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Excellence Method in Maintenance with Application for Cryogenic Nuclear Unit (EMAC)

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Abstract: - The studies recommend a demarche by conception for a solution by resolve of maintenance for a Cryogenic Nuclear Plant (CNP) where the maintenance is fundamental, or for which the maintenance is only important.
The demarche has to basis the achievement a two big stage. The first stage is a demarche by conception for maintenance on scientific basis, while the second stage is a demarche by implementation.
The first stage notification the management of maintenance in conditions constraints by quality, risk and cost. In conditions had established priority these constraints it will be start the project of research in maintenance.
The second stages notification the aspect of design and technology in maintenance for a Cryogenic Nuclear Industrial Unit (NIU).

Key-Words: - integrated cryogenic maintenance, predictive cryogenic maintenance, preventive cryogenic maintenance

1 Introduction

Cryogenic Nuclear Plant (CNP) has as main objectives the elaboration of a technology for the removal of tritium from heavy water used in nuclear plants of CANDU fabrication and the elaboration of a technology for complete inspection of an equipments used in the present of tritium at very low temperatures.
The demarche has to basis the achievement a two big stage. The first stage is a demarche by conception for maintenance on scientific basis, while the second stage is a demarche by implementation.
The first stage notification the management of maintenance in conditions constraints by quality, risk and cost. In conditions had established priority these constraints it will be start the project of research in maintenance.
The second stages notification the aspect of design and technology in maintenance for CNP. The solution adequate with this demarche by conception will going to achievement a one solution viable for implementation, which is the solution for operative maintenance. The operative maintenance is definite as maintenance in utilization and it will be basis on RCM (Reliability Centered Maintenance), a conception by design for usage – NOLAN and HEAP 1978.
This demarche will be possible to solve the problem of maintenance from CNP, because it put in value the essential role on which it have the management of risk, the management of quality and through the characteristics from efficient feedback, which can constitute a one solution by integrated maintenance applied for Nuclear Cryogenic Plant.
The integrated maintenance through research and implementation demonstrates it be a one engineering process complex referring to: research of conception, design and realization equipment dynamics and static complex usages in CNP.
EMAC is a method by conception and implementation that integrated maintenance at the way of life cycle for the considered cryogenics systems, through the aptitude or the cybernetic characteristic of maintenance integrates. The implementation (see Figure 1) is realized through software LabVIEW for the specific objective achieve by Program for Operative Maintenance in Temporal Dynamic Regime (POMTDR).

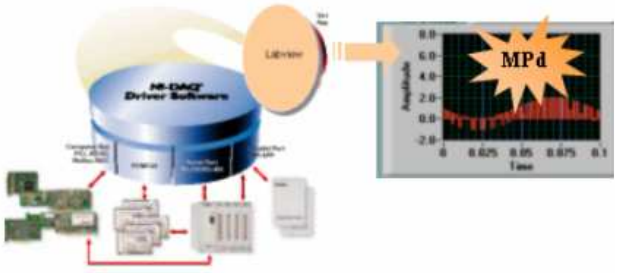

Fig. 1, LabVIEW software and DAQ system for MPd

2 Conception for EMAC

The industrial maintenance in nuclear cryogenic domain has interdisciplinary character, who represents a

technological economical and complex social reality, which must designed, implemented and exploitation conform finalities proposal mission, scope, objectives, vocation. There are numerous considerations, which determine us to associate industrial maintenance in nuclear cryogenic domain with the General Theory of Systems, considering the productive units as open systems of with evolution depend always by a management effort of human nature, based on the feedback principle:

- It is conceive, it is design and it is implementation for a nuclear cryogenic technical system constituted from interconnected elements and coordinated for realize the scope and purposed objects;
- It has the constitutive elements, behaviors, techniques and characteristic aspiration, sometime contradictory;
- The internal and external medium of industrial plant is in continuum exchange which impose analyses, essay, revises, adaptabilities, organizations for maintenance activity, the maintenance must to have a dynamic quality;
- It is necessary the elaboration and the adoption a global theory by maintenance, on which can build concept and methods attached of internal medium of nuclear plant in the scope of knowledge structures, organizations, the characteristics technological tides;
- The managers (the maintenance manager, the operative maintenance managers), must to base their decisions on a prospective vision, knowing the present stage, we can understand the whole or the part from plant, which create premises of some future developments.

The systematic shape can't be dissociate from the observer which shape himself a system which build the model in function by his knowledge, by the position that he occupied in comparison with the system and the objectives which have been established for the demarche that realize them.

The observer experience in reality perception and in model technique in special in data analysis at the level of real system represents the guarantee conditions that can assure the model success. Taking into account of up mentioned reasons each observer builds or uses a model, which appears satisfactory psychological, temporal, special, social, economical and technical. Hence result the perpetual work for enrich or simplify the models already existed.

In this context the proposal method applies in special to the leadership function (the manager observer) as a part of nuclear maintenance responsibilities.

The model represents (see Figure 2) an assembly of activities, which define in series of relationships between three elements that interfere in this process:

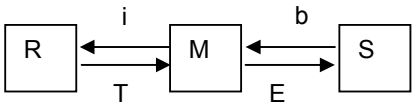

Fig. 2, The model in the manager programming

R-Reality
M- Man
S – Shape (Model)
i – Represent the image that the man (M) created about reality (R); this depends of more legal factors both by R and by M
b – Represent the process of building the model
E – Represent the process of testing the model
T – Represent the improvement of theory owned by man (M) about reality (R). The existences of some mathematical or physical similitude between two systems constitute the model basis.

The excellence model in maintenance proposal referred to the phase of using in exploitation of one nuclear technical system after the systematic form, synthesized in figure 2 and the detail of this is according to figure 3, and it has at base a conceptual system well substantiated and with application for operative maintenance under the form of Program for Operative Maintenance in Temporal Dynamic Regime (POMTDR), respective for the achievement of important feedback for conception – design phase, as a function of integrated maintenance.

EMAC use a System Informatics for Maintenance Nuclear (SIMN).

SINM is organized on modules representing functions and utilities specific to the operative maintenance for corrective maintenance, preventive maintenance and the maintenance for permanent improvement.

Because the function of corrective maintenance, visa in special a technological and technical aspect for maintenance, the objective of preoccupation for the proposal excellence method referred in special at the preventive maintenance, based on time (PMT) and the preventive maintenance based on state (PMS), which will be named in continuation maintenance predictive (MPd).

MPd is a maintenance based on the momentary state of

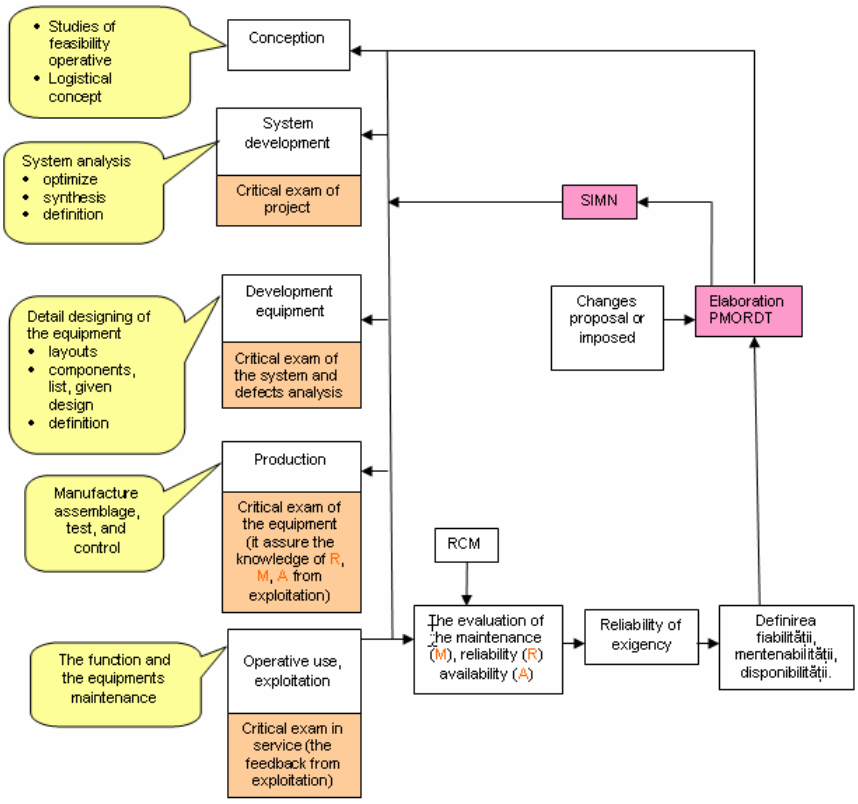

Fig. 3, Conceptual model for an excellence method in maintenance

technical system; realize the considerable savings both through the increase of average time between stops and through the decrease of possibilities for causing some catastrophic damage. The necessary data for determination of function state of one machine can be obtained through micromechanical measurements, corroborated with the monitoring of process parameters.

From MPd results accumulation of statistical data, on machines categories (see Figure 4.), the correlation of these with the function state, with the variation of state parameters and with the concrete work conditions, with the vibrations and the noises levels, information what substantiate PMORDT.

For complex sizes are accessible and statistical interpretations too, which offer the features of respective repartitions (average, leakage)

Result that TMBF characterize the equipment reliability (Time of Maintenance Between Failure) and TM characterize the maintenance time.

The number of damages can be obtained with help of some statistical distribution (exponential, Weibull, normal, etc.). The normal distribution is proper to the wear process and for the electrical and electromechanical products the most suitable is Weibull distribution.

This distribution modeling well the processes of mechanical and electrical wear.

In the mechanical domain the safety problems, in classic way, are looked through the prism of safety coefficient defined as the ratio between the average limit (Lmed) and the average workload, thus:

$$c = \frac{L_{med}}{P_{med}} \qquad (1)$$

A system has a different reliability from it components, but dependent on the reliability of these elements. The limit value from relationship 1 can be referred at the dynamic limit of yield point or at the breaking limit of

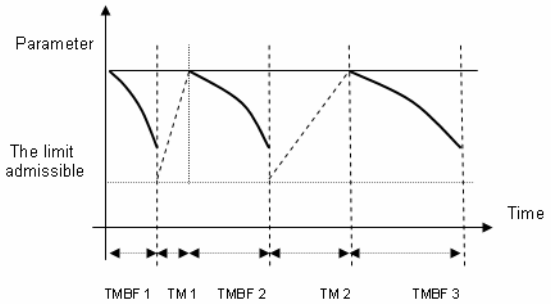

Fig. 4, The graphical temporal by function of one equipment repairable

the material. The recent papers orientated oneself towards statistics methods for the define of this coefficient, considering the limit tasks (the strength at

solicitations) and the work tasks (applied) as being submitted to the distribution of normal repartition.
The reliability can be determined provisional through laboratory attempts and with date from exploitation.
The provisional reliability determines with help of given tables in different specialty papers, which contain life length or failure rate of the components.

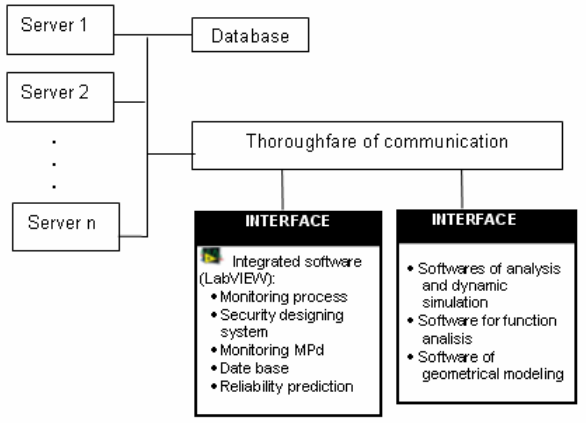

Fig. 5, Maintenance integrated in Life Cycle of technical system

Having on base the exponential distribution, the values from tables of parameter λ_o correspond to the nominal solicitations and for different condition is done the correction:

$$\lambda = k\lambda_0 \quad (2)$$

The global coefficient of correction k can be defined through the relationship:

$$k = k_s k_a k_f k_t \quad (3)$$

Where:
ks = is the correction imposed by over solicitations
ka = the correction of environment
kf = the correction imposed by the constructive and of execution characteristic feature is the correction imposed by age and the moment from time of function for what is determined the reliability.
The laboratory attempts can be: determinative attempts, accomplished with the purpose of determination of distribution reliability parameters, control attempts accomplished with the purpose of verify of framing reliability of some lot in prescribed limits representing one of the tasks of technical control of quality.
The operational reliability is determined in real conditions on function, that doing through the collection with the help of some historical cards, the realization by reports of failures, which are processed with the help of statistic methods.
For integration impose the realization of some System Informatics for Maintenance Nuclear (SIMN) organized to function systematically and fast, with application at the complex technical systems.
This SIMN must conceive so that is integrated with the used software for the monitoring of process technology.
The functions for SIMN are:
General function:

- Acquisition and transfer date;
- Registering of sequences, events;
- Analysis post failure;
- Saving of process date;

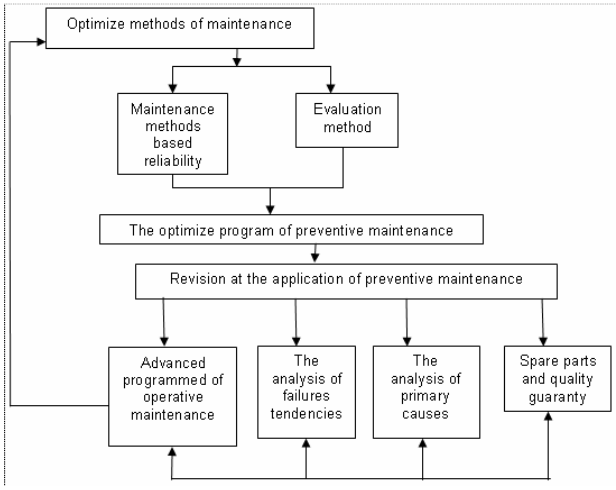

Fig. 6, Structure for realization POMTDR

- Archives date;
- Hierarchy priorities;
- Security and processing alarms.

Central function:

- The operative pursuit;
- Reports and data sheets;
- Maintenance (planning of working operative maintenance);
- Condition technical system (availabilities);
- Automatic adjustment;
- Automatic stating / stopping;
- Pursuit sensor condition;
- Types of function for technical systems;
- Simulation – training;
- Forecasts of reliability.
- Specific functions:
- Interconnection and date change in other systems;
- Administration of leadership system.

The operational reliability is determined in real conditions of function. In some case the laboratory attempts are unsaying, the exploitation remain the only source of information concerning at reliability.
For that is necessary an informational system organized to function systematically and fast.
This must to realize the characteristic feature or the dynamical quality with make possible the realization of

one integrated maintenance during the life cycle of product in the sense of integrated engineering.
So SIMN must to quantize the foreseen reliability in the designing phase through the processed date from exploitation phase going so at the improvement of maintenance such as permanent activity on the one hand, respective through rigorous substantiation (the reliability exactingnesses, maintenance and quality) of the redesigning of the maintainable technical system considered on the other hand.
SIMN permit the realization of co-operation between decision managers responsible for the realization of function during the life cycle of product or the existent functions in the frame of given industrial process.
The idea is that the functions must to be known, accurately perceived and quantized concerning the sizes technical, economical human. The role guarantee of this necessity has the advanced level of implementation of quality system in plant.
The conception for SIMN has on basis the achievement of some initial condition for the approach of implementation of integrated maintenance, which is:

- The quarantine of motivation for problem solution is assured through quality function in nuclear domain (starting with the post file);

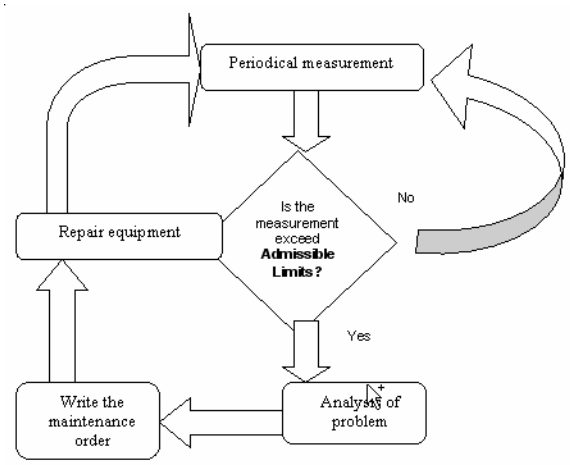

Fig. 7, The period of failure development

- The classification of initial and limit condition, assured through the maintenance policy of leadership function of nuclear unit (with the respect of compulsion concerning the quality and the authorization of function in the nuclear domain);
- The elimination of the prejudices, the search of the variants and the taking of decision (the search of solutions is facilitated by an intuitive thinking, characterized by imagination in principal in subconscious, almost impossible of influenced and of rebuild and logic, consciousness step by step, communicative).

In the consideration of the SIMN integration, for the nuclear technical system designing are necessary network computers, respective the internet use, taking into consideration that the nuclear units are process type, the informational link with plants which design and / or produce the nuclear technical systems are as a rule localized in more countries. The necessary feedback created through the integrated maintenance characteristic generates date, simulation of test or analysis.
The used software programmed must to be integrating to permit the engineers to change and to distribute the designing date. This condition can be realized through the software interface, each programmed communicating with the server / servers for product, process or organization into consideration of the information distribution (Fig. 5). For software integration through SIMN of the maintenance in real time propose the use of software LabVIEW.
So the proposal method integrates the technical, economical and human resources through Internet using the standard protocol (TCP/IP).
At the conception and the implementation of system of integrate maintenance and detailed through SIMN the principal demarches are:

- The integration of nuclear technical systems;
- The integration of date, with their definition and substantiation the process of date for final result;
- The realization and the guarantee of co-operations both on horizontal and vertical line;
- The assume of responsibilities through taking the decision like interactions from inside of system or with the plug in systems resulting correct decisions in real time;
- The determination of flexibility of maintenance system after his realization, taking into consideration the implementation through SIMN with dynamical structure, orientated towards future and designed for generate-process-stock and later on for actualizes the necessary information and the taking of specific decisions of some maintenance process.

The objective of proposal method is to realize POMTDT. The proposal structure is corresponding to the figure 6.
MPd is a preventive maintenance based on equipment state. The predictive maintenance represents the modality of prediction and prophylaxes in maintenance. It is characteristic of some type of event, which can be predetermined with the help of different tools: diagnosis, measure wear, information received from a sensor. This method of maintenance prevents appearance of supplementary sources of failure, as a result of disassemble sometime useless, of preventive

maintenance, interfering in the most favorable moment. This aspect represents the contribution of time dimension, which enrich the predictive maintenance on her plan, which is considerate prophylactic.
Those methods are the following:

- The monitoring of process parameters (MPP)

Consist in the setting under permanent or occasional control of key points of technical systems through the

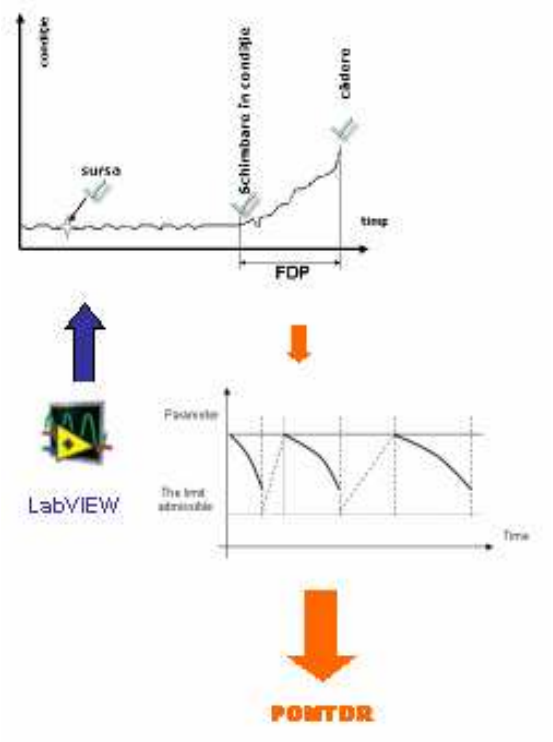

Fig. 8, The determination of failure developing period (FDP)

measurement and the knowledge of function state, this realizing with automating tools and permitting either alert or actions starting or intervention starting well defined in case in which is about of type model of behavior or in case in which is available an auto diagnosis coupled system.
MPP use tools of understructure control and tools of information transmission, which must to be equipped in conception of the equipment.

- Monitoring physical parameters of equipment (MPPE)

MPd, compare the tendency of measure physical parameters to reach the established limit like forbidden in the purpose of the detection, analyses and correction of the problems before the failures happen. The MPd can be applied at any problem of the equipment if in first place physical parameters like vibration, temperature, pressure, electrical voltage and electrical current or electrical resistance can be measured.

An engineering limit for the measurement of physical parameter must to be in establishment of problem, which can be detected during the routine monitoring. The problems corrections from the root are the key of some many predictive efforts. The reasons for a predictive monitoring system are:

- The avoidance of unplanned stops;
- The reduction of reparations duration;
- The limitation of effects through their discovering earlier;
- The optimize of maintenance activity;
- The function under observation in damage conditions;
- The correct diagnosis of the defects;
- Decrease of costs.

2.1 The cycle MPd

Once a new piece of critical equipment will be added in program, it goes in the cycle MPd like in the graphic from Figure 7. If the measurement exceeds the admissible limits, it will be analyzed and supplementary under more forms.
Once the problem source is determined (see Figure 8.), can be chosen the best activity for repair.

3 Conclusion

In conclusion the nuclear complex technical systems must to have in vision of the Excellency Method in Maintenance, the realization of some dedicated software, the existent functions for designing, realization and exploitation, a kind of prototype of integrated software modules, of these systems during of the life cycle.

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