

## INTRODUCTION

The term "safety culture" first came into use after the Chernobyl accident, and in the course of its brief 10-year existence, the expression has been the source of inspiration for a very large number of texts, procedures and plans which, in many cases, have given rise to specific activities and objectives.

In the field of radiation protection, a monumental effort has been made to implement optimization criteria or ALARA in nuclear installations, and such endeavors have managed to bring about a considerable reduction in the collective doses associated with the operation of nuclear power plants throughout the world.

These programs for designing radiation protection on the basis of optimization criteria and of applying concepts such as efficiency, costs, benefits, rationalization, etc., must be the foundations upon which to create an effective overall radiation protection culture that should cover the whole organization, and which at the same time succeeds in ensuring that the concept of radiation protection transcends the basic framework of activity in the installations, and enters other spheres of the organization until it reaches top level management and its aims are considered to be as important as economic or productivity goals.

## BACKGROUND

*The primary aim of radiation protection is to prevent the occurrence of harmful health effects in individuals being exposed to ionizing radiation, without unduly limiting the beneficial effects that the activities which give rise to such exposure have upon individuals and society.*

The conceptual framework of radiation protection is established in the recommendations set out by the International Commission on Radiation Protection (I.C.R.P.), adopted in national regulations, this in turn being based upon the E.U. Directives, in the case of the countries which are members of the European Union, and the publications issued by the International Atomic Energy Agency (I.A.E.A.) in Vienna.

The radiation protection model for nuclear installations is based on the basic principles of safety and protection announced by I.N.S.A.G. and I.C.R.P., which are outlined below:

- To reinforce "Safety Culture" in order to enhance positive attitudes and bring about an improvement in the behavior of both individuals and the organization.
- Nuclear safety, radiation protection for the workers and the general public and the preservation of the environment are fundamental basic principles which govern the operation of the nuclear installations.
- All activities that involve exposure to ionizing radiation, must yield sufficient benefit to society and to the exposed individuals to outweigh the radiation health

detriment it causes or could cause.

- Radiation sources and installations should be provided with the best available protection and safety measures under the prevailing circumstances.
- The design of the installation and the operating procedures, shall be in accordance with the principle of defense in-depth, so that any potential failures can be compensated by the safety and prevention measures.
- The safety of an installation and protection of the workers and the population, must be ensured by sound management and engineering, quality assurance, training and qualification of personnel, comprehensive safety assessments and attention to lessons learned from experience and research.
- The principle which governs interventions undertaken in the event of an emergency must be justifiable.

These basic principles were later formulated by the I.A.E.A. in a draft of a Safety Fundamentals of the Safety Series collection in two (2) main objectives of radiation protection and safety and eleven (11) basic principles that are derived from those two, concerning practices and actions to which we will be making reference.

- **Objective of Protection**

*To prevent the occurrence of determinist effects in the individuals by keeping the doses below the relevant thresholds and to ensure that all reasonable steps are taken to reduce the occurrence of stochastic in the population at present and in the future.*

- **Objective of Safety**

*To protect individuals, society and the environment from harm by establishing and maintaining effective defenses against radiological hazards from sources.*

The radiation protection system for practices, is based on four (4) principles:

- Justification of practices
- Dose limits
- Optimization of protection
- Prevention and mitigation

The interventions are governed by two (2) basic principles:

- Justification of intervention

- Optimization of intervention

Three (3) principles of implementation are drawn up from the above, concerning the following:

- Location of sources
- Design and construction
- Operation and use of sources

Finally, details are given of two principles regarding the organization and management of radiation protection and safety:

- Legal framework
- Responsibilities

These basic principles of radiation protection are not new, they were all drawn up, either in identical or similar form, many years ago and form part of the manuals and operating procedures for the installations. Workers are already familiar with them but, and this is the paradox, they have not been able to create a radiation protection culture among the organizations that perform or develop them.

Although it has been in existence for a much shorter period of time, the "nuclear safety culture" has well managed to create, or is managing to weave an effective culture tissue among both organizations and individuals, so that safety can proceed with the ongoing process of improvement. One of the reasons of the success has been its novelty in the formulations and the wish of not lag behind. Whatever the reasons are for the success of the implementation of the "nuclear safety culture", the fact is that it must serve as an example to be followed, and that such a safety culture should likewise be extended to the concepts of radiation protection in such a way that it is no longer possible to distinguish one concept from the other, or at least, that the organization develops ongoing ways of improving radiation protection.

