Database for Maintenance Analysis of the Argonauta Nuclear Instrumentation System

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The maintenance of systems and equipments is a central question related to Nuclear Engineering. Although systems are not fully reliable, it is often necessary to minimize the failure occurrence likelihood. The elaboration of a maintenance plan has as objective the prevention and recovery from system failures, increasing reliability and reducing the cost of unplanned shutdowns [1]. It is also important to consider the issues related to organizations safety, especially those dealing with dangerous technologies. The objective of this report is to propose a methodological framework for the definition and implementation of a database, to be used in the maintenance analysis of the Argonauta nuclear instrumentation system [2]. In order to perform this analysis, a technical parameters database related to the reliability, maintainability and availability of the electronic modules that are part of the Argonauta nuclear instrumentation system will be defined and implemented [3]. The nuclear instrumentation system of the Argonauta reactor is composed of the electronic modules described in Table 1.

Table 1 – Electronic modules of Argonauta nuclear instrumentation system

PULSE CHANNEL – Modules	No.	POWER CHANNEL – Modules	No.
Preamplifier	9034	Linear Current Meter	9038
Pulse Amplifier	9035	Logarithmic Current Meter	9039
Count Rate Meter	9036	High Voltage Power Supply 1	9030A
Timer Counter	9028	Low Voltage Power Supply	9033
High Voltage Power Supply 2	9031A		
Low Voltage Power Supply	9033	SAFETY CHANNEL	9040

The database structure consists of the following information's: the description and identification of the electronic module, the total hours of operation of the electronic module, the number of module failures, the total hours spent on maintenance of the electronic module, the number of repairs made in the electronic module, the failure rate and MTBF (Mean Time Between Failures) of the electronic module, the repair rate and MTTR (Mean Time To Repair) of the electronic module and the availability of the electronic module. The Table 2, Table 3 and Table 4 show the database obtained for the electronic modules of Argonauta nuclear instrumentation system.

Table 2 – Failure rates and MTBF of the electronic modules

Modules	No.	Total of operating hours	No. of failures	Failure rate (1/h)	MTBF (h)
Preamplifier	9034	4,498	1	2.22E-04	4,498
Pulse Amplifier	9035	4,418	1	2.26E-04	4,418
Count Rate Meter	9036	4,410	2	4.54E-04	2,205
Timer Counter	9028	4,410	2	4.54E-04	2,205
Low Voltage Power Supply	9033	4,362	4	9.17E-04	1,090.50
High Voltage Power Supply 1	9030A	3,898	6	1.54E-03	649.67
High Voltage Power Supply 2	9031A	4,458	2	4.49E-04	2,229
Linear Current Meter	9038	4,050	8	1.98E-03	506.25
Logarithmic Current Meter	9039	4,402	1	2.27E-04	4,402
Safety Channel	9040	4,034	2	4.96E-04	2,017

Table 3 – Repair rates and MTTR of the electronic modules

Modules	No.	Total of maintenance hours	No. of repairs	Repair rate (1/h)	MTTR (h)
Preamplifier	9034	8	1	1.25E-01	8
Pulse Amplifier	9035	88	1	1.14E-02	88
Count Rate Meter	9036	96	2	2.08E-02	48
Timer Counter	9028	96	2	2.08E-02	48
Low voltage power supply	9033	144	4	2.78E-02	36
High Voltage Power Supply 1	9030A	608	6	9.87E-03	101.33
High Voltage Power Supply 2	9031A	48	2	4.17E-02	24
Linear Current Meter	9038	456	8	1.75E-02	57
Logarithmic Current Meter	9039	104	1	9.62E-03	104
Safety Channel	9040	472	2	4.24E-03	236

Table 4 – Availability of the electronic modules

Modules	No.	MTBF (h)	MTTR (h)	Availability (%)
Preamplifier	9034	4,498	8	99.82
Pulse Amplifier	9035	4,418	88	98.05
Count Rate Meter	9036	2,205	48	97.87
Timer Counter	9028	2,205	48	97.87
Low Voltage Power Supply	9033	1,090.50	36	96.80
High Voltage Power Supply 1	9030A	649.67	101.33	86.51
High Voltage Power Supply 2	9031A	2,229	24	98.93
Linear Current Meter	9038	506.25	57	89.88
Logarithmic Current Meter	9039	4,402	104	97.69
Safety Channel	9040	2,017	236	89.53

The failure and repair times of the electronic modules were modeled using exponential distributions of probability. The generated database and the proposed method can help in the maintenance analysis of the Argonauta reactor and other similar research reactors.

References

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