 8.7.1 and 6.8. 5.2, 7.6.1.7.3-	keeping and 7.2, 6.8.8.2 7.6.1.7.5	maintenance 2-6.8.8.4, 6	.9.1-6	5.9.3,	DATE 8/17/7

SUBSYSTE			COMPONE	INAMOLON				168
	- EPS	1	480 VO	LT TO 115/2	30 VOLT		FME A N	0 7.6.1.5.2
)	OF COMPO		O VOLT ACCESSO	DV DUMED HE	בה זא דעב דה	MED D	EI (1)1/ TI	שר כעטיב
		CHANISM.	O VOLT ACCESSE	NI TONLE US	LD IN THE TO	WEK D	CLOM 11	TE CABLE
	TITON HE	011/11/11/11	-		<del></del>	<del>.,</del>		
FAILURE N	ODES& EF	FECTS due to no in	put: no power	for tower	and base lig	hts.		PLICABLE RATING MODES
			ousekeeping an				Mai	ntenance
2 N	o output	due to inter	nal fault: cı					
S	ame as #	1					<u>Mai</u>	ntenance
3								
_								-
4								•
F.	AILURE FRE	QUENCY			FAILURE S	EVERIT	Υ -	<del></del>
	FAILURE	FAILURE RATE	MEAN TIME BETWEEN FAILURE	MINIMAL	MARGINAL			0.5
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	(YEARS)	I	II		TICAL	CATASTROPHIC IV
1	_	•	-	х				
2	100	1.1	100	Х	ļ <u>.</u>	ļ		
3	<del> </del>				<del>                                     </del>			
FAILURE	DETECTION	METHODS			<u> </u>	ļ- <del></del>		·
1-2	None, rem	otely	-					
			stored data or	convenience	e outlet pow	er for	r troub	ile-
7	shooting	/repair equip	ment.					
4								
			ON (IF APPLICABLE)			,		
			wer required to			g/repa	<u>ir ope</u>	rations.
	Reset C1	rcuit breaker	or replace tra	anstormer as	s required.			
ļ ——-								<del></del>
l				<del></del> -				
		<del></del>						
				<del></del>				
					<del></del> -			
			<del></del>	- <del> </del>	·			*
				NAME G.	TRUSK/H. ROT	ГН	——Т	DATE 8/17/78
В	SHUTDOW	N DN TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHI	ITION T	Rev	EV 10/17/78 1. 10/25/78 ER
L			· · · · · · · · · · · · · · · · · · ·	<del> </del>				

SUBSYSTE	M		COMPONEN				age 169 ——
TOW	ER - EPS	<u> </u>	BATT	ERY		Fr	MEANO 7.6.1.6.1
FUNCTION							
			OWER (DC) WHEN				
SUPPL	IES THE	ELECTRICAL PO	WER SYSTEM PRO	TECTIVE REL	AYS AND PORT	IONS OF	THE CONTROL
SYSTE	м.						-
FAILURE N	odes & ef	FECTS ed: WTS shuts	down	i	ı		APPLICABLE OPERATING MODES
							- A11
2 0	verchar	ged/Overheated	i. DC output v	oltage too	hıgh		A11, ,
<u> </u>		<del></del>	C output voltag	e is too lo	w would resu	ılt	A11
1	n w12 Sr	nut down.					A11
4B	attery	<u>Internal Faul</u>	t: Same as FM	1 if many c	ells are sho	rted	~
W	TS shut	down if open o	circuited	<del></del>			
F	AILURE FRE	QUENCY			FAILURE S	EVERITY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE x 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITIC	
1,4	70	11.4	14,3	-		Х	
2	29	11.4	34.5	Χ	ļ		
3	1	11.4	1000		<u> </u>	X	
4					<u> </u>		
FAILURE	DETECTION	METHODS					
1 WTS	shuts d	own. On-site	trouble shoot	ing -		•	
2 ()n-s	ite ins	pection of da	ta.	3			
			emergency shut			<del></del>	
			emer gency shar	down			
	as FM		ON (IF APPLICABLE)	<del></del> :	<del>-</del>	<del></del> -	
			BV power result	s in WTS fa	nlsafe shutd	lown. B	attery
					-		
<u>mon 1</u>	toring o	circuit deteci	ts open battery	<u>line.</u>			
							<del></del>
See_	<u>also FM</u>	<u>EA's 6.6.2.10</u>	6.8.8.4. 7.6	1.6.2 and	7.6.1.76	<del> </del>	
						٦	
							<del></del>
				-			•
		<del></del>			<del></del>		<del></del>
				- <del>[</del>	TDUCK/U DO	ти	1 0/17/0
				NAME G.	TRUSK/H. RO	111	DATE 8/17/8
OPERATIN			_		_		Rev. 10/17/8 Rev <del>10/25/-78</del>
В	SHUTDOW TRANSITION WARM UP	IN ON TO WARM UP	D TRANSITIO E STANDBY F TRANSITIO	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATHI	SITION TO	
		-			_		

SUBSYSTE T	M OWER -EP	S	COMPONE BATTE	NT RY CHARGER			PAGE	7 6 7 6 0
FUNCTION	OF COMPO	NENT	THE DATTEDY IN	A CTATE OF	CULL CUADOS	- AND	FMEA NO	
			THE BATTERY IN	A STATE OF	FULL CHARGE	AND	SUPPLIE	
ABLE	POWER (D	· · · · · · · · · · · · · · · · · · ·						
FAILURE A	ODES & EF	FECTShagh /not	regulating pr	vananly). R	attery over	hargo	API	LICABLE
l ——		is high.	regulating pr	operiy). b	accery over	ar ge	J	ATING MODES
<b>——</b>	<del></del> _		ing properly):	DC voltage	is low and			A11
i		undercharged.						A11
			l be discharged	, WTS will	shut down.			
							,	A11
4								
			<b>,</b> , , , , , , , , , , , , , , , , , ,					
F.	AILURE FRE	QUENCY			FAILURE S	EVERIT	·Y	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE () EARS)	MINIMAL I	MARGINAL II	CR	ITICAL III	CATASTROPHIC IV
1	25	2.3	200	Х				
3	25 50	2.3	200 100	····		<del></del>	X	
4	30_	2.3	100		<u> </u>		<del>-^</del>	
FAILURE	DETECTION	METHODS						
1 Non	e – Regu	ires on-site	check	<del></del>				· · · ·
			check (if very	ካow, WTS ma	ay shut down	).	<del></del>	
3 WTS	shutdov	vn (after bat	tery discharges	5)				
4								
		corrective action	ON (IF APPLICABLE)					
	110410	- Inspection			<del></del>			
ļ <del></del>				<del></del>				
		See	also FMEA 7.6.	1.6.1				
					1			
				NAME G.	TRUSK/H. RO	HTC		ATE 8/17/8
OPERATIN			_					v 10/17/8 . 10/25/78
	TRANSITIONS WARM UP	N DN TO WARM-UP	D TRANSITION E STANDBY F TRANSITION	TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	O FEATHEI	

SUBSYSTE T	BSYSTEM COMPONENT TOWER - EPS BATTERY HEATER						PAGE FMEAN	171 0	7.6.].6.
FUNCTION MAINTA	OF COMPO	NENT RATTERY TEMPE	RATURE AT OR A	AROVE THE M	INIMUM ACCEPT	ABLE			H IN
			OUTPUT VOLTAGE						
	SYSTEM.				•				<del></del>
FAILURE M	ODES&EF	FECTS open circuit:	: Battery may	be too col	d. (See FMEA			PP LICA	ABLE G MODES
	6.1.6.1				•			A11	
2 He	ater the	ermostat is sh	nort circuited	or stuck s	hut: battery	may			
		and fail.*					-	<u> A11</u>	
<u>3 No</u>	accesso	ory power ava	<u>llable: Same a</u>	as #1					
				····				<u> </u>	
4									
F	AILURE FRE	QUENCY			FAILURE S	EVERIT	Y		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL	CAT	ASTROPHIC IV
1	50	2.3	100	X					
3	25 25	2.3	200 200	X	-		<u>X</u>	<u> </u>	<del></del>
4									
FAILURE	DETECTION	METHODS							
1 & 3			ower is needed						
2	None un	til battery i	s destroyed or	maintenanc	e personnel	nspec	t.		
4									
	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	<del></del>	-				
1 & 3	Redun	dant heaters	are provided.						
2	Perio	dic inspectio	n of battery e	lectrolyte	level and cas	se tem	peratu	ire	
	is ne	cessary.				<del></del> -			
	<del></del>								
		lso FMEA 7.6.	162	- -	<del></del>	<del></del>			
<del></del>	see a	150 THLA 7.0.	1.0.2		<del></del>				
									<del></del>
*	Pressur	e relief is p	rovided to pre	vent danger	ous pressure	build	lup.		
				·	<del></del>		<del></del>		
				NAME G.	-TRUSK/H. ROT	H			8/17/8 10/17/8
8	SHUTDOW	N DN TO WARM-UP	E STANDBY	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATHI	ITION T		lev.	10/25/78

SUBSYSTE	M EPS		COMPONEN HIGH	T VOLTAGE IN	PUT BUS	PAGE	172 NO 7.6.1.7.1
FUNCTION		NENT				PMEA	NO 7.0.1.7.1
			TION FOR THE IN			WER CABLES	AND A PATH
FOR PO	WER FLO	W TO THE GENE	RATOR SIDE OF 1	THE BUS TIE	BREAKER.		<u>.</u>
FAILURE M	ODES & FE	FECTS					APPLICABLE
FAILURE V	en circ	uit: WTS wil	l not enter ope	erate mode	or will shut	down OP	ERATING MODES
		· · ·	"3			· · ·	F, G
2 51	ort cir	cuit. Same a	IS #I				F, G
3 G1	rounded	conductor: S	Same as #1	<del></del>			· · · · · · · · · · · · · · · · · · ·
<u>3</u>	ounded	-	74mc_43_#1				F, G
4					-		
							·
F,	AILURE FRE	EQUENCY			FAILURE S	EVERITY	<del></del>
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL II	CRITICAL	CATASTROPHIC
1	50	1.1	200			Х	
	25 25	1.]	400			X	
3 4		<del></del>	400		<del> </del>	Х	
1 -3 W	TS is sh	nut down.					
3							
4 .						· · · · · · · · · · · · · · · · · · ·	·
			on(IFAPPLICABLE) ent BTC from clo	nsing or tr	in the BTC.		•
				3 5	<u> </u>	•	·
				,			
					*****	·····	
							•
		····			<del></del>		
				•			<del></del>
				NAME G.	TRUSK/H. RO	TH	DATE8/17/8
OPERATIN	G MODES						Rev. 10/17/8
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION		G OPERA H TRANS I FEATH	ITION TO FEAT	HER

SUBSYSTE			COMPONEN	Т		PAGE	173		
	TOWER - EPS HIGH VOLTAGE OUTPUT BUS FMEANO 7.6.1.7.2								
	OF COMPO		TION FOR THE OL	ITCOINC HIC	U VOLTACE DO	י מחודכ	AND A		
			TION FOR THE OU				AND A		
PATH	FUR PUWE	K FLOW TO THE	UTILITY SIDE (	L THE ROS	TIE RKEWER.				
FAILURE M	IODES & EF	FECTS	<del></del>			<del></del>	APPLICABLE		
	odes&er	uit: WTS wil	1 not enter ope	rate mode	or will shut	OPE	RATING MODES		
	own.		<del> </del>				F,G		
2 SI	hort cir	cuit: same a	s #1	<del></del>					
				·			F,G		
3 G1	rounded	conductor: s	ame as #1		<u> </u>				
				·····			F,G		
4									
F	AILURE FRE	QUENCY	1		FAILÛRE	SEVERITY	-		
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL I	MARGINAL 11	CRITICAL	CATASTROPHIC		
1	50	1.1	200			X			
2	25	1.1	400			X			
3	25	1.1	400		<del> </del>	X	<del></del>		
<del></del>	l		<u> </u>		<del></del>	<del></del>	<del>-                                    </del>		
FAILURE	DETECTION	METHODS					•		
1-3 l	WTS 1s s	hut down.							
7							· · · · · · · · · · · · · · · · · · ·		
7				<del></del>	-	<del></del>			
4		·		,		<u> </u>			
			OÑ (IF APPLICABLE)	- 	. 6	` (			
			ot permit "open		ir utility L	ower is ser	ised as		
	not pres	ent or diff.	prot. will trip	BIC.		<del></del>			
	See also	FMEA 7.2.1.1	through 7.2.2.	9.	<del></del>		<del></del>		
				····			<del></del>		
							<del>-</del>		
					<del></del>	<del> </del>	<u> </u>		
							····		
				-	•				
				····					
				NAME G.	TRUSK/H. ROT	 [H	DATE 8/17/78		
OPERATIN	IG MODES		<u>'</u>				REV 10/17/78		
Δ	- SHUTDOW	IN	D TRANSITION E STANDBY	TO STANDBY	G OPER	ATE SITION TO FEAT	Rev. 10/25/7		

SUBSYSTEM TOWER - EPS		NT 480 VOLT R CIRCUIT BE	ACCESSORY REAKER PANEL	1	PAGE ]	7 6 7 7 4
FUNCTION OF COMPONENT			TOTAL TRAINED		FME A NO	7.0.1.7.0
PROVIDES A PATH FOR THE FLO	W OF 480 \	OLT ACCESS	ORY POWER WI	THIN T	HE BUS	
TIE BREAKER.						
FAILURE MODES & EFFECTS  1 Open circuit: Loss of indi	vidual 480	OV load fund	rtion.			LICABLE ATING MODES
						ALL
2 Short circuit. circuit bre	aker trips	then same	as No. 1			
=						ALL
3 Conductor grounded · Same a	s No. 2	* · · · · · · · · · · · · · · · · · · ·				
3 Ophicus tot. 4. ounided Same S	<u> </u>	<del></del>				ALL
						ALL
4						
FAILURE FREQUENCY			FAILURE S	EVERITY	, *	·-
I MESTE I FAILURE RATE I	EAN TIME			<u> </u>		
FAILURE   MODE   TAILURE   BETW	EEN FAILURE (YEARS)	MINIMAL	MARGINAL II		FICAL 11	CATASTROPHIC IV
1 50 1.1 2	00	<del></del>				
2 25 1.1 4	00					
	00	<del></del>				
-4			<u> </u>			
FAILURE DETECTION METHODS						
1 -3 None, remotely						
ጸ 1-3 Onsite: loss of individu	al functio	on	· · · · · · · · · · · · · · · · · · ·			
3				· <u>-</u> .		
4			··			
FAILURE CAUSE AND CORRECTIVE ACTION (IF	APPLICABLE)					
						<del></del> '
						<del></del>
See FMEA 7.2.2.1 t	hrough 7.2	2.2.9 <b>,</b> 6.8.7	<u>'.1</u>		<del></del> -	
		<del></del>				
	<del>_</del>					
		NAME H.	ROTH/G. TRUS	K K	D	ATE 8/17/78
OPERATING MODES	<del></del>	<del>- • </del>	· · ·		R	ev 10/17/78
	TRANSITION	N TO STANDBY	G OPERA H TRANS			v. 10/25/78
,		TO OPERATE	I FEATHI			

SUBSYSTE	м		COMPONE	NT 115/230 V	VOLT ACCESSO	RY	PAGE	175
TOWER	- EPS		POWER	CIRCUIT BREA	AKER PANEL		FMEAN	o 7.6.1.7.4
	ОГ СОМРО							
PROVIC	DES A PA	TH FOR THE FL	OW OF 115/230	VOLT ACCESS	ORY POWER WI	THIN	THE BUS	TIE
BREAKE	ER						_	
FAILURE	ODES & EF	FECTS		5 (020 V 1	4 C	<u> </u>		PPLICABLE
			<u>individual 11</u>	5/23U V 10a	a tunction i	<u> </u>	OPE	RATING MODES
fe	eder to	tower.			·····			A11
2 SI	nort cir	<u>cuit: cırcui</u>	<u>t breaker trip</u>	s, then sam	e as #1.			
								A11
3 G1	rounded	conductor: s	ame as #2.					
3					·····			A11
<del></del>							<del> </del>	7.1
4	<del></del>							
			<del></del>	<del>,</del> -	<del></del>		<u> </u>	
F.	AILURE FRE	QUENCY			FAILURE	EVERIT	Y *	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE x 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL	CR	ITICAL	CATASTROPHIC IV
1	50	1.1	200		<del>                                     </del>		·	
2	25	1.1	400		<del> </del>	<del> </del>		
3	25	1.1	400		ļ	<del></del>		
4						<u> </u>		
FAILURE	DETECTION	METHODS						
<u> </u>					~			
1 - 3	None, re	emotely		<del></del>			·	
71-3_	On-site	: loss of in	ndividual funct	ion				
<i>‡</i>								
4	·							
FAILURE	CAUSE AND	CORRECTIVE ACTION	ON (IF APPLICABLE)					
	*See ind	lividual FMEA	sheets.					
								<del></del>
							·	
					<del></del>			
				<del></del>				
l							<del> </del>	
F 								
							<del></del>	
	Y						-	
				NAME G.	TRUSK/H. ROT	H		DATE 8/17/78
OPERATIN	G MODES							EV 10/17/78
	SHUTDOW	N	D TRANSITIO	N TO STANDBY	G OPERA	\TE	F	lev. 10/25/78
B		ON TO WARM-UP	E STANDBY	N TO OPERATE	H TRANS	ITION 1	TO FEATH	ER
<u>_</u>	III OF				, , , , , , , , , , , , , , , , , , , ,			

SUBSYSTE			COMPONE				PAGE	176
	TOWER -		UNIN	TERRUPTABLE	POWER CIRCU	IT	FMEANO	
FUNCTION	OF COMPO		TUE ELON 05 (III		. =			÷ `
			THE FLOW OF UN	INTERRUPTAB	LE POWER WITH	HIN		
<del></del>	THE BUS	TIE BREAKER.					<del>,</del>	
							<del>, , , , , , , , , , , , , , , , , , , </del>	<del></del>
1 0p	en circ	uit: power no	ot available fo	or operatin	g protective			PLICABLE ATING MODES
ď			ower/nacelle					- At-L
2 Sh	ort circ	cuit: same_a:	s No. 1					
								ALL
3 Gr	ounded o	conductor sa	ame as No. 1					ALL
4								
F	AILURE FRI	EQUENCY		<del></del>	FAILURE S	EVERIT		-
<u> </u>	FAILURE	FAILURE RATE	MEAN TIME		123.123		·T	<del> </del>
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL 11		ITICAL	CATASTROPHIC
1	<u> </u>	1.1	200	<del></del>		<u> </u>	$\times$	
2	50 25	1.1	200 400		<del>                                     </del>		X	<del>- · · · · · · · · · · · · · · · · ·</del>
3	25	1.1	400		*		X	
4		<u></u>	<u> </u>		<u> </u>			
FAILURE	DETECTION	METHODS .						•
1 -3 W	TS shuts	down						
2								
3					_			
4	-		·· <del>-</del> · ·					
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)					
				·				
		_						V.
	See F	MEA's 6.8.8.4	, 7.2.2.8, 7.2	.2.9.				
								.*
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				_ <del></del>	<del>-</del>		<del></del>	
				NAME G.	TRUSK/H. ROTH	1		OATE 8/17/78
OPERATIN	G MODES							v 10/17/78 v 10/25/78
B	SHUTDOW TRANSITION WARM UP	N ON TO WARM-UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T	O FEATHE	
<u></u>								

7	М		COMPONENT			PAGE	177
'	TOWER -	EPS	CONTROL	L CIRCUIT		FMEA	7.6.1.7.6
FUNCTION	OF COMPON	VENT					· · · · · · · · · · · · · · · · · · ·
ŗ	ROVIDES	A PATH FOR T	HE FLOW OF CONT	ROL SYSTEM	COMMANDS ANI	DATA WITH	IN
		TIE BREAKER.					
	THE DOS	TIE DILETICE.					
		E OTC				<del></del>	PRI IO ÉDIF
FAILURE N	ODES& EFI	cuit: <u>associ</u>	ated relay will	not functi	on. loss of	OPE	APPLICABLE RATING MODES
			oss of status d	-	•		F.G.
		•	-	~			7.0.
			as No. 1, or re			enciy	
	causing	<u>WTS:shutdown.</u>		<del></del>			F.G
3 (	Grounded	conductor:	same as No. 1				,
` —			~ ,	- ~		-	F.G.
4		<del></del>					
		<del></del>	<del>, </del>				
F,	AILURE FRE	QUENCY			FAILURE S	EVERITY	<del></del>
FAILURE	FAILURE MODE	FAILURE RATE	MEAÑ TIME BETWEEN FAILURE	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
MODE NO	FREQ %	x 10 ⁻⁶ PER HOUR	(YEARS)	~_ I	11	111	IV
1	50	2.3	100			X	<del></del>
2	25	2.3	200			X	<del></del>
3	25	2.3	200			X	•
4							
EALLURE	DETECTION	LMETHODS					
							<del></del>
1-3	VTS shut	down				<del></del>	
2							
3	,	•				· <del></del> -	
4							
FAILURE	CALISE AND	CORRECTIVE ACTIV	ON (IF APPLICABLE)		-		
			circuits will t	rip the GCE	if failure	ın BTCU	
(							
		zas the gener			-		
		zes the gener				<del></del>	
		zes the gener					
	jeopardi.	zes the gener	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.			-	
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.				
	jeopardi.	· · · · · · · · · · · · · · · · · · ·	ator.		RUSK/Ĥ. ROTI	1	DATE 8/17/78
	See also	· · · · · · · · · · · · · · · · · · ·	ator.		RUSK/Ĥ. ROTI	1	
OPERATIN	G MODES	FMEA 7.2.3.2	D TRANSITION	NAME G. 1	G OPERA		Rev 10/17/78

SUBSYSTE			COMPONE	NT R OUTPUT TRA	NCEODMED		PAGE	
<del></del>	R - EPS	15.17	PUWER	C UUIPUI IRA	INSPURIER		FMEAN	7.6.2
FUNCTION MATC	HES THE	OUTPUT VOLTAG	GE OF THE WTS G	ENERATION S	YSTEM WITH T	HE VC	LTAGE	OF THE
INTE	RFACING	UTILITY POWER	R TRANSMISSION	LINE.				<del>-</del>
FAILURE N	ODES& EF	ited winding	: WTS shuts do	own				PPLICABLE RATING MODES
								G
₂ Sh	ort cir	cuited winding	gs: WTS shuts	down, fused	d manual disc	con-		
ne	ct swite	ch fuses open	•					G
3 W1	nding sl	h <u>orted to gro</u>	und. same as f	<u> </u>				
							1	G
4 01	1 overh	eated WTS s	huts down					
								G
F	AILURE FRE	QUENCY			FAIL URE S	EVERIT	ΓY	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILŪRE (YEARS)	MINIMAL	MARGINAL II	CR	ITICAL	CATASTROPHIC IV
1 -3	90	1.1	111.1				X	
<b>¾</b> 4	10	1.1	1000				Χ	
3					<del> </del>			<del> </del>
EALLIBE	DETECTION	L	<del></del>	L	<del></del>			
	<del></del>							
	TS shut	s down		<del></del>				
2							·	
3								
4	CALIEE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	<del></del>	<del></del>			<del></del>
		7.2.1.4.	ON (IF AFF EICABLE)					
		<u> </u>						
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	<del></del> -							
<del></del>				<del></del>				
<u> </u>			<del></del>					
					-		<del></del>	
<u> </u>				Naus				DATE
OREGATION	CMODES			NAME G.	TRUSK/H. RO	<u>)TH</u>		DATE 8/17/8
В	SHUTDOW	N ON TO WARM UP	E STANDBY	N TO STANDBY	G OPERA H TRANS I FEATHE	ITION T		Rev 10/17/8 ev 10/25/78 ER

SUBSYSTE			COMPONEN			PAGE	179
	- EPS	<u></u>	FUSED M	ANUAL DISCO	NNECT SWITCH	FMEAN	0 7.6.3
	OF COMPO						
_PROVI	DES A ME	ANS OF TOTALL	Y ELECTRICALLY	ISOLATING	THE WTS FROM	THE UTILIT	Y AND
PROVI	DES A FA	IL-SAFE VISUA	L INDICATION TH	HAT THE CIR	CUIT IS OPEN	<u> </u>	
FAILURE	ODES & EF	FECTS					PPLICABLE -
<u>1 0</u>	<u>pen circ</u>	uit: WIS shu	ts_down/or:can	not start u	p	OPE	RATING MODES All
<del></del> _					<del> </del>		AII
<u>2</u> S	tuck shu	t: cannot di	sconnect WTS f	rom utility			A11
3							-
			· · · · · · · · · · · · · · · · · · ·		- 		
4							
<del></del> -		-					
F	AILURE FRE	QUENCY			FAILURE S	EVERITY	
	FAILURE	FAILURE RATE	MEAN TIME				1
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS) -	MINIMAL I	MARGINAL	CRITICAL	CATASTROPHIC
							<del>  -                                   </del>
	90	7	185		<del> </del>	X	
<u>2</u>	10		1666	X	<del> </del>	<del> </del>	<del> </del>
4					<del>                                     </del>		<del> </del>
			<del></del>	<del></del>	<del></del>	-	
FAILURE	DETECTION	METHODS	<del></del>		<del></del>		
1 WT	S shut d	lown.					
² Rec	uires m	anual check.		-	<u> </u>		
3							-
4			·~-				
	CALISE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)	,	<del></del>	<del></del>	
			sed or if it fu	-	WTS will eit	her shut do	wn or will
				Joes open,	NIO WILL CIT	ner phae do	WIT OF WITT
		tion to opera					<del></del>
<u>If</u>	switch	is stuck shut	, WTS cannot be	<u>e disconnec</u>	ted from uti	<u>lity but fu</u>	<u>sed</u>
pr	otection	ıs still ava	ılable. Bus ti	<u>ie contacto</u>	r and genera	tor circuit	
br	eakers c	ontinue to fu	nction.				
				10.5.0			
						<del></del>	
				····	<del></del>		
			-				-
			······································	<del></del>			
				NAME G.	TRUSK/H. ROT	Н	DATE 8/17/78
OPERATIN	G MODES			<del></del>			REV 10/17/78
A B	SHUTDOW TRANSITIO	N ON TO WARM UP	E STANDBY	TO STANDBY		TE SITION TO FEATH	REV 10/25/78
٦	WARM UP		F IMANSIITON	TO OPERATE	I FEATHI	EN	