## **CULTURE OF RADIATION PROTECTION**

Without attempting to define culture, it is worth mentioning certain characteristics that are common to any definition thereof, and which can be summarized as follows: a set of principles, values and beliefs jointly shared by all members of an organization, together with standards and expectations that influence the behavior and attitudes of the members of such an organization.

Applied to radiation protection, this concept could then be defined as the entire set of technical and social standards, together with the behavior and attitudes of the individuals concerned with a reduction in the exposure of workers and the general public to ionising radiation.

The element that distinguishes this definition from other general definitions of the radiation protection concept, and that which gives it its cultural nature, is the part that includes the attitudes and the behavior of the individual.

If this definition is correct and the initial thesis that no effective radiation protection culture yet exists, it is also true to say - or at least the conclusion to be drawn is - that either the basic principles are not shared by all levels on the hierarchical scale, a possibility which would have to be ruled out on grounds which are self-evident, or that the behavior and attitudes of the constituents of the organization are not sufficiently active where radiation protection is concerned.

In the light of the above - What are the factors that might exert a positive influence on the behavior of individuals in the field of radiation protection? Without fear of error but without wishing to provide an exhaustive account, the following factors influence such behavior:

- The perception of risk
- Attitudes towards work
- Work group dynamics
- Attitude towards technology
- Attitude towards the organization, hierarchy, leadership, procedures and working habits
- Personal motivation and expectations of improvement

We will now go on to analyze these factors as a whole, together with other conditioning elements regarding radiation protection, with a view to specifying all that is necessary for the creation of a radiation protection culture.

## **REGULATORY ASPECTS**

It is the case in nearly all countries, that the practical application of the principle of optimization of radiation protection ALARA (As Low As Reasonably Achievable) is developed within the organizations, at the same time as the safety culture is being developed.

The driving force behind the application of the principle of optimization has not been equally applied in all countries and organizations, sometimes this being due to the regulatory bodies and at other times because of factors inherent to the organization itself.

In countries where standards are more clearly defined, the initiative generally corresponds to the regulatory bodies, but acceptance and implementation have been

brought about more through imposition than a general consensus that has been convinced of its necessity and, as a whole, the process tends to be rather laborious and time-consuming, probably due to the lack of flexibility of the regulatory practices to be applied to all circumstances. One single and valid implementation pattern does not appear to exist for all organizations.

However, what is relevant in this case, is that all the effort made in implementation must be used and situated in a more general radiation protection framework, in which optimization will naturally be the most important current criterion, but without excluding the attitudes and behavior of individuals.

Other countries, which have less prescriptive controls and a more performance based, the application of the optimization criterion, are allowing the utilities, in a more flexible climate, to find the tools needed for using their specific cultural elements and to create an effective and efficient "ALARA culture" in the organization, and they have a more suitable shape from which to expand upon the objectives already achieved, thereby establishing a genuine radiation protection culture.

## **STRATEGIC FORMULATIONS**

A first step towards ensuring a successful radiation protection culture is to expand its scope of activity. Radiation protection must not only exist within a nuclear power plant framework, but should also operate at the highest decision-making levels of the company.

The current scenario in which nuclear activity takes place, makes the safe operation of nuclear power plants and radiation protection for the workers, the general public and the environment, an ever-increasing necessity. The obligations that those responsible for the operation of nuclear installations have to the workers and to society in general, based upon essential values and quality management attributes, require a clearly defined professional code of conduct, that not only guarantees the responsibility of the professionals to society in such a way that nuclear safety and radiation protection are constantly being perfected, but also by participating in society at the same time, having a role that is clearly subordinate to the latter where service is concerned. In this way, radiation protection becomes a requirement regarding the strategic outlines and company policy, as an ongoing attempt is made to modernize and improve management.

The maximum body for company representation and decision-making, which we shall refer to as the General Management, is a key element for initiating, implementing and maintaining a radiation protection culture, because jurisdiction as regards the allocation of resources, falls upon this body, which is likewise responsible for defining the culture of the entire organization.

The General Management must also include the permanent objective of protecting the workers health, the prevention of accidents, occupational illnesses and diseases and the protection of the environment, as an integral part of its strategic plans. This ongoing preoccupation of nuclear power plants must materialize itself in paying

attention to the constant improvement of radiation protection in nuclear installations.

Such corporate undertakings must take the form of a few clearly defined and easily definable aims, well known to all the organization members, and sufficient resources must be allocated to guarantee their fulfillment. In short, radiation protection should also become part of the management and decision elements of the General Management.

