

Industrial safety and experience feedback: the case of French nuclear power plants

Philippe Fauquet-Alekhine^{1,2}

¹ Nuclear Power Plant of Chinon, Head Management Department, BP80 – 37420 Avoine, France

² Lab. for Research in Sc. of Energy, 86200 Montagret (Nueil\Faye), France
email: philippe.fauquet-alekhine@edf.fr¹, larsen.sciences@yahoo.fr²

Fauquet-Alekhine, Ph. (2012) Industrial safety and experience feedback: the case of French nuclear power plants. In Fauquet-Alekhine, Ph. (eds) *Socio-Organizational Factors for Safe Nuclear Operation*, Montagret: Larsen Science Ed., 1, 19-24 (*)
<http://hayka-kultura.com/larsen.html>

Abstract

The French nuclear power plants operated by Electricité de France are of type "pressurized water reactor. This collective design promotes a capitalization and a pooling of means, including experience feedback (REX), which must be a force for operation of this nuclear fleet.

The REX and integration are satisfactory when they register in two dimensions at least, one is organizational and the other one is time. But the organizational dimension can be easily reduced, and the dimension of time is often "dilated".

The ideal form of the organizational dimension can be reproduced in a closed loop that uses the findings, results, analysis, and solutions that should be implemented. These solutions, implementing the integration of findings from learning, give rise to new findings and assessment of effectiveness. The loop is closed.

The ideal form of the dimension of time, may be summed up in "as soon as possible".

Thus, the closed loop of the organizational dimension joins the effective nature of the REX, and the ideal of the time dimension joins the efficient nature of the REX.

Frequently encountered problems reside in the non-closure of the loop and the inability to quickly, or even to do everything simply. Yet, each actor of the company is aware of this need. Despite this, the experience feedback of the REX, show all the difficulties to calibrate the REX process at the right level.

To work this broad question and solutions, the management of the Generation division of EDF (DPN) launched a project in 2007, the REX project.

The paper outlines the various stages of diagnosis, solutions research and deployment thereof, and the success factors identified both locally and nationally.

The solution adopted to achieve the target model is an organization of the REX and its integration by the CAP: the Corrective Action Program. To ensure the adequacy to the needs of nuclear plants and verify the feasibility in the context, the stage of diagnosis was followed in 2010 by a phase of experimentation on a few plants, before engaging a global deployment anticipated in the second half of 2011.

1. Introduction

The French nuclear power plants operated by Electricité de France are divided into 19 plants scattered throughout the French territory. All these plants are of type "pressurized water reactor" (PWR). This collective design promotes a capitalization of learning from experience and sharing means that are a force for a safe operation of the nuclear power plants. Thus, if each plant (2-6 nuclear reactors each) has a degree of autonomy, there exists nevertheless a national organization in many areas that promote exchanges, centralization of information, analysis, and redeployment of innovative solutions.

The experience feedback must, of course, proceed of such an organization, both at the local level as at national level. Feedback is a broad topic that inevitably includes many themes in an industry as complex as the production of electricity of nuclear origin. And as any action or any project, it must contribute to strengthening nuclear safety (see Fauquet 2002, 2003, 2004), for obvious reasons of every day protection of humans and environment, and because a risky system operation implies the continuous demonstration of a high level of safety (Amalberti, 1996 and 2001). This allows to guarantee in case of technical problem, that the technical process and the organization will succeed to control facilities in the situation.

It should be noted that the objective of nuclear safety is to protect human and his environment of radioactive contamination by the containment of the core and derivative products.

The experience feedback concerns many areas at various levels; we cannot here expose all. Also we have chosen to focus the presentation on a large enterprise project, the "REX project" (in French: "le Projet REX"), explaining its genesis and its deployment, and illustrating it from concrete examples of the operation of Chinon nuclear

* This work has been presented at the *J. des Grandes Ecoles de la Mer « Facteur Humain & sécurité maritime »*, 26-27 January 2011, Le Havre, France.

power plant. Before it should be appropriate to specify what is expected in terms of experience.

2. An efficient effective feedback loop

The experience feedback, or REX for “retour d’expérience” in French, comes from experience, as its name indicates. This experience, manifest in the form of results, findings (qualitative or quantitative), gives rise to a formal or informal analysis first. Within such a coordination, the experience is able to be integrated in a process of learning from experience.

