RADIATION PROTECTION IN SPANISH NUCLEAR INSTALLATIONS

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INTRODUCTION

Radiation Protection was born as a discipline at the same time as the use of ionizing radiation, once the potential harmful effects on living beings of this new phenomenon was recognized. The evolution of the use of the nuclear energy at an industrial scale brought about the evolution of this discipline, initially in association with responsibilities relating to hygiene and safety at work and subsequently as an independent responsibility within organizations involved in nuclear electricity production.

From the very beginning, in the year 1968, the Spanish nuclear plant organizations included specific resources for the radiation protection of both the plant workers and the general public living around the installations. Since that time, however, radiation protection organizations and technology have evolved considerably. The purpose of this article is to present a general overview of the current status of the radiation protection activities carried out at Spanish nuclear power plants.

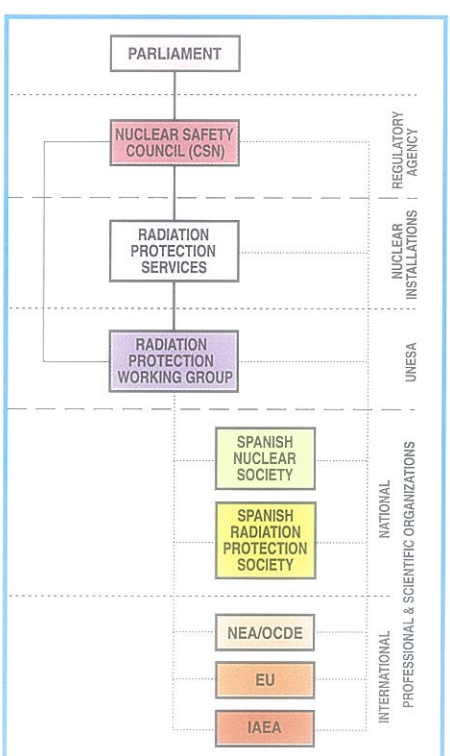
ORGANIZATIONS INVOLVED IN RADIATION PROTECTION IN SPAIN

With a view to providing a complete picture of the responsibilities and roles of the different bodies involved in radiation protection in Spain, a brief description of the general organization is presented (see figure 1).

In Spain the ultimate responsibility for radiation protection lies with the corresponding regulatory authority (Nuclear Safety Council (CSN), as expressed in Law 15/1980). This body, which is also responsible for Nuclear Safety, depends on and reports directly to the Spanish Parliament, not to any government-related organization as in other countries. Since its creation in 1980, the CSN has promoted the publication of national legislation and standards relating to radiation protection, the current national legal framework in this area now being particularly complete. Table 1 shows a summary of this legislation.

The next step in the chain of responsibility is constituted by the Radiation Protection Services that are required to exist at all installations in which ionizing radiations are used. These Services, which may belong to the organization associated with the installation, or in some cases be subcontracted, must have an identified responsible party, who must be in possession of a specific license for that Service, granted by the Regulatory Body.

F I - *Organizations involved in radiation protection in Spain.*



Thus, in each of the Spanish nuclear installations there is a Service of this kind, which belongs to the installation operating organization.

In Spain, the electricity utilities coordinate their activities within UNESA. As part of the Nuclear Directorate of UNESA, which is concerned with nuclear energy, the Radiation Protection Services of all the nuclear power plants are coordinated through a Working Group, whose membership includes all the Radiation Protection Services managers. Also within the framework of the Nuclear Directorate, permanent relations are maintained with the Regulatory Body, at a level adequate for the performance of work on issues common to all power plants and relating to radiation protection.

In addition to this institutional framework, there are several professional associations concerned with Radiation Protection. These play an important and active role in the application of Radiation Protection. Of these associations, the most actively involved with the nuclear industry are the Spanish Nuclear Society (SNE) and the Spanish Radiation Protection Society (SEPR). Apart from direct relationships with its associates belonging to the nuclear industry, UNESA collaborates to a large extent with these associations at institutional level through the joint organization of Courses, Seminars, etc.

RADIATION PROTECTION ACTIVITIES AT SPANISH NUCLEAR INSTALLATIONS

General functions of a Radiation Protection Service

As regards the radiation protection activities carried out at Spanish nuclear installations, there are several types of organizations, although they all apply the same principles and have similar functions.

Table I

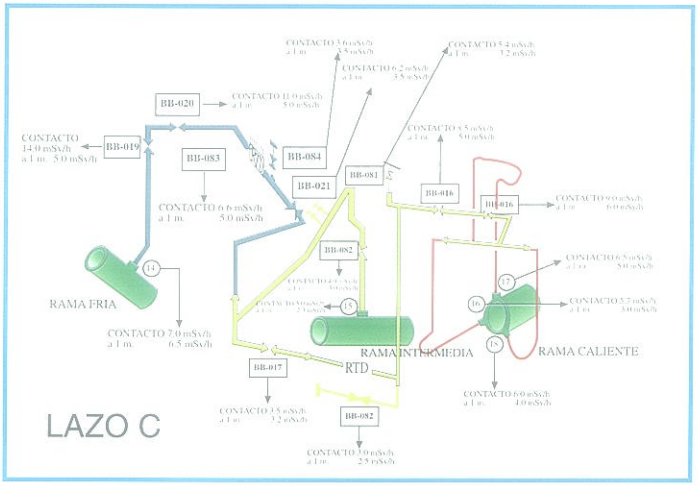
LEGAL FRAMEWORK IN RADIATION PROTECTION

• BASIC LAWS RELATING TO THE USE OF NUCLEAR ENERGY
- Law 25/1964 on Nuclear Energy
- Law 15/1980 on the Creation of the Nuclear Safety Council as the Regulatory Body solely responsible for matters relating to nuclear safety and radiation protection
- Law 40/1994 concerning the restructuring of the electricity sector, which modifies partially Law 25/1964

• SECOND LEVEL LAWS (DECREES) RELATING TO RADIATION PROTECTION
- RD 2869/72. Rules on Nuclear and Radioactive Installations (currently under revision)
- RD 2519/82. Rules on Health Protection against the hazards of ionizing radiation
- RD 1753/87 & RD 53/92. Modifications of the Rules on Health Protection against the hazards of ionizing radiation
- RD 74/92. National Rules on the Transport of Hazardous Material by Road

• GUIDES AND STANDARDS
Technical reports published by the Regulatory Body (CSN), industrial organizations, professional associations, etc. They contain recommendations and are not generally compulsory. Examples of Guides and Standards are:
- Safety Guides issued by the Regulatory Body
- Application Guides issued by the Spanish Nuclear Society
- Reports issued by the Spanish Radiation Protection Society
- Spanish Standards issued by AENOR (body responsible for standardization in Spain, equivalent to ISO at international level)

F II - *Example radiation map*



An important characteristic is that all the Radiation Protection Services or Departments of Spanish installations are currently independent from other plant sections, and report directly to plant management.
The main activities of the Radiation Protection Services of nuclear installations are as follows:

- Surveillance and control of radiological parameters, both inside and outside the installation
- Establishment of adequate safety and protection conditions for the performance of activities within the installation and implying any radiological risk
- Supervision and control of compliance with radiation protection standards at the installation
- Control of access to radiological areas
- Dosimetric control of exposed workers, belonging both to the installation and to off-site organizations
- Collaboration in the establishment and development of an ALARA program
- Implementation and development of maintenance, functional testing and periodic calibration of radiation protection instrumentation and equipment
- Surveillance and control of off-site discharges of radioactive effluents
- Management and control of radioactive wastes
- Control and surveillance of the handling, storage and movement of radioactive materials in the installation
- Implementation and development of the Environmental Radiological Surveillance Program
- Participation in preparation and drawing up of the Site Emergency Plan and compliance with obligations
- Establishment of personnel training programs in relation to Radiation Protection
- Updating of Radiation Protection documentation and records

A radiation Protection control and check point

The criteria relating to performance of these activities are described in a basic installation document known as the Radiation Protection Manual. This document has to be approved by the Regulatory Body for each installation, and is periodically reviewed so as to be kept updated with respect to whatever technological and organizational modifications might occur.
Regardless of the actual organization within each Radiation Protection Service, there is a functional distribution of resources in order to ensure performance of the aforementioned activities. Thus, the Radiation Protection Services may be divided into the following main areas of activity:

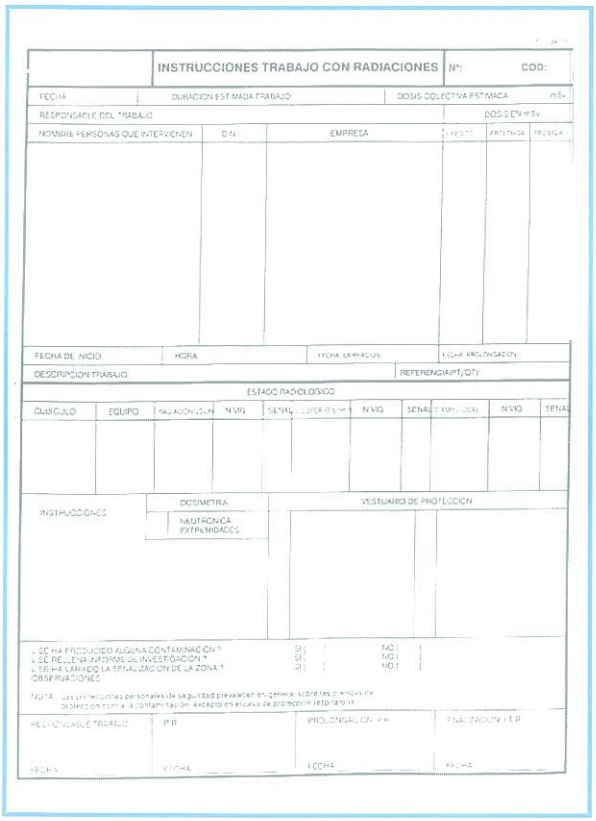
- Operational Radiation Protection
- Surveillance of Exposed Workers
- Surveillance of the Public and the Environment
- Surveillance and Control of Radioactive Wastes

The objectives and activities of these areas are described in the following sections.

Operational Radiation Protection

The main objective of this activity is to ensure the availability of updated information on radiological risks in the different areas of the installation. This information is necessary for the implementation of appropriate protective actions in relation to the work to be carried out in these areas.
The surveillance is carried out by means of continuous, periodic and individual measurements of radiation and contamination levels, as well as of the activity of the different plant system fluids. The measurements are carried out using fixed and portable detectors or, in some cases, by sample analysis.
In most installations there is a complex infor-

F III - *Typical Radiation Work Permit format*



INSTRUCCIONES TRABAJO CON RADIACIONES

mation network, in existence or under development, that transmits information on radiation area conditions to a database. This information may be accessed by the services responsible for planning and performing tasks in this area, including in some cases photographic information of the equipment.

Depending on the radiological risks, a standard classification of the areas is established in the regulations. Thus, the installation may be divided into the following areas:

- Free Access Area: It is very unlikely that doses higher than 1/10 of the annual dose limits (currently 50 mSv/year) will be received. In these areas no special radiation protection actions are required.
- Supervised Area: It is not unlikely that doses higher than 1/10 of the annual dose limits will be received, although it is very unlikely to that the doses received will exceed 3/10 of the annual dose limits.
- Controlled Area: It is not unlikely that doses higher than 3/10 of the annual dose limits will be received.

As a general rule, access to the controlled area is limited to authorized workers. A special permit - Radiation Work Permit (PTR) - issued by the Radiation Protection Service is required to enter this area. This permit establishes the radiation risks of the area to be entered and the adequate protection measures to be applied. These measures are specific to each kind of activity, and workers are obliged to act in accordance with the conditions and recommendations indicated on the permit.

