LPRDS-ETS-2009 MEMORANDUM

TO: CLIVE NTULI, LPRDS TEAM

FROM: TYLER PELTON

SUBJECT: GPR007: MAINTAINABILITY

DATE: 5/13/2009

The Statement of Work for the LPRDS-ETS-2009 requires a Mean Time To Repair (MTTR) of less than one week. Given that most orders take well in excess of 2 weeks to be ordered, shipped, and delivered; it is necessary for the LPRDS-ETS-2009 to maintain an inventory of spare parts, to be used as Line Replaceable Units, should a problem occur. Drawing on the GPR006 Reliability analysis and Bill of Materials, the parts and their generic failure rates were consolidated into a set of individual components (such as the ground fault monitor and battery packs) as well as assemblies (such as the printed circuit boards). From there, the easiest components to keep in stock were then determined, compensating for the longer shipping times required on big-ticket items, such as the AC transformer and the ground fault monitor.

MIL-HDBK-472(Note 1) and MIL-STD-470B were consulted, in addition to information on the Internet about maintainability studies and engineering. After comparing the information from the above sources, the equation below was used to determine the MTTR:

$$MTTR = \frac{\sum_{i=1}^{n} (\lambda_i MCT_i)}{\sum_{i=1}^{n} \lambda_i}$$

Assuming that this system could be implemented in a business setting, each week was defined as a normal 40-hour week. Using this equation with the table below, the system was determined to have an **MTTR of 39.77 hours**. Based upon a 40 hour work-week, this meets the requirement of 1 week.

Spare fuses for those present in RPI, ESS, and EDS cabinets.
Fully populated spares for each PCB in the system
- ESS: $135.19
- RPI: $120.33
- SCADA: $65.70

LEDs for the display board (these are regularly in stock, anyway): $0.25 ea.
LiFePO4 battery pack $180.00
Safety relay $5.81
HV Solid-State Relay $153.99
IGBT Gate Drivers $16.00

The total cost of the spare parts would be $677.27.

In order to meet the requirements for GPR007, there will also be a demonstration of two failures, of various likelihoods. The likely failure will involve replacing the ESS printed circuit board. The unlikely failure will involve replacing the solid-state relay in RPI.

		Maintainability				
RPI	Quantity	Component MTBF	Repair Time	Kept In Stock?	Total hours to repair	Component MTTR
Fuse	1	0.01	1 hours	Y	1	0.01
Current Transformer	1	10	2 weeks	N	80	800
Ground Fault Monitor	1	10	2 weeks	N	80	800
N.O. Relay	1	0.1421	1.5 hours	Y	1.5	0.21315
Ice Cube Relay	1	0.0931	2 hours	Y	2	0.1862
PCB	1	2.116	2 hours	Y	2	4.232
						0
SCADA						0
PCB	1	0.40877	2 hours	Y	2	0.81754
Linux PC	1	6.13	1.5 weeks	N	60	367.8
Display LEDs	20	1.152	0.25 hour	Y	5	5.76
Display LCD	1	5	2 weeks	N	80	400
Safety Relay	1	0.0931	2 hours	Y	2	0.1862
						0
EDS						0
PCB	1	17.22	2 hours	Y	2	34.44
Transformer	1	4.5	1 week	N	40	180
Safety Relay	1	0.0931	2 hours	Y	2	0.1862
IGBTs	4	0.9	.75 hours	Y	3	2.7
Gate Drivers	2	0.2	0.5 hours	Y	1	0.2
						0
ESS						0
PCB	1	6.66	2 hours	Y	2	13.32
Batteries (12V packs)	16	1.1	1 hours	Y	16	17.6
12V DC/DC Converter	1	1	1 week	N	40	40
Safety Relay	1	0.0931	1.5 hours	Y	1.5	0.13965
N.O. Relay	2	0.2842	1.5 hours	Y	3	0.8526
Manual Switch	1	0.22	1.5 weeks	N	60	13.2
Fuse	3	0.03	4 hours	Y	12	0.36
						2682.20354
					System MTTR (hours)	39.7684758