These main company strategies and obligations must bear the following in mind:

- Economic and social factors that affect the protection of the workers and the general public alike, given that the purpose of radiation protection is to provide an acceptable level of protection, without limiting the benefits that nuclear installations give to society and without forgetting their social dimension.
- The integration of radiation protection criteria into the general production, quality and continuous improvement targets, by means of a radiation protection policy based on predictions and goals, the measurement of the results and an analysis of experiences. It has to be possible to measure these goals by establishing performance indicators that must reflect the results of the company's policies.
- This integration of the elements of radiation protection at top level management, ought not to be interpreted as implying a modification to the existing organizational structures, but rather that a natural integration process should take place. This would require that the General Management be provided with an advisor in radiation protection so that the latter could provide the former with constant and continually updated information as regards the achievement of the objectives and a monitoring of all relevant activities.

## **PLAN MANAGEMENT POLICY AND ORGANIZATION RESPONSIBILITIES**

The second step in a commitment towards radiation protection culture concerns the management of the installation.

The Management of the installation must promote the initiatives that lead to the establishing of a radiation protection network involving all the workers. The principle that the workers themselves must be the beneficiaries from radiation protection as well as being those responsible for it, must no longer be a mere maxim, and has to become a reality.

It has been proved that a nuclear power plant operating with a small collective dose has better indicators and performances, as well as being more economical and safer than other plant with the same power but with a higher dose. The dose is, in itself, indicative of the quality of the operation in a nuclear installation. The lower the dose the greater the quality.

A lower dose means less time spent in the radiation zones, more reliable equipment, a greater availability of personnel, lower maintenance and operating costs, more time devoted to training and, in all probability, shorter outages times and thus greater revenues.

Therefore, from a power plant perspective, the plant management provides the main impetus for radiation protection culture, and is also its most enthusiastic adherent, and defines the radiation protection policy as an integral part of its operational goals, allocating the resources required for successfully carrying out this policy and involving all management levels to this end. So, by way of example, the use of tools for cost-benefit analysis can make it possible for a decision to be taken to reduce power, with a view to making an urgent maintenance intervention in operation.

There are a variety of ways in which other managerial levels can be involved. One of the most effective ways is to make an associate between the specific objectives and the dose. The dose is also converted into an additional goal for each department.

Each department has a maximum annual limit that must be efficiently and effectively managed, and reported to Management for their activities and achievements, in the same way as with a budget.

Therefore, the radiation protection service (R.P.S.) for the installation is not alone in its responsibility for this, because the duties must be shared among all those involved in the organization of the plant. This is a natural way for the principles of radiation protection to filter through and throughout the entire installation, and to bring about an integration in the existing organization, operation procedures and radiation protection maintenance criteria, as well as enhancing the creation of interdisciplinary groups for the purpose of programming, planning, carrying out and reviewing/revising all the work.

Of course, this process of change cannot take effect without the involvement of the radiation protection service on the site. If it is the workers who are the protagonists when it comes to radiation protection, they must be offered every assistance in making their tasks easier. The term customer-oriented service must be the aim of the service and has to play an active role to make the work easier for others at all the stages involved in those plant activities in which the worker dose is a common element.

The all too well known mentality of acting as a sort of police force within the controlled zone must be abandoned, and such activities should be replaced by systems of surveillance, advice and support for the tasks. The bureaucratic concept of passing through a control point for the radiation protection service to authorize the work must also be abandon. The Radiation Work Permit must cease to be a Permit, and to form part of the Work Order, thereby enhancing the smooth-running of the radiation protection measures. Furthermore, the R.P.S. ought to provide the executing services with all radiological information concerning the plant, so that these services can plan their tasks well in advance and succeed in obtaining a more efficient management of the personnel in their charge. The use of radiation and dosimetric data bases at the disposal of all personnel, together with the presence, in the controlled zone, of all mimics updated in

real time plus radiological information for the premises will help well-trained foremen to manage both their own radiation protection and that of those in their charge.

## **WORKER ATTITUDE**

If the controlling bodies act in such a way as to enhance the natural integration of the radiation protection criteria into the management of nuclear installation in the widest sense of the term, so that the radiation protection culture becomes an undeniable fact, only worker involvement will remain to be achieved.

The worker thus becomes a basic element in the framework of the radiation protection culture. If active worker participation does not become a reality, the whole process is doomed to failure. Therefore, it is essential to modify the behavior and attitudes of the workers, so that they themselves not only carry out the company's radiation protection policy, but also feel themselves to be fully integrated in the plans and their developments.