As specified above, the REX concerns many issues in various areas. For example, the area of the worker in a given activity, the area of a professional practice and know-how, the area of a department organization, the area of an industrial site organization and interactions of departments, trades and external entities to the plant... This non-exhaustive list is very few of the multitude of possible examples.

The REX and its integration are satisfactory when they register in two dimensions at least, one is organizational and the other one is related to time. But we will see that the organizational dimension can be easily reduced, and that the time dimension is often “dilated”.

The ideal form of the organizational dimension can be depicted so: it is a closed loop that uses findings concerning results. These findings give rise to an analysis that produces solutions that should be implemented. These solutions, implementing the integration of learning from findings, have an effect on the results giving rise to new findings and assessment of effectiveness. And the loop turns without stopping.

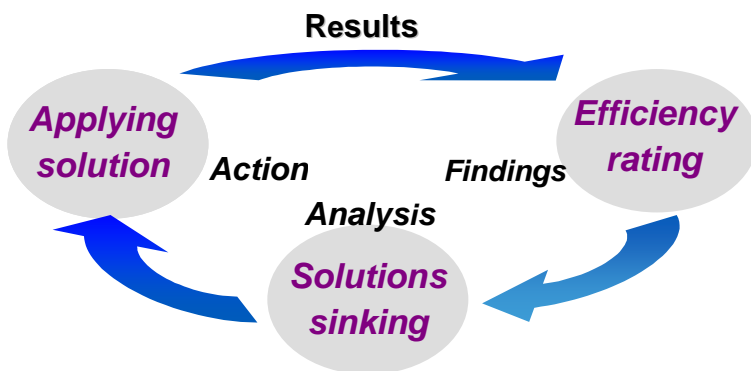


Fig 1. The REX ideal closed loop of the organizational dimension.

The common problem is the non-closure of the loop. It can intervene at various stages. For example:

- the findings exist but are not exploited: the loop stops before the question of the need to be analyzed,
- the analysis is made, solutions are proposed, but their implementation is not effective,

- solutions are implemented, but their effect is not analyzed because the findings are poorly targeted.

Concerning the ideal form of the time dimension, it is simple since it can be summarized as “as soon as possible”.

Thus, the closed loop of the organizational dimension is related to the efficacious nature of the REX, and the ideal form of the time dimension is related to the efficient nature of the REX.

Each actor of the company is aware of this need. However, the experience and the feedback concerning the REX show all the difficulties of businesses to sink the REX process at the right level.

Let us consider two examples from the Chinon nuclear power plant to illustrate these remarks.

The first concerns the maintenance of nuclear reactors. Annually, each reactor stops for outage and to renew the coil. At each outage period, some people are surprised that “everything happens as if every time we rediscovered what is a outage, with the same problems”. If these comments cannot be generalized to the organization of a outage, the fact remains that there are too many actors of the outage who has this feeling. In this type of situation, the REX is integrated, but only at the personal level: indeed, the person confronted with the same problem from one outage to the other has implemented solutions that s/he keeps in mind, to more quickly handle the same problem when renewing. But what expects the worker is that the REX will be integrated in the organization, so that if the problem arises the solution exists or if they have to deal with, it requires less energy than the first time. Here, in the area of the intervener, the REX is integrated, but at the level of the organization, this is not the case.

The second example concerns the REX of a profession in a department. The technicians complain about the absence of REX. However, a decision was made by the department management to formalize a REX meeting concerning the end of the outage. The finding is that this decision has remained at the state of intent.

Each actor is aware of the need for the integration of the REX and also people have a natural need of REX for any work activity. A simple experiment was made on a dozen of groups of 10 to 20 people each on the nuclear power plant of Chinon. It has been proposed to people in a room to engage themselves in a particular work activity. Although conducted in room and far from the usual technical activities, the general components of a classic work activity were encountered, namely achieving a work activity with:

- a constraint of time,
- a requirement for such a modus operandi.

- the need to summon a know-how developed for a long time,
- disturbances making the achievement of the outcome difficult,
- a request to achieve a specific result.

The work activity was to count the number of "F" in a 4 lines text that would be projected on the screen (see Fig. 2). In any case, the outcome seems fairly easy. However, the context was the following, complicating the realization of the application with reference to the above constraints:

- the text was shown during 20 seconds only,
- the text led to be read and letters had to be counted at the same time, and it was forbidden to read the letters one by one,
- the need to summon a know-how developed for a long time concerned the reading skills,
- the text was in English (while people were French), in tight uppercase letters.

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Fig. 2. English text submitted to French people during 20 seconds in order to count 'F' letters whilst reading the text at the same time.

For a group taking the test for the first time, the results may vary between 2 and 7 "F" detected per person, with a high proportion for the values 3 and 6. The typical distribution is shown on Fig. 3.

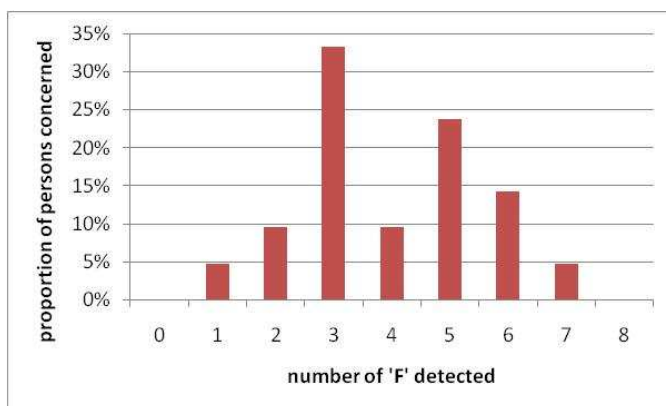


Fig. 3. Typical distribution of the number of French people watching the English text (see Fig. 2) submitted during 20 seconds and counting 'F' letters whilst reading the text at the same time: two extremes appear around 3 and 5.

Before taking this test, the instructions have been presented, the text was projected 20 seconds and hidden, and a discussion followed to compare the results of each person and discuss the difficulties encountered. After this discussion, the facilitator suggested to work another subject without moving back to the text and thus without knowing the exact result: "and now, I propose to following the presentation without I give you the correct result, the number of F in the text. We shall not come back on this test, you will never know the result, unless you manage to find one day the text elsewhere, but it is not me who will give you the solution. What do you think of it? Would you like to know the right result? " For the last question, between 70 and 100% of these groups usually replied to be very disappointed not to know the right result. When it was asked the reasons for this disappointment, the participants explained their need to know how to position themselves to the expected result, to better understand where they had errors, and possibly how otherwise do a next time, even if it was just a test without consequence.

This experience shows the spontaneous expectation of each one in terms of REX. If participants expressed such a desire even for a harmless test, it is quite easy to imagine how much they are expecting a share after a professional activity. It is important to note in this experiment:

- the spontaneous character of expectation of the REX,
- the existence of this expectation even for a harmless activity.

The result of the demonstration suggests that almost everyone in professional life is spontaneously expecting REX and that almost each one is predisposed to participate.

In this condition then, why the REX and its integration do not work as everyone would expect it?

To work this broad question and solutions, the management of the Generation division of EDF (DPN) launched a project in 2007, the REX project. Indeed, training people (Fauquet-Alekhine & Pehuet, 2011; Pastré, 2005) increasing interventions (Fauquet-Alekhine, 2009 and 2010a; Colas, 2001; Rousseau, 2008), enforcing the safety through event analysis (Fauquet, 2007 and 2008) or through socio-organizational analysis (Clostermann, 2010; Fauquet-Alekhine, 2010b), are not sufficient if the socio-technical system weakens over time (De la Garza & Fadier, 2007; Heimann, 2005; Reason, 1993 and 2008).

3. From diagnosis to implementation

The REX project started by a step integrating diagnosis and studying practices and organizations at the international level.

The approach consisted in:

- Taking into account analysis by nuclear industries.
- Participating observations on French nuclear plants.
- A in-depth benchmark in the United States.
- Listening to many actors at all levels of the organization of EDF (also from other divisions than the DPN).
- A thorough sharing of the diagnosis.

The major findings for the company organization were the following:

- The REX from the national level takes place over the local REX.
- A parallel REX exists to the operational activity, enhanced by the treatment of the safety events, and not enough through the success of the interventions.
- Developments of the REX is done by slides which have been by time superimposed while forgetting to rethink the whole from local need standpoint.

The solution adopted to achieve the REX target model is an organization of the REX and its integration by the PAC : « le Programme d'Action Corrective », inspired by the American CAP (Corrective Action Program). The PAC will be presented in the next section.

To ensure the adequacy of the solutions with the needs of nuclear sites and verify the feasibility in the context, the first step was followed in 2010 by an experimentation step on a few plants, before engaging a global deployment planed in the second half of 2011.

To enable the success of the project, efforts focused in particular on the following points:

- Identify quick wins in 2010 that restore confidence and socialize them.
- Involve all the plants in the project in 2010 via existing networks and with the help of a “mirror group”.
- Adapt the deployment of the project to the situation of each site.
- Maintain operational system during the transitional period of deployment.

These actions have in support two transverse components essential for the achievement of the objectives:

- A component "Means, methods, skills, and tools" to build the necessary means for the implementation of a renovated REX organization. Output products expected: a corpus of knowledge, methods and tools so that each actor has prerequisites required in the field of the REX; training for key actors (managers, preparation operators, REX project managers...) and for newcomers.
- Another component "Change management, culture and behaviors" to create the necessary conditions for the development of the REX. Output products expected: awareness, in the short term, of the way to go, and a change in behavior, both at the national and local levels.

4. The necessary structuring of the experience feedback and of its integration

The solution adopted to achieve the target model is an organization of the REX and its integration by the PAC: the Corrective Action Program (in French: Programme d'Actions Correctives, PAC).

The PAC is based on a frequency of analysis of the input findings in a computer database, and a closure findings-analysis-actions-results-findings...

Identification of the REX and the material of which it is made up are done via the findings every day D_i . Any person on the plant is involved in this work of computer input.

The consolidation of data entering is made at D_{i+1} . It is to verify the characterization of the findings to ensure homogeneity of these characterizations. This point is fundamental because if there is heterogeneity at this level, trend analysis and statistical analysis are generally impossible.

At D_{i+1} , the findings are prioritized, assigned to actors identified as in ability to process the findings and solutions. This means that every day, all of the findings entered the day before are studied.

The actors of this work analysis at D_{i+1} are part of the department management and involve themselves in the analysis for their department.

The integration of the REX is done through the analysis of two types: specific analysis and trend analysis. These are made at D_{i+2} , posted weekly and kept in check weekly and monthly. The aim is to appreciate whether the findings are archived for memory without action, or for simple action, or for specific analysis. The whole gives rise to trend analysis.

These findings being made on a daily basis at all levels and in all occupations, and then followed by various time scales, the effects induced by actions will lead to findings which will close the loop.

In addition, a review of efficiency is scheduled each month. In parallel, the conclusions are settled up in periodic performance reviews.

This target structure is not yet reached in the organization of Chinon nuclear power plant. It was chosen to go through a transitional phase, with a gradual integration of the objectives. First, the quality of the finding entering process and data extraction tool has been optimized. In parallel, the presence of the managers in the field has been worked to achieve a level of completeness and relevance to the issue. Secondly, a weekly analysis of the findings has been implemented. The third time is to come to achieve the target model.

5. Conclusion

We find that taking account of feedback and its integration are not obvious work activities to be implemented effectively and efficiently in the industry. They are daily disturbed by the industrial constraints induced by the real time, easily suffer from a lack of coordination of the treatment of the REX, and upstream, can remain in the state of intent if the framework is not clear. Their upgrade involves a solid diagnosis, and a deployment of their solutions integrating both careful planning and appropriate means.

According to the proposed solution (the corrective action program or PAC), the induced effects can hit the practices and culture of company. In this case, a component of accompanying change is necessary. This implies registering the project in the long term: a brutal and decreed change could lead to failure.

The feedback of the experience feedback itself also warns the sustainability of the solution: if the current state of the experience feedback suffers from an accumulation of poorly coordinated actions and decisions which remain in the state of intent, how the new organizational system will prevent this with time? Another potential danger is displayed: the drift of the system. it will need to ensure that the CAP will not turn into a machine made to accumulate observations with actions not dealt with. The planned organization should avoid such excesses.

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