In most installations, entry and exit to and from the controlled area is accomplished via one single location, which includes a radiation protection control and check point. On entering, the Radiation Work Permit and the conditions for the entry are verified, and operational personal dosimeters are handed out.

On exit, the workers pass a personal contamination control point and the dose recorded by the operational personal dosimeter is checked by a reading device, together with other data on the task performed. Materials, tools and equipment exiting the controlled area are also subjected to a radiological control in order to confirm that they are not contaminated. If they are, they must be decontaminated or kept inside the controlled area.

Exposed Worker Surveillance

In order to ensure that the individual workers doses do not exceed the legal and administrative limits, individual dosimetric surveillance is carried out at different phases. This requires that there be a Dosimetry Service authorized by the Regulatory Body. Consequently, all the Spanish nuclear installations have such an authorized Dosimetry Service.

Workers involved in activities which imply the risk of receiving doses (internal or external) are of special concern in relation to radiation protection, and are subjected to special medical and dosimetric surveillance. This group of workers is known as "professionally exposed", and is classified in two categories:

- *Category A*: workers who, given the working conditions, are not unlikely to receive doses higher than 3/10 of the dose limits.
- *Category B*: workers who, given the working conditions, are unlikely to receive doses higher than 3/10 of the dose limits.

Professionally exposed workers must be subjected to dosimetric surveillance. The national legislation requires that the individual external and internal doses of exposed workers be determined and recorded.

The external dose is determined by a Thermoluminescent Dosimeter (TLD). Legally, only category A workers have to be assigned a dosimeter; however in practice most exposed workers are assigned such a TLD dosimeter. The Dosimetry Service reads these dosimeters once a month. In addition, all exposed workers entering the controlled area carry a Direct Reading Electronic Dosimeter (DLD), for control of the dose associated with each activity. These DLD dosimeters are read at the exit of the controlled area. At the end of the month an official dose is assigned to each worker, generally based on TLD doses. If there is any discrepancy between the TLD and DLD doses, the Dosimetry Service investigates the situation and finally assigns an official dose.

Internal dosimetry is performed using whole body radioactivity monitors. Measurements are performed when the workers join and leave the installation, and in any case once a year or if there are reasons to suspect that there has been an incorporation of radioactivity in the worker.

The data obtained by the dosimetry systems have to be internally recorded by the Dosimetry Service in order to update the dosimetry history of each worker in the installation. In addition, each worker has a Radiological Card. This is an official individual document including the worker's dosimetry, medical and training data, and is used to transfer this information between the different installations in which the worker might be involved. Similarly, the Dosimetry Services send monthly dosimetry data to the National Dosimetry Bank, which is managed by the Regulatory Body.

In addition to the dosimetry control, there is a very strict control of the possible surface con-

Manual area dose measurements

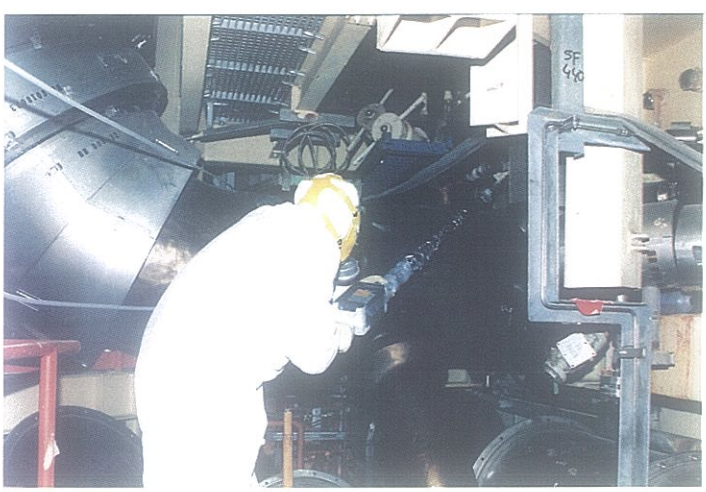


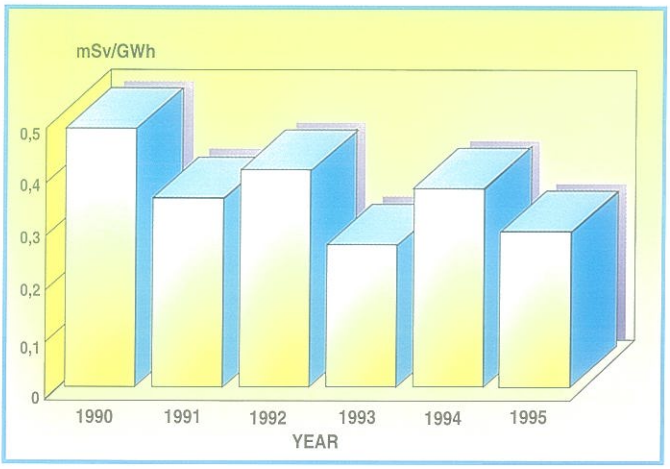
Table II
CURRENT LEGAL DOSE LIMITS FOR EXPOSED WORKERS AND GENERAL PUBLIC

	EXPOSED WORKERS	
	CURRENT	FUTURE[1]
WHOLE BODY	50	100[1]
SKIN	500[3]	500[4]
LENS OF THE EYE	150	150
EXTREMITIES	500	500
INDIVIDUAL ORGAN	500	--

	PUBLIC	
	CURRENT	FUTURE[1]
WHOLE BODY	5	1
SKIN	50[3]	50[4]
LENS OF THE EYE	15	15
EXTREMITIES	50	--
INDIVIDUAL ORGAN	50	--

1 *European Directive 96/29/EURATOM*
2 *Over five consecutive years and not exceeding 50 mSv in any single year*
3 *Over 100 cm² averaged in the most exposed area*
4 *Over 1 cm² independently on the exposed area*

F IV.- *Evolution of the annual collective dose for exposed workers per Mwe produced*



tamination of the workers. At the exit of the controlled area, the workers pass a personal contamination control, in order to ensure that they do not carry any radioactive contamination and to avoid the possibility of dispersion of this contamination beyond this area. Normally there are two contamination monitors. The first is passed with the worker wearing his protective clothing and the second without them. If the first monitor indicates that the contamination levels have been exceeded, the protective clothing is deposited in a contaminated clothes vessel and the worker carries out a check using the second monitor. In the event of personal contamination, decontamination would be carried out.

Surveillance of the Public and the Environment

During the operation and maintenance of nuclear power plants, gaseous and liquid radioactive effluents are generated and released to the environment. However, they are adequately treated and diluted before release, in order to minimize environmental impact and public dose. In any case, the plants have to ensure that the radiological impact of these effluents to the public is below the established limits, and furthermore, that the operation of the treatment systems is optimized by having an impact below a "restricted" dose, which is 10% of the official limit.

For this purpose, an extensive radiological surveillance program for the members of the public is undertaken. This program acts at three different levels:

• *Discharge Monitoring Program*

Before releasing radioactive effluents, these are sampled and analyzed in order to quantify and gain insight into their isotopic composition. In addition, total activity monitors measure the released fluids so that any activity in excess of the established limits is immediately detected, and flow is interrupted.

• *Dose Evaluation*

The dose to the public is estimated taking into consideration the total amounts of radioactive material discharged via the liquid and gaseous pathways and actual aqueous and gaseous dispersion data, for both the average and most exposed individuals. The bases for the calculation are established in the Off-site Dose Estimation Manual (MCDE). This Manual also establishes effluent limitations, surveillance and control instrumentation requirements, the operational conditions of the treatment systems and external dose operational limits.

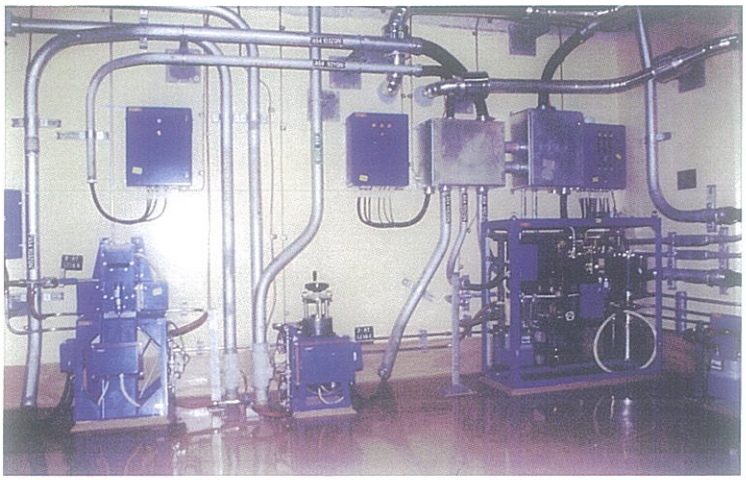
• *Environmental Radiological Surveillance*

The purpose of the environmental radiological

Spanish radiological card for exposed workers

TLD and DLD dosimeters

Whole body counter to detect incorporation of radionuclides



Discharge pipe monitoring

surveillance program is to confirm that there is no significant increase in the radioactivity levels around the installation. Thus, samples of different materials and foodstuffs are taken periodically at control points and analyzed in specialized low background radiation laboratories. The bases of this program are established in the Environmental Radiological Surveillance Program (PVRMA). This Manual describes the surveillance and control points, sample types, sampling frequency and types and frequency of analyses.

Surveillance and Control of Radioactive Wastes

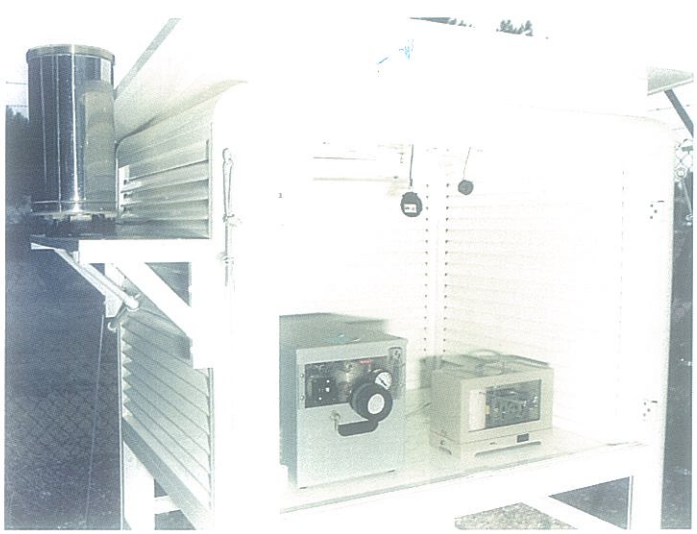
The operation of the installations generates a certain amount of solid wastes that may or may not be radioactive, depending on the level of activity in these materials. The radiation protection services are responsible for classifying this wastes, there being three levels of classification:

- *Non radioactive wastes*: The general criterion currently applied for the classification of wastes as non radioactive is that these materials do not present signs of either radioactive contamination or activation and that, in view of their use in the installations, are most probably not contaminated. At present a quantifiable level for considering wastes as being non-radioactive is under study by the Regulatory Body.
- *Wastes susceptible for clearance*: In accordance with international trends, and in order to optimize the storage of radioactive wastes, materials with very low levels of radioactivity may be recycled in a controlled manner, such that the doses involved in the recycling process and subsequent use are below what is known as the "trivial dose". In this respect specific studies have to be carried out defining the characteristics of the material, identifying the settings in which exposure of the population may occur and characterizing the possible exposure paths, including potential exposures. Some studies have been undertaken in relation to the clearance of sludge, oils and scrap, and are at present under study by the Regulatory Body.
- *Radioactive wastes*: Solid wastes classified as radioactive may be divided into three categories: low, medium and high activity. The first two categories are conditioned and immobilized at the power plant in standardized cans for storage at the national low and intermediate level solid waste disposal facility (El Cabril). The high activity wastes are safely stored at the installation pending a national decision regarding their final disposal. The radiation protection service is responsible for ensuring that the cans comply with the levels of radiation and external contamination established by the national radioactive waste management company ENRESA.

FUTURE TRENDS IN RADIATION PROTECTION AT SPANISH NUCLEAR INSTALLATIONS

The establishment of future trends in radiation protection in any field is undoubtedly conditioned by publication no. 60 (1992) of the International Commission of Radiation Protection (ICRP) and its influence on the revision of international and national legislation. Thus, in 1994 the International Atomic Energy Agency (IAEA) published its "Basic Safety Standards for Protection against Ionizing Radiation and for Safety of Radioactive Sources", a revision of the previous Basic Standards of 1982, and in 1996 the European Union approved the Council Directive laying down the "Basic Safety Standards for the Protection of the Health of Workers and the General Public against the dangers arising from Ionizing Radiation", as a

PVRMA sampling station



Standardized radioactive waste can

revision of the previous Directive of 1984.

Although adaptation of these new international regulations to the national legislation will undoubtedly affect some current Radiation Protection practices, a preliminary analysis of ICRP-60 concludes that the basic criteria relating to Radiation Protection at Spanish nuclear power plants comply with those of this publication. Nevertheless, the official dose limit reduction (for workers and public), and underlining of the optimization principle that appears in ICRP-60 will undoubtedly imply some future adaptation.

The above and the current situation of the nuclear installations having been taken into account in a sectorial actuation plan covering all fields established by the installations under the coordination of UNESA, the future development of radiation protection appears along two main lines: Practice harmonization and Radiation Protection Optimization.

The main objective of the first line - practice harmonization - is to standardize the practices of the different radiation protection services of nuclear installations to the extent possible. The UNESA Nuclear Directorate Radiation Protection Working Group plays a very important role in this respect. In recent years practices such as:

- Access of external workers with Radiological Card
- Criteria for data supply to the databases managed by the Regulatory Body: Dosimetry and Effluents
- Texts of the Operating Technical Specifications (ETF) related to effluents and Off-site Dose Estimation Manual (MCDE)
- Basic criteria on ALARA organization
- Surface contamination measurement procedures

have been standardized within this Group. At present an extensive comparative analysis of the Radiation Protection Manuals of all the nuclear power plants is under way, the objective being to establish priority future harmonization projects in the areas of radiation protection measurement techniques, procedures, management of external workers, service companies qualification and equipment.

The second line - radiation protection optimization - has three main aspects: exposed workers, general public and radioactive waste. Important efforts are being made within the plant organizations to promote the extension of the optimization responsibilities to all the sections concerned with activities implying doses. In this respect, the UNESA Radiation Protection Working Group has served for the interchange of information on different models of organizations that have been developed at the different installations, and for definition of the basic criteria that they must all meet.

As regards the issue of exposed workers, efforts to reduce the source term within the plants, the development of robotic applications and revision of the working procedures, taking into account both the plant's own experience and international experience of these operations, have led to an important reduction in the annual collective dose, as is shown in figure 4. It is also important to point out that the recent steam generator replacement operations carried out at two of our nuclear installations has been accomplished with very good optimization of performance. The main objectives for the future are the transmission of this optimization culture to the service companies and the development of information networks within the plants, so that the radiological information is updated in real time.

Important efforts are being made in radioactive waste optimization to reduce the number of radioactive waste cans. This is accomplished basically through waste management and decontamination and, in the future, through the application of clearance levels.

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