QUALITATIVE AND QUANTITATIVE DECISION AIDING TECHNIQUES APPLICABLE IN RADIATION PROTECTION

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1 - RADIATION CONTROL PRINCIPLES

EDF's exposure reduction program comprises a three pronged attack on the radiation field buildup process, based on modification of PWR's design features, and operating conditions.

1.1. Reducting the sources of radioactive fields

More than 75 % of the occupational radiation exposure is due to deposite activity on the out-of-core surfaces. So it is very important to minimize these deposites.

There are three ways in witch such contamination can be reduced :

- use of alternative materials with less corrosion product, input a lower activity potential (e.g. to eliminate Cobalt 59).
- primary chemistry control
- optimizing conditions under witch large-scale corrosion product transfert and migration occur during cold shutdown, due to changes in coolant physical and chemical characteristics, as fast flow clean up of primary coolant during cold shutdown.

1.2. Reducing equivalent dose rates

Biological protