
Mean Time Between Failure (MTBF) Data Analysis of UPS

Equipment at the Exxon Chemical Plant in Baton Rouge, Louisiana



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Abstract

The data provided by Exxon's maintenance personnel covered a time span of 11 years from 1978 through 1989. Twenty-three UPS systems, all manufactured by Solidstate Controls Inc, were included in the database. Each system consisted of a charger, inverter, Static bypass switch, mechanical bypass switch, and a 60-cell battery.

The 23 systems were installed at different times and the total accumulated run-time hours reflect this. The total accumulated time over the eleven years was 1,252,680 hours (143 years).

Referring to page 3, each failure has been tabulated chronologically with the oldest failures starting at the bottom. The dates shown in parenthesis (e.g. '81) are the installed date for that system. The annotation (T/A) refers to a failure that occurred during a maintenance period. In a refinery, maintenance is permitted only during scheduled intervals called "turn-arounds". These turn-around intervals usually are two or three years.

Some of the failures were due to external causes such as water damage, fire, or explosion. These are noted as external causes.

Analyzing the failures starting on page 3

36 items are listed, but the item described as high audible noise was not counted as a failure.

Of the 35 items remaining 11 were battery failures, so the remaining equipment failures were 24 items. Looking at these 24 items, 11 failures occurred either during a turn-around or from external causes. Thus we are left with 13 bona fide UPS equipment failures that occurred while the refinery loads were running.

Breaking down these 13 failures, two involved the chargers, eight involved the inverters, and three involved the static switches.

MTBF by definition is the total running hours divided by the number of failures. Looking at the three major sections of a UPS system, the MTBF can be stated as follows:

Chargers	$\frac{1,252,680 \text{ hours}}{2 \text{ failures}}$	=	626,340hours/failure
Inverters	$\frac{1,252,680 \text{ hours}}{8 \text{ failures}}$	=	156,585 hours/failure
Static Switch	$\frac{1,252,680 \text{ hours}}{3 \text{ failures}}$	=	417,560 hours/failure

It should be noted that it is a common practice in the UPS industry to state in the sales literature a MTBF number based solely on the static switch. This so called mission MTBF is defined as the number of hours between loss of power to the critical load. Under this definition the inverter could fail once a day, but as long as the static bypass is available, no power interruption to the critical load occurs. Mission MTBF ignores the loss of availability of the static bypass and hides the failures of the inverter and charger.

Solidstate Controls believes that the MTBF for each major UPS section should be stated independently and should be based on actual field data rather than the theoretical calculations described in the military standard, MIL-217F, which is often the basis for published MTBF numbers.

The MTBF for the ferroresonant inverters is particularly noteworthy since it is 2-3 times higher than inverters using pulse-width or step-wave technology. The simple, rugged design of our inverters is reflected in the field data supplied to us by Exxon.

Incidents

Years in Service/System		# of Units in Service	
0	AROM	C 805 SHTS ('81)	
	APCC	LOOSE SCR/WIRING ('86)	
	BELA-5#1	D.C. INPUT FUSE ('87)	23
	NEO ACID	STAT. SW. PCB ('88)	
	NEO ACID SACC #1	BATTERY- OFF GAS ('88) PWR B.C. CONTROL PCB ('88)	
1	8 PLA	BATTERY CAPCTY TEST FAIL ('86) EXIDE	
	NACC#1	BATT'RY FAIL (188) GNB	
	SACC #2	BATTERY OVERHEAT (88) GNB	22
	RLA #1	BATT'RY RECALL ('87) PWR	
2	BELA-5#1	BATT'RY FAIL (87) PWR (T/A)	
	BELA-5#2	BATTERY FAIL ('87) PWR (T/A)	
	IPCC #1	MBS LOCKED UP ('80) (T/A)	21
	IPCC #2	SCR FAIL-INV. ('80) (T/A)	
	RLA-1	BR'KR TRIP - D.C. DISQBRK'R ('87)	
3	APCC	LOW DC DISC. ('86)	17
4	POX	ST. SW. SCR,- FUS ('78)	14
5	IPCC #1	3 rd- HARM CHK ('80) (T/A)	
	SACC COMPR	ST. SW. PCB ('80)	12
6	NACC Comp.Ca	ALT. SRC ALARM PCB ('80)	
	SACC Compr	ALT. SRC ALARM PCB ('80)	12
7	IPCC #2	MBS LOCK-UP ('80) (TYA)	
	0X0-NRTH	BATR'RY FAILED CAP'CTY TEST ('80) C&D	12
	POX	FU 2,4,5 BLEW ('78)	
8	AROM	C 805 SHRT'D ('81)	external cause
	AROM	BATPRY CELL FAIL ('81) EXIDE	10
	PALA	B.C. ALARM PCB ('80)	
9	IPCC #1	HIGH AUDIBLE NOISE ('80)	
	IPCC #2	BATTERY FAIL ('80) EXIDE	
	PALA	C 1 CAPC. OPEN ('80)	external cause
	PALA	C 805 CAPC. LEAKS ('80)	
	POX	SCR SHRT'G PCB- WATER IN UNIT ('78)	external cause
	SACC COMPR	MBS LOCK-UP ('80) (T/A)	external cause
	SACC COMPR	OSC. PCB RELAY ('80) (T/A)	
10			
11	POX	CRK'D BATTERY CELL; GND	
		DETCT PCB ('78)	external cause