Nevertheless, worker involvement is a complex process that is still at the blueprint stage, and a wide range of factors come into play, such as: economic, cultural, social, technical, interpersonal relationships, etc.

In the light of the above, no attempt is being made to establish universal recipes for actions to be taken in order to bring about active worker involvement in the setting up and development of the cultural process. However, the following list of conditions and pre-requisites have to form part of management activities if the workers are to be involved:

- **Risk Perception and Attitude towards Technology**

The non-tangible nature of ionising radiation risk, even the expression to define them - stochastic and determinist risks -, the social pressure that tends to magnify such risks, an unawareness of the technology, the possible existence of an inherent yet subconscious tendency to reject, etc., may well have caused the workers to fail to understand the reasons for radiation protection standards and thus not take part in defining them, leading them to a situation in which they complacently accept such rules without really knowing why. Therefore, it would appear obvious that the initial training and any later re-training, must always place emphasis on these basic concepts and explain the risks of ionising radiation in a clear and unambiguous way, by way of analogies involving other more easily recognizable risks. All positive experience obtained in the prevention of professional risks, must be put at the disposal of the radiation protection service and the radiological risks must be included in a more global management of professional risks, given that the activities involved in radiation protection are not exclusive to the technicians, but also require the participation of all those involved in nuclear activities and are of equal importance at all organizational levels.



- Behavior of Management and Senior Staff

If the workers are to be involved in the culture of radiation protection, management must be able to imbue them with a perception of its own desire to promote the principles, not only of willingness to have such a policy, but also that management itself sees it as being necessary. The existence of Committees at the highest level which deal with radiation protection questions on a routine basis, the frequent presence of senior staff in radiation zones verifying the conduct of the workers and showing an interest in the development of the work being carried out in the radiation zones, making sure that radiation protection matters are as important as safety, economic and operational objectives, etc., must be activities that are conducive to an improvement in worker participation where radiation protection is concerned.

- Education and Training

Reference has already been made to some aspects of worker training. Recipes that cannot be justified must be abandoned, and training activities must be focused upon the general philosophies of protection and correct practice in radiation protection for the personnel and the general public. Familiarity with the codes of conduct in radiation zones and the carrying out of high quality work, are the logical consequences of training programs that have properly assimilated.

- Worker Participation in Management

The existence of work-outs and improvement groups that integrate the active participation of the workers and in which new lines of action are proposed that, once approved, receive the whole support of management, should help to achieve worker involvement when it comes to developing radiation protection. Seeing that these initiatives are finding an increasingly prominent place in the annual plans of the units, provides a climate that is favorable to achieving more active worker participation in the implementation of a radiation protection culture.

- Information and Communication

Regular worker participation of the monitoring of the goals of radiation protection in a clearly visible and manifest way, the preparation of information sheets, posters, awareness campaigns, a prompt reply from management to the suggestions made by workers, etc., will mean that the information and communication will flow from management to the workers and vice versa, again creating an atmosphere which is conducive to motivating the workers and gaining their support, when it comes to consolidating and crystallizing radiation protection culture.

## CONCLUSIONS

From the above, some conclusions can be drawn in order to establish an efficient radiation protection culture among organizations for the operation of nuclear power plants.

- The organization ought to practice a realistic and open-minded sense of self-criticism, when analyzing the specific weight and scope of the radiation protection in the structures of the company, as well as ensuring that Management really is involved in the radiation protection culture, and in the process of deciding how to extend this discipline beyond the strict confines of the Plant itself, these should be the pre-requisites to defining the starting point from which to achieve a radiation protection culture.
- Experience in the management of professional risks must serve as a reference point for incorporating radiation risks into the overall management of risks in nuclear installations.
- An endeavor must be made to generate transparent information concerning the operations and risks that exist at nuclear installations both in the direction of the workers and of society in general, so that the former with their behavior can help to reduce risks and the latter can be convinced that this technology should be accepted. The image the company conveys to the outside world must be improved through the achievement of goals that are more and more demanding in matters regarding radiation protection.
- Both the behavior of the regulatory bodies and that of the organization itself, in the field of radiation protection, must progress towards being based more on performance targets with rational criteria concerning costs, benefits, economics, clients, etc.
- Programs and techniques must be developed that serve to motivate the workers and get them to participate in all the activities whose purpose it is to improve radiation protection, until such time as radiation questions form a natural part of everyday working life.

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