

Rational Reliability Centered Maintenance Optimization for power distribution systems



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ABSTRACT

Reliability Centered Maintenance Method (RCM) currently used for maintenance optimization based on the analysis of modes of dysfunctional system failures (FMEA), and after determining the criticality of the system, an adequate maintenance plan is adopted. Following the succession of several applications of this method, in several areas, along twenty years of experience, it was proved that the use of this approach was incomplete for other analysis and evaluation criteria were completely ignored especially in electrical systems. Our view is to apply this method rationally by introducing a whole dependability study (RAMS).

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Introduction

In this work (*extracted and summarized from my doctoral thesis*) [1], we have applied a maintenance optimization approach based on techniques of modeling and simulation by applying the experimental approach RCM that based on the functional and dysfunctional analysis of failure modes of the grid by using the FMEA model, and by using the SADT approach for decomposing hierarchically these different functional analysis tasks to classify the material in order of criticality. Then we have modeled the system by using static methods (combinatorial, deductive, functional and qualitative approaches) such as reliability diagram RBD and fault trees analysis FTA that identify the paths of weakness in the system and determine these characteristics RAMS, by using data of REX feedback that are collected from the old method (scheduled periodic preventive maintenance SPPM); then we determine the characteristics of dependability and reliability indices (time, rate and cost) by dynamic methods (analytical, behavioral, quantitative and stochastic approaches) such as Markov graphs MG and Petri network PSN, and therefore the determination of residence times, the execution frequency of the program and the probability of

exiting the dreaded condition for each component of the electrical network based on cost. And parallel with the modeling we will do a cost analysis of the life cycle to estimate the total cost of ownership of the electricity networks of each analyzed element. Finally, everything is completed and simulated by the Monte Carlo simulation in order to give important recommendations to keep the electrical system in the best circumstances [1–3].

Presenting the new approach: Rational RCM

The implementation of a simplified maintenance plan comprises 4 steps. These steps call on many data whose supports are relating to production, quality, and maintenance. All along these steps, involved groups must determine objectives having priority and validate results of each phase in order to continue without over diversifying their work [1–4,10,12,13] (see Fig. 1).

Case studies: Application to the power distribution systems

To illustrate our view in this work, we will give a general description of the electrical distribution station located in the region of RELIZANE Northwest of ALGERIA. The suggested

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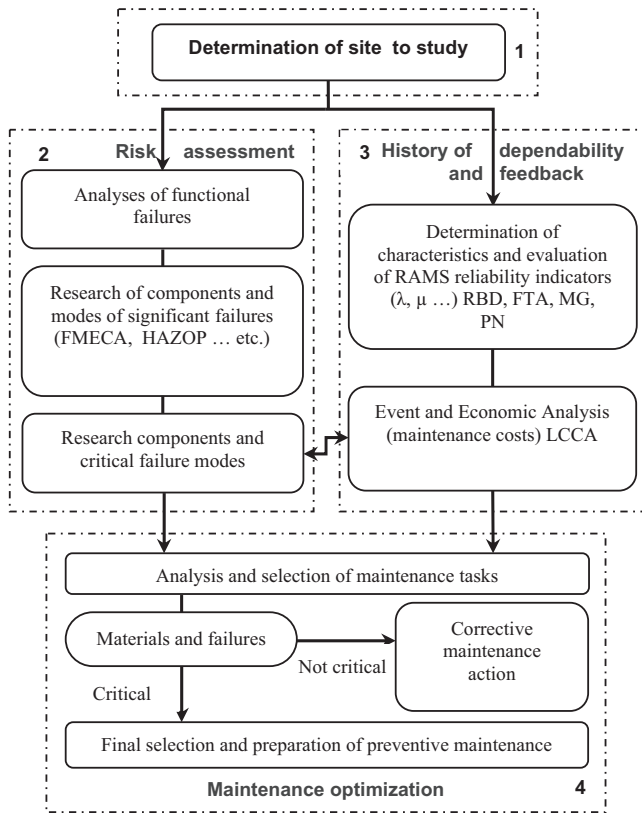


Fig. 1. Steps of RCM rational approach.

Table 1
Data of reliability.

Equipment	Failure mode	MTTF (years)	MTTR (h)	Estimated average cost of repair/year (x 10 ³ AD)
Electrical line EL	Clippings	3.5	2.5	345
Bus bars SB	Short-circuit	8	4	210
Insulator IS	Ageing	4	3	135
Transformer PTR	Priming Low insulation resistance Triggering power at the time of operation shedding Noise: the necking phenomena in transformers	5.5	3.5	240
Breaker CB	Long and short interruptions	8	5	165
Arresters PL	Overvoltage	8	2.5	75
Fuse F	Overloads	2	1	75
Sectionalizer SW	- Closing difficult or - Opening difficult	7.5	5	30

Table 2
Probability of occurrence (Safety).

Criteria	Frequency (O)	Value
Failure by 10 years	Very rare failure	0.1
Failure by 5 years	Rare failure	0.2
Failure by 3 years	Possible failure	0.3
Failure by one year	Frequent failure	0.4
Failure by 4–6 months	Very common failure	0.5

Table 3
Severity (Availability).

Criteria	Severity (S)	Value
Power interruption < 5 min	Minor	0.1
Power interruption < 20 min	Significant	0.2
25 min < Power interruption < 30 min	Average	0.3
1 h < Power interruption < 2 h	Major	0.4
5 h < Power interruption < 1 day	Catastrophic	0.5

Table 4
Detectability (Maintainability).

Criteria	Detectability (D)	Value
Time taken to detect the failure	Obvious detection	1
Failure early detectable	Possible detection	2
Failure is difficult to detect	Detection unlikely	3
Failure painfully detectable	Detection improbable	4
Failure undetectable	Cannot detect	5

Table 5
Partition equipment and action plan.

Condition imposed	Consequence	Maintenance action
$C < R$	No problem, nothing to report	Correctives de maintenance
$R < C < S$	Acceptable but!	Special surveillance preventive/predictive maintenance
$C > S$	Complete questioning of the study	- Systematic preventive maintenance action - New ameliorative study.

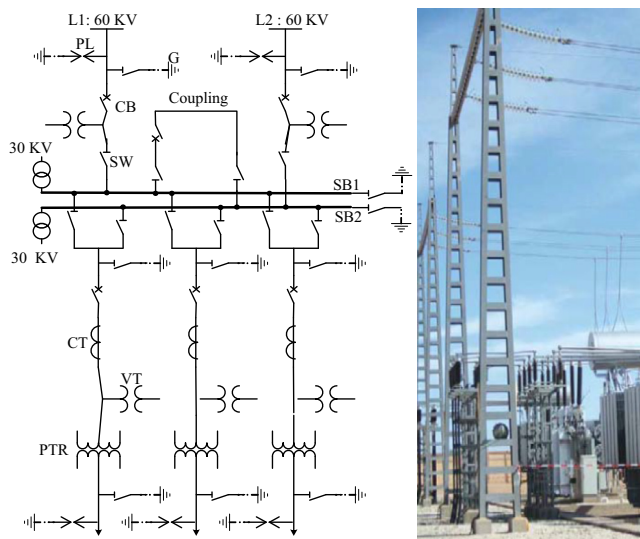


Fig. 2. Distribution network station of RELIZANE.

alternative for the Power Distribution Systems can be schematized as follows (Fig. 2) [1–3].

Data reliability material according to the method SPPM

These data are collected and calculated in collaboration with engineer's service station maintenance of Subsidiary Power Distribution System PDS SONELGAZ of RELIZANE [1–3] (see Tables 1–5).

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