#### CONTROL SUBSYSTEM - FAILURE FREQUENCY

Based on the analysis contained in sheets 180-257, there are no catastrophic failure modes that can be caused by a control system failure. Trade studies completed during conceptual design concluded that a single thread system was most cost effective; therefore, no effort has been made to compute failure frequencies for individual signal lines. The cumulative failure rate for the entire control system is three failures per year.

SUBSYSTE	М		COMPONEN	NT			PAGE	180
		YSTEM (NCV)	POWER	FAIL RESTART	CKT		FME A N	0 . 7.7.1
	OF COMPO		T OF COMPUTER I	OURING POWER	INTERRUPTIO	ON.		
						-		
	-							
FAILURE N	ODES & EF	FECTS LINE SHORTS P	OWER FAIL INTE	RRUPT ACTIVA	TES-EMERGEN	CY_		PPLICABLE
SHUT [	OOWN ACT	IVATED.						ALL
			OWER FAIL DOES	NOT OPERATE	ON POWER			
INTERF								ALL
₃ PF	STATUS	FAILS HIGH-CA	USES INITIALIZA	ATION ON POW	ER FAIL INTE	RRUPT		
<u>-</u>								ALL
, PF	STATUS	FAILS LOW-CALL	SES POWER FAIL	EMERGENCY S	HIIT DOWN ON			
START		TALLS CON ONG	JES TONER TRIE		MIOT DOWN ON			B-C
	AILURE FRE	EQUENCY	• 1		FAILURE S	EVERIT	γ	<u>D-C</u>
<del> </del>	FAILURE	PAILURE RATE	MEAN TIME			1		
FAILURE MODE NO	MODE FREQ %	× 10 ⁻⁶ PER HOUR	BETWEEN FAILURE (YEARS)	MINIMAL	MARGINAL II		TICAL III	CATASTROPH IV
1,4						X		<del> </del>
2,3				Х		^		
3								
4			,	<u> </u>			_	
FAILURE	DETECTION	METHODS						
1 SYSTE	M WILL	NOT RESTART; P	OWER INDICATION	N MANUAL CON	TROL BOX BL	INKS.		
		<del></del>						
	C OPERA							
	•	NOT START						
			ON (IF APPLICABLE)			_		
					·			
								Co.
								<del> </del>
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		<del></del>	· · · · · · · · · · · · · · · · · · ·				_	
-						-		
			<u> </u>	<del> </del>				
					<del></del>		<del></del>	
			<del></del>	NAME J. H	UTTON			DATE 8/11
OPERATIN			_					Rev 10/25/
В	SHUTDOW TRANSITION WARM UP	N ON TO WARM UP	D TRANSITION E STANDBY F TRANSITION	N TO STANDBY N TO OPERATE	G OPERA H TRANS I FEATHI	ITION TO	O FEATH	ER -
				······································				

SUBSYSTE	М		COMPONE	NT .		PAGE	181
	OL SUB S		CPU, F	ROM & DATA	BUS	FMEA	
	OF COMPO						
STORE	S AND OF	PERATES_COMPUT	IER PROGRAM.		<del></del>		<del></del>
				<del></del>			
				- <del></del>	· · · · · · · · · · · · · · · · · · ·		·
FAILURE N	MODES&EF U FAILUF	FECTS RE-CONTROL OUT	TPUTS ARE NOT L	IP-DATED OR	GO TO "O"	ОР	APPLICABLE ERATING MODES
							ALL
2 DD0	M OD DAT	TA RUS EATLUDE	S-ERATIC COMPU	TED ODEDATI	ON DECLUTE		
			IEM FMEA-GENERA				ALL
	V2 ATHEL	7_60101801_3131	THE PILA-GENERA	ILL L. SAME. AS	_Cr Q _FAILURE	-	
3							
			<del></del>	<del></del>			
4		_					
		OUENOV	<del> </del>	<del></del>			
	AILURE FRE	<del></del>	ME AND TIME	<del></del>	FAILURE S	EVERITY	<u> </u>
FAILURE	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	MEAN TIME BETWEEN FAILURE	MINIMAL	MARGINAL	CRITICAL	CATASTROPHIC
MODE NO	PREU 76	2 10 FER HOOR	(YEARS)	' 	11	111	IV
1						X	
2 3						X	
4		· · · · · · · · · · · · · · · · · · ·		<del></del>			
FAU URF	DETECTION	METHODS					
			RESPOND TO CHA	NGES & FAIL	SAFE SYSTEM	SHUTS_DOW	N WTS WHEN
-X UNS. -X 2.	<u>AFE COND</u> SEE 1 AB	ITIONS ARISE.					
	SEE I AB	OVE.		-			
4				<del></del>			<del></del>
FAILURE	CAUSE AND	CORRECTIVE ACTI	ON (IF APPLICABLE)				
							<del></del>
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				·			
					<del></del>		· · · · · · · · · · · · · · · · · · ·
				-			1
<u> </u>				NAME J. I	IUTTON		DATE 8/11/78 Rev 10/25/78
OPERATIN	G MODES						NGV 10/25/78
8		N ON TO WARM UP	E STANDBY	N TO STANDBY		ITION TO FEAT	HER
С	WARM UP		F TRANSITION	N TO OPERATE	I FEATHE	R	

SUBSYSTE			COMPONE	NT	. —	T	PAGE	182
		YSTEM (NCV)	INTERR	JPT_LOGIC	<u> </u>		FME A N	
	OF COMPO		ING OF COMPUTE	R FUNCTIONS		•		
PRUVII	JES CIUL	ING & SEQUENC	THE OF COMPUTE	V 1 0NC 110N3				<del></del>
	<del> </del>							<del></del>
			<del></del>			<del></del>		
FAILURE N 1 1/1	ODES&EF	NT PULSE FAIL	S-COMPUTER STO	PS UPDATĪNG	DATA INPUTS	&		PLICABLE SATING MODES
CONTR	OL OUTPU	TS						ALL
2 1/	10 SEC	INT PULSE CDT	PARTIAL FAILU	RE SHORTENIN	NG CONTROL C	YCLE.		-
-								ALL
2 TΔF	RINTERR	IIPTS FATI -ANA	LOG DATA INPUT	STOPS				NSA
3 Int	J TIVI LIKIN	OTTO TALL MAN	LOG DITTY IN OT	3.1013	<del></del>			0.1.1
67.0		UDTO FAIL ORT	CERVICINA CTO	<del></del>			<del></del>	ALL
4 510	) INTERK	UPIS FAIL-CRI	SERVICING STO	25				
<u> </u>	AU UDE ERI	OUENCY			FAILURES	SEVERIT	<del></del> -	ALL
ļ	AILURE FRE	<u> </u>	MEAN TIME	}	FAILURES	PEVERIT	<u> </u>	
FAILURE MODE NO	FAILURE MODE FREQ %	FAILURE RATE × 10 ⁻⁶ PER HOUR	BETWEEN FAILURE	MINIMAL	MARGINAL		FICAL	CATASTROPHIC
WIODE NO	FREG %	210 121110011	11EANS/	·				
1	-		<del> </del>		[ ]	- X		-
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SUBSYSTE		•	COMPONE	-		PAGE	214
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CONTROL SUB SYSTEM  ROTOR BRAKE COMMAND SIGNAL  FUNCTION OF COMPONENT PROVIDES SIGNAL TO ACTIVATE WTS ROTOR  FAILURE MODES & EFFECTS 1 SHORT CIRCUIT, BRAKES WILL BE APPLIED  QPEN CIRCUIT; BRAKES WILL BE APPLIED  ALL  ALL  FAILURE FREQUENCY  FAILURE FREQUENCY  FAILURE SEVERITY	36
PROVIDES SIGNAL TO ACTIVATE WTS ROTOR  FAILURE MODES & EFFECTS 1 SHORT CIRCUIT, BRAKES WILL RE APPLIED OPERATING MO ALL 2 OPEN CIRCUIT; BRAKES WILL BE APPLIED ALL 3	
FAILURE MODES & EFFECTS  1 SHORT CIRCUIT, BRAKES WILL BE APPLIED  2 OPEN CIRCUIT; BRAKES WILL BE APPLIED  ALL  3  4	
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FAILURE FREQUENCY FAILURE SEVERITY	
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FAILURE DETECTION METHODS	
1 CONTROL WILL BE IN LOCKOUT MODE	
² CONTROL WILL BE IN LOCKOUT MODE	
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FAILURE CAUSE AND CORRECTIVE ACTION (IF APPLICABLE)	
ALSO MONITORED AND CONTROLLED BY FAIL SAFE SYSTEM	
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OPERATING MODES Rev 10/2	5/78
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В		ON TO WARM UP	E STANDBY F TRANSITION		H TRANS	TION TO	FEATHER	

SUBSYSTE	OL SUB :	CT CNAI -	COMPONEN	-	-	PAGE FMEAI	218
	OF COMPO		I GENERA	TOK FIELD I	ENABLE SIGNAL	PMEAT	vo 7.7.29
		GENERATOR TO F	PRODUCE POWER			•	•
AILURE M	ODES&EF	FECTS CUIT: GENERATO	OR WILL NOT OUP	UT POWER AN	ID THE WTS		APPLICABLE RATING MODES
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SUBSYSTE	M		COMPONEN	IT		PAGE	219
	OL SUB S		GENERA	TOR OUTPUT	SIGNAL	FMEA	
	OF COMPO		CONTROL SYSTEM	DDADADTIAN	AL TO CENEDA	TOD OUTDUT	
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		CORRECTIVE ACTI	ON (IF APPLICABLE)	NAME D.			DATE 8/10/
DPERATIN	3 MODES	CORRECTIVE ACTI	ON (IF APPLICABLE)	NAME D.	KENKMAN		DATE 8/10/7
	SHUTDOW			NAME D.	KENKMAN G OPERA		Rev 10/25/7

SUBSYSTE	М			COMPONE	¥T		P	AGE	221
CONTR	OL SUB	SYSTEM		BUS TI	E CONTACTO	R OPEN SIGNA	L FI	MEAN	
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² CON	TROL WIL	L BE IN LOCKO	OUT MODE					
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С	WARM UP		F TRANSITION	TO OPERATE	I FEATH	ER		

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	OL SUB		BUS T	IE DISCONNEC	T COMMAND SI	GNAL	FME A N	0 7.7.44
	OF COMPO		STEM TO DISCON	NECT THE GEN	IERATOR OUTPL	JT FRO	M THE	UTILITY
PWR L	INE							
		-						
FAILURE N	ODES&EF	FECTS CUIT: CONTROL	SYSTEM WILL NO	OT CONTROL E	DISCONNECT;			PPLICABLE RATING MODES
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2 OF	EN CIRC	UIT; DISCONNE	CT WILL OCCUR	AND WTS WILL	SHUT DOWN		A	LL
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	OL SUB S		REMOTE	RS 232 SIG	inal	FME	ANO 7.7.45
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PROVI	DES REMO	OTE CONTROL/MO	ONITOR CAPABILI	TY FOR THE	M12		
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CONTRO	COMPONENT COMPONENT PAGE 225  CONTROL SUB SYSTEM LOCAL RS 232 SIGNAL FMEA NO 7.7.46						
FUNCTION							
PROVI	DES MANU	JAL CONTROL/MO	NITOR CAPABILI	TY AT THE V	TS SITE	<del></del>	<del></del>
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FAILURE M	ODES&EF ORT CIRC	FECTS CUIT; TERMINAL	WILL NOT OPER	ATE WTS IN	MANUAL MODE		PPLICABLE RATING MODES
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SUBSYSTEM COMPONENT FAIL SAFE GEAR BOX PAGE 253									
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#### THE BUEING COMPANY

#### APPENDIX B

Figure	١,	MOD-2 Safety System
Figure	2,	Control System Block Diagram
Figure	3,	Electrical Power System Schematic
Figure	4,	Hydraulic Schematic, Pitch Control

Figure 5, Hydraulic Schematic, Yaw System

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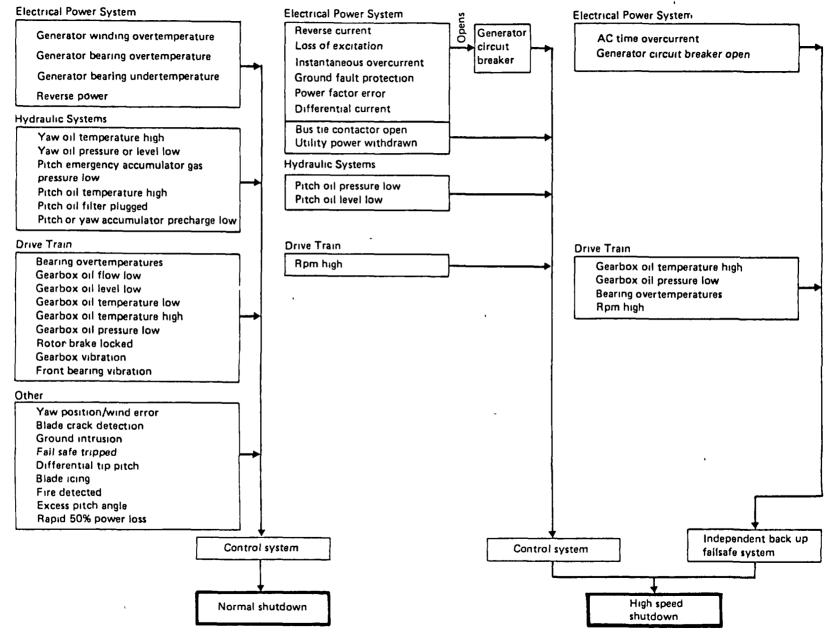


Figure 1, MOD-2 Safety System R

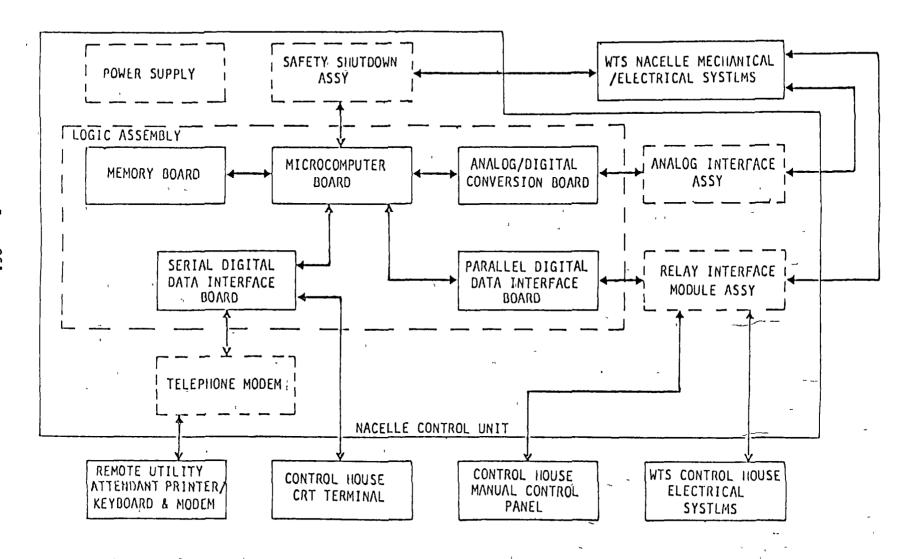
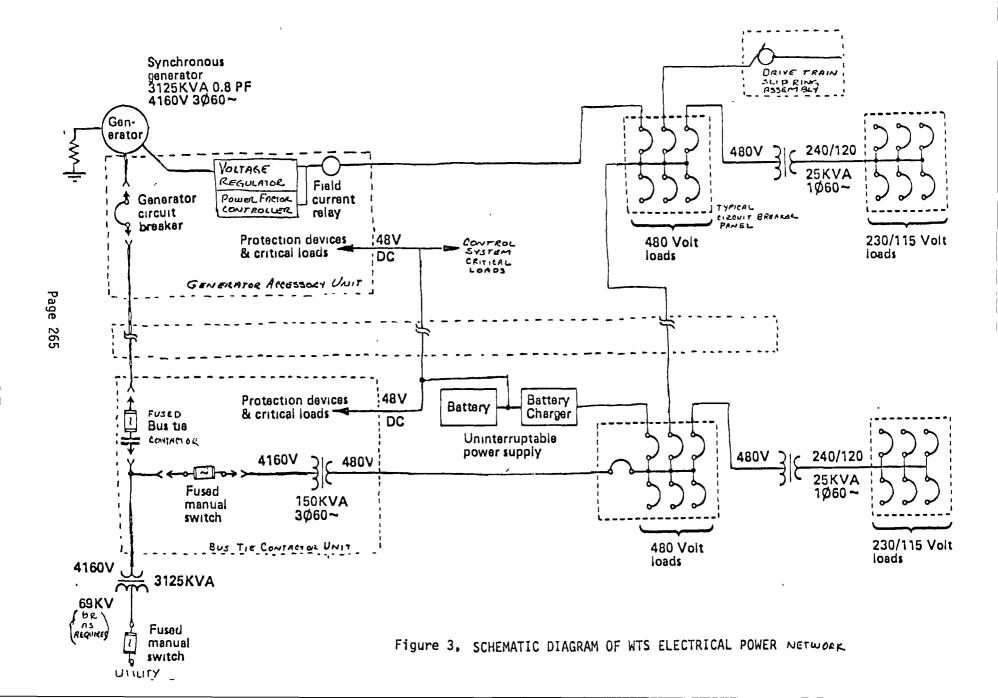


FIGURE 2, CONTROL SYSTEM BLOCK DINGRAM



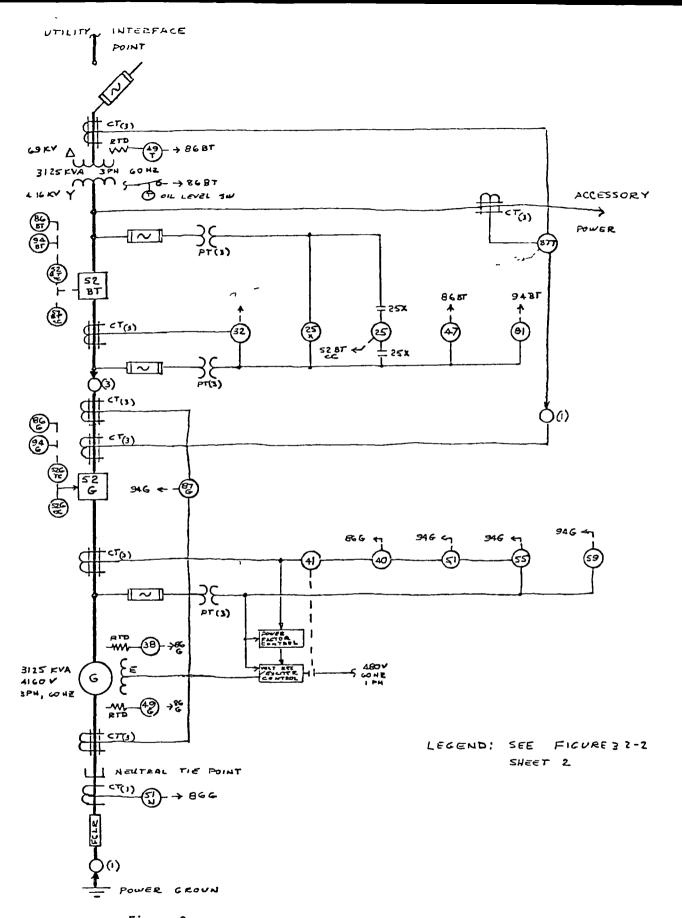


Figure 3, SCHEMATIC DIAGRAM OF WTS ELECTRICAL PROTECTION (SHEET 1 OF 2) (Con't)

#### LEGEND!

- 25 SYNCHRONIZING RELAY
- 25x SYNCHRONIZATION CHECK RELAY
- 32 DIRECTIONAL POWER RELAY
- 38 GENERATOR BEARING OVER TEMPERATURE RELAY
- 40 LOSS OF EXCITATION RELAY
- 4) FIELD CUERENT RELAY
- 47 PHASE SEQUENCE RELAY
- 49 THERMAL RELAY
- 51 AC TIME OVER CURRENT RELAY
- 526 GENERATOR CIRCUIT BREAKER
- 52 BT BUS TIE CONTACTOR
- 55 POWER FACTOR RELAY
- 59 OVER VOLTAGE RELAY
- SIN GROUND PROTECTION RELAY
- 81 UNDER FREQUENCY RELAY
- 86 LOCKING OUT RELAY
- 87 DIFFERENTIAL PROTECTIVE RELAY
- 94 TRIPPING RELAY
- FELR FAULT CURRENT LIMITING RESISTOR
  - (X) SUBSCRIPT QUANTITY USED
- SLIP RING (ARROW DENOTES BRUSH)
- IN FISED MANUAL DISCONNECT DEVICE
- BT BUS TIE
- CC CLOSE COIL
- CT CURRENT TRANSFORMER
- E EXCITER
- G GENERATOR
- PT POTENTIAL TRANS FORMER
- RTD RESISTANCE TEMPERATURE DEVICE
- T TRANSFORMER
- TC TRIP COIL

Figure 3, SCHEMATIC DIAGRAM OF WTS ELECTRICAL

PROTECTION (SHEET 2 OF 2) (Con't)

Page 267

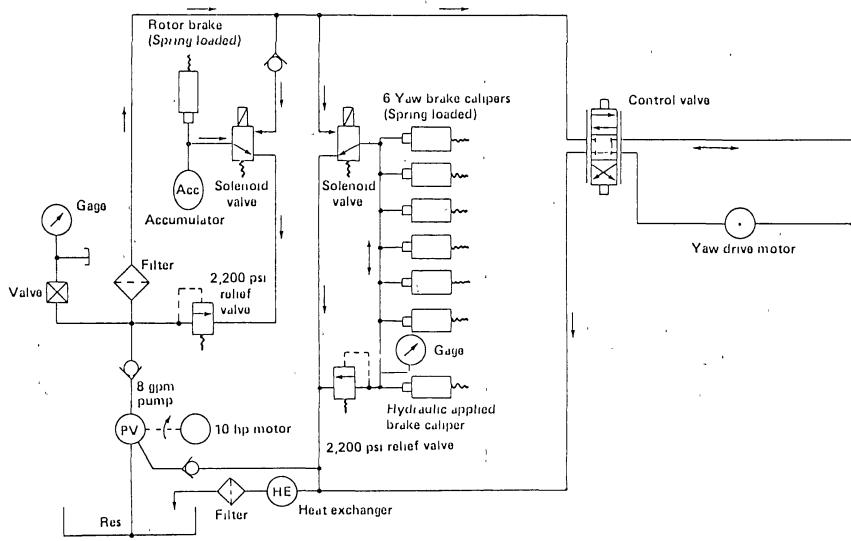


FIGURE 5, HYDRAULIC SCHEMATIC, YAW SYSTEM

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FIGURE 4, HYDRAULIC SCHEMATIC - PITCH ,

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APPENDIX C

MEMO K-6265-SS-487, DATED 18 October, 1978, MOD-2 FAILURE MODE AND EFFECTS ANALYSIS

To:	•		W.	Wiesner	
cc:	\ \	1	R. J.	Davison Douglas Erickson Engle Davis	;

Subject:

\MOD-2\Failure\Mode and Effects Analysis

Reference:

K-6266-RL-177, Same Subject, Sept. 14, 1978

The shut down analysis requested in the subject reference has been performed as part of a more comprehensive study on emergency shutdown conditions. The following shutdown analyses were performed:

Condition	Description	Shutdown Procedure
#1	Normal shutdown	Feather at 1 ⁰ per second, drop load at 125 kw
# <b>2</b> -	Emergency shutdown	Feather at 4 ⁰ per second for 6 seconds and 1 ⁰ per second thereafter, drop load at 125 kw
#3	Drop load, emer- gency shutdown	Drop load, feather at 4 ⁰ per second for 6 second and 1 ⁰ per second thereafter
#4	Control system malfunction Emergency shutdown	Power exceeds 2X rated, drop load, feather at 4 ⁰ per second for 6 seconds and 1 ⁰ per second thereafter
#5	One tip jams Emergency shutdown	One tip jams, feather other tip at 6 ^o per second for 8 seconds and 1 ^o per second thereafter, drop load at 125 kw
#6	Lose one tip Emergency shutdown	Lose one tip, feather other tip at 60 per second for 8 seconds and 10 per second thereafter, drop load at 125 kw.

The maximum rotor overspeeds resulting from the shutdown condition are presented below.

	MAX ROTOR S	SPEED (RPM)
SHUT DOWN CONDITION	45 MPH	28 MPH
#1	17.530	17.529
#2	17.516	17.515
#3	18.536	19.771
#4	20.016	· [2>
#5	17.519	➂
#6	17.526	[3>

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1.5 gust required to drop load



Unable to drop load with 1.5 gust



Have not run these cases but rotor speed should not be much different than condition 5 or 6 for 45 mph since load is not disconnected.

Shutdown condition #4 and #5 correspond most closely to the conditions requested in the reference memo. The worst overspeeds result when the load is dropped before initiation of the shutdown procedure (Conditions #3 and #4). The max overspeed, however, does not exceed 15 percent. Under the other shutdown condition, the load is not dropped until the aerodynamic torques are small resulting in negligible overspeeds.

Prepared by:

S. A. Shipley

oproved by S. Andrews

THE BUEING COMPANY

#### APPENDIX D

#### CABLE RUNS AND SLIP RING ANALYSES

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Crack Detection- Power Cable to Motor	Crack detection system	Phase-to-phase short or short to ground	Crack detection system disabled. "No flow"switches activate resulting in WTS shutdown.
Crack Detection - wires to no flow and flow sensor switches	Crack detection system	Wires short to each other	Switches disabled such that crack would go unnoticed. No serious problem since upon first WTS shutdown NCU would detect a fault and inhibit restart.
Ice detector sig- nal cable	Ice detection system	Wires short together.	Wires short together-causes WTS shutdown. Wires open-detector inoperative-Detector on other blade still operative. Short to ground-damages NCU I/O module when detector activates. Damage not sign
Control system - 48 VDC power sup- ply cable and 208, 120 VAC power supply		Power line shorts to ground or to negative wire, or an AC shor occurs.	Circuit breaker opens result-

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Tip Control Cables to each Tip (from low speed shaft)	Rotor - Pitch Control	Worst Case - Short in Cable such that tip is driven hard over.	WTS shuts down via micro- processor command. Tip still under control stops WTS. No significant damage to WTS (Mi- croprocessor detects rapid change in power output and large difference in tip posi- tions).
Power cable to pitch hydraulic motor	Pitch control and teeter brake	Worst case is loss of power to pump motor and subsequent loss of hydraulic pressure	WTS shuts down upon detection on loss of pressure. No damage to WTS.
Pitch hydraulic pump on cable	Pitch control and teeter brake	Short - wire to wire; short to ground	Both failures result in pump shut down and WTS shut down.
Pitch and teeter brake status sig- nals and solenoid command signals	Pitch control and teeter brake	Short such that 115 VAC is applied to all or some lines.	Possible combinations:  1. Start-stop solenoids disabled-WTS shuts down (115 VAC short to ground)  2. Teeter brake disabled, 115 VAC line shorts to ground, WTS shuts down  3. Sensors by-passed. NCU thinks all status signals are o.k. Lack of detection of second fault possible until WTS has a normal shut down. Then it will detect fault and not restart. Probability of shorting to all related sensors is negligible.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Generator to Generator Accessor Unit - Power Cable	Electrical Power	Short to ground, wire-to- wire shorts	Differential current protection relay causes generator circuit breaker to open in both cases.
Generator to Generator Accessor Unit - Sensor Outputs	Electrical Power	Short to ground, wire-to- wire shorts	Sensor signals are at 110 VAC and a short to ground will result in WTS shutdown via I/O module opening. Wire-to-wire shorts would disable sensor, and therefore must be checked during preventative maintenance. A short to the exciter will result in abnormal generator output which will be detected by the G.A.U. resulting in WTS shutdown.
D.C. power panel to Generator Accessory Unit	Electrical Power, Controls	Short to ground.	Opens circuit breaker result- ing in WTS shutdown.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Oil Reservoir to Gearbox	Dríve Train	Short to ground or wire-to-wire short.	Short to ground opens I/O or care breaker and WTS shuts down. Wire-to-wire short could render "oil pressure low" or "oil temp high" sensors inoperative, but these signals are redundant.
Environmental Control - All Cables	Environmental Control	Short to ground or phase to phase short	Circuit breaker opens disabling fans. Not detected by N.C.U. May cause failure in N.C.U. which could result in erroneous signals to pitch, yaw or electrical controls. Similar to a random N.C.U. failure. Fail safe system shuts down WTS (see FMEA controls for analyses of each N.C.U. control line).

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Fire Detector Cable	Fire detection and extingu- ishing system	Wire to-wire short resulting in the detector being ineffect- ive.	Fire would not be detected until second detector picked up smoke. Integrity of wiring checked during preventative maintenance. Emergency egress for personnel provided.
460 VAC cable from power distribution box to yaw drive system; 120 VAC single phase	Yaw drive system	Short - phase-to-phase or to ground	Circuit breaker opens rendering yaw drive system inoperative and resulting in WTS shut down as NCU detects that yaw drive system is inoperative.
Yaw drive signal and status lines	Yaw drive system	Both status and command sig- nals are 110 VAC, so wire-to- wire shorts are very unlikely. A short from any wire to ground possible.	Shorts to ground result in I/O or cuit breaker opening and WTS shutdown. Wire-to-wire short I renders command lines or status lines inoperative. Inoperative command line results in WTS shutdown via NCU. Status signals have back-up (i.e., yaw oil pressure low results in unresponsive yaw system which is detected by NCU).

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Generator Acces- sory Unit Outputs to NCU	· •	Short to ground on any single wire. Since all wires but one in this cable are at 110 VAC, the probability of a wire-to-wire short is very small, but long term insulation creep could result in this failure mode. The remaining wire is the power transducer.	Short to ground results in circuit breaker opening and WTS shutdown via pitch accumulators firing and driving blades to feather position.  Results of a wire-to-wire short is to render the status signal inoperative since sensor output would be bypassed Can be detected by periodic wrap-around check during preventative maintenance; second failure required before any problem exists.  Shorts to the power transducer result in immediate WTS shutdown via NCU.
Cables to wind sensors	Yaw system, control system at start-up	Wire-to wire-short or short to ground	Cables from both sensors are separated so that a failure within one cable causes a disparity in signals resulting in WTS shutdown.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
NCU to Drive Train	Drive Train	Wire to wire short applies 110 VAC to other 110 VAC lines or to 5 VDC failsafe lines.	Short of 110 VAC to other 110 VAC lines would bypass protection sensors (bearing overtemp #1 and #2). Highly unlikely and detectable by checking during preventative maintenance. Short to 5 VDC lines (overspeed and RPM sensors) would result in shutdown via N.C.U.
460 VAC power distribution to gearbox controls	Drive train - controls	Phase to Phase short or short to ground	Circuit breaker fails and WTS shuts down.
NCU to Drive Train Oil Reservoir	Drive Train	Short to ground or wire-to-wire short.	Short to ground results in circuit breaker opening and WTS shutdown (all wires are 110 VAC). Wire-to-wire short could disable "oil pressure low" line, but it is redundant and is therefore not a problem.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
208/120 volt Power Distribution Panel - Housekeep- ing Circuits and EPS	Aircraft Warning Lights, Generator Protection Cir- cuits	Short to ground, wire-to-wire short	All shorts to ground open circuit breakers. Wire-to-wire shorts would open circuit breaker if different phases short together or if 208 volt line shorts to 120 volt line. Other wire-to-wire shorts have no impact
460 VAC Power Dis- tribution Panel - Housekeeping Cir- cuits	Generator Heaters, House- keeping, 208/120 VAC supply	Short to ground, wire-to-wire short	Same as 208/120 volt cable above
NCU to Yaw Slip Rings	CRT, Ground Intrusion System, Telephone Line, WTS status indicators, Bus Tie Contactor	Short to ground, wire-to-wire short	CRT, telephone and status indicators not critical functions and no significant damage occurs. Control wire to Bus Tie Contactor shorts to ground or open circuit causes Bus Tie Contactor to open resulting in WTS shtdown. Bus Tie Contactor status lines shorts or opens results in WTS shutdown. Short or open sync. enable line inhibits WTS start-up.

#### THE BUEING COMPANY

LOW SPEED SHAFT
SLIP RING ANALYSIS

#### LOW SPEED SHAFT SLIP RING ANALYSIS

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
LOW SPEED SHAFT SLIP RINGS Rings 1-10	Power Circuits - 460 VAC and 28 volts DC	Ring to adjacent ring short	All of these shorts result in a circuit breaker opening and loss of pitch hydraulic pressure or pitch control. WTS shuts down via hydraulic pressure low or erroneous pitch position feedback signal
#11	Command return (ground)	Short to #10 (280 DC) Short to #12 (110 VAC)	Same as above. Fires emergency accumulator resulting in safe WTS shutdown
#12	Accumulator inhibit com- mand	Short to #13 (110 VAC)	Would prevent firing emergency accumulator on one side, but second accumulator would fire and safely shutdown the WTS.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
Status signa? line #16	Pitch Control	Short to #17 (110 VAC)	Would not provide oil low information, Pressure low and/or temperature high would result in shutdown.
Pitch Hydraulic Oil Level Low #17	Pitch Control	Short to #18 (110 VAC)	Same as #16 above
Pitch Hydraulic Oil Filter Clogge #18	Pitch Control	Short to #19 (110 VAC)	Would not provide oil filter clogged information. Filter would be by-passed by relief valve.
Pitch Hydraulic Pressure Low #19	Pitch Control	Short to #20 (110 VAC)	Would not provide pressure low information. Would be detected by fail-safe system and WTS would shut down.
Pitch Hydraulic Oil Temperature High #20	Pitch Control	Short to #21 (110 VAC)	Would not provide oil temperature high information. If WTS performance suffered, the control system would detect it. No major damage would occur if undetected.

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CABLE RUN	SYSTEMS AFFECTED .	FAILURE MODE(S)	· EFFECTS
Pitch Hydraulic Accumulator Precharge Pressure Low #21	Pitch Control	Short to #22 (110 VAC)	Would not provide status. Backed up by fail safe system
Pitch emergency accumulator gas pressure low #22	Pitch Control	Short to #23 (110 VAC)	Would not provide gas pressure low signal. Fail-safe system backs up this detector. (See #14)
Crack detection status signal #23	Crack detection _	Short to #24 (110 VAC)	Would not provide crack de- tection capability.
Crack detection status signal return #24	Crack detection	Short to #25 (110 VAC)	Same as #23 above
Emergency Accum. Inhibit Command #25	Pitch Control	Short to #26 (spare) Short to #24 (110 VAC)	No impact Same as number 12.
#26	Spare		

Ice Detection		l l
,	Shorts to adjacent slip rings	Would render one side of rotor ice detection inoperative. Signals to each detector separated so both sides would not fail. Test signals checks circuit integrity.
Spares		
Pitch control	Slip ring to slip ring short	WTS would shut down since the NCU would detect an error between the two blade tip positions. Worse case would be loss of a servo amp in the NCU.
Spare		-
Test Instrumentation	Slip ring-to-slip ring shorts	Not a part of the in-line WTS functions - would not inhibit normal or high speed shut downs.
- 1	Spares Pitch control	Spares  Pitch control  Slip ring to slip ring short  Spare

THE BUEING COMPANY

YAW SLIP RING ANALYSIS

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS Ground - #1 & #6 Primary Power out - #2-4 Neutral - #5	Electrical power	Ring-to-ring short	Short would probably vaporize. If not, instantaneous over-current and/or ground fault relays would trip the generator circuit breaker and open the bus tie contactor. As a back-up, the BTC is fused.
480 volts A.C. #7-9	All systems that utilize 480 and 240/120 VAC. (Controls, electrical)	Ring-to-ring short	Minor shorts (a wire strand) would vaporize. A major short would trip the 480 VAC circuit breaker(s) resulting in WTS shutdown.
48 VDC lines #10-13	Control system	Ring-to-ring short	Loss of 48 VDC to controls would result in shutdown. The uninterruptable power to the BTC would be maintained since there is a fuse between the battery output and the slip rings, but the wire to the BTC is on the battery side of the fuse.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS Fault current Limiting device (FCLD) #14	Electrical power	Short to #15 (low level current is on #15 - differential CT).	Would create imbalance which Would trigger differential CT.
Differential CT ØA #15	Electrical Power	Short to #16 (FCLD)	Same as #14 above
Fault current Limiting device #16	Electrical power	Short to #17 (low level current)	Same as #14 above
Differential CT ØB, ØC and Common #17, 18, 19	Electrical power	Ring-to-ring shorts 17-18, 18-19 Short #19 - #20	Same as #14 above
Sync. Enable Relay #20	Electrical Power	Short to #21 (BTC Tripping relay - 110 VAC when closed).	No impact on sync. enable relay since it already has 110 VAC applied. No impact on the BTC relay since it too has 110 VAC applied when rotating. During shutdown, both #20 and #21 have "0" volts applied, so no impact from a short.

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS BTC Tripping Relay - #21	Electrical Power	Short to ring #22	Would short I/O module and disconnect BTC resulting in WTS shutdown.
Command return #22 (from BTC and sync. enable relay.)	Electrical Power	Short to #23	None, #23 is a spare
Spares - #23 and #24	-	-	-
Generator Circuit Breaker (GCB) Closed indicator return #25	Electrical Power	Short to #26 (Generator field current meter)	Would apply 48 VDC to the Generator Field Current meter. Could cause 48 VDC circuit breaker to open, shutting down the WTS. No serious consequences if current draw is insufficient to trip the breaker.
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CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS Generator Field Current Meter (+) #26	Electrical Power	Short to #27 (48 VDC)	Same as #25 above.
Generator Circuit Breaker Closed Indicator	Électrical Power	Short to #28 (current meter)	Same as #25 above.
Generator Field Current Meter (-) #28	Electrical Power	Short to #29 (110 VAC)	Would cause ammeter to act eratic. No WTS operational consequence.
BTC Tripped #29	Electrical Power	Short to #30 (110 VAC)	Would incorrectly indicate that the BTC was closed when it was opened. NCU will detect and lock out the WTS.
Utility Power Present #30	Electrical Power	Short to #31 (110 VAC)	Would indicate that utility power was present when it wasn't. NCU would not have AC power so could not start up. If the short occurred during operation and subsequently, power was lost, the WTS would shift from 60 HZ frequently and shut down.

SYSTEMS AFFECTED

FAILURE MODE(S)

**EFFECTS** 

YAW SLIP RINGS  110 VAC for BTC signals (Ident. #90 and 91 Slip ring #31)	Electrical power	Short to #32 (110 VAC)	None. #32 is the instrumenta- tion van signal that is either at "O" or 110 VAC. In opera- tional use, this line will be 110 VAC.
Instrumentation Van Not Ready Signal #32	Instrumentation	Short to #33 (48 VDC ground return)	Would destroy 110 VAC test sig- nal I/O in NCU. No operational impact.
D.C. Return for 48 VDC signals #33	Manual control panel indicators	Short to #34 (48 VDC)	Same as #32 above.
Auto Mode Indicator #34	Manual control panel indicators	Short to #35 (48 VDC or 0)	Could erroneously indicate that the control system was in auto mode. Would be obvious fault since the manual mode light would also be on.
C/S Enabled Indicator #35	Manual control panel indicators	Short to #36 (48 VDC or 0)	Could erroneously indicate that the WTS was shut down. Indicatorswould be in conflict and failure obvious.
Shut Down Indicator #36	Manual control panel indicators	Short to #37 (48 VDC or 0)	Could erroneously indicate that the WTS was in manual mode. Failure would be obvious.

CABLE RUN

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS Manual mode indicator #37	Manual control panel.	Short to #38 (110 VAC or "0")	Would put 48 VDC onto 110 VAC line if in manual mode. Could damage NCU I/O Module, but would not result in secondary damage.
Shutdown Switch #38	Manual control of WTS	Short to #39 (110 VAC)	Both lines are at 110 VAC or one is at 0. Shutdown would occur if short happens while running.
120 VAC supply #39	Manual control panel	Short to #40 (48 VDC)	Could damage NCU I/O module. No secondary damage. Failure would be obvious since several functions on the panel would be disabled.
Emergency Stop #40 & 41	Manual control panel	Short to #41 and/or 42	By-passes switch and stops WTS. Short to #42 could damage NCU I/O. No other damage.
Ground Intrusion Switch #42 and 43	Ground Intrusion	Short to #43 or #44	Would erroneously indicate a ground intrusion. Short to #44 no problem. (#44 is a spare)

CABLE RUN	SYSTEMS AFFECTED	FAILURE MODE(S)	EFFECTS
YAW SLIP RINGS #44 - 51	None - Spares		
Remote telephone lines #52 - 56	Communications to remote utility control console	Ring-to-ring shorts. All circuits are low level TTL.	Loss of communications with site. No damage to WTS.
Local CRT #57 - 61	Local CRT signals	Ring-to-ring shorts. Circuits are low level TTL.	Loss of information to local CRT. No damage to WTS.
#62 - 120	Test Signals - used dur- ing initial test only. Disabled prior to turn- over.		

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16 Abstract						
	The report contains the results of a failure mode and effects analysis of the Mod-2 wind					
	turbine. This work was performed by the Boeing Engineering and Construction Company,					
	a Division of the Boeing Company, as a part of contract DEN 3-2 to design and build three					
	300 foot diameter, 2500 kWe, wind turbines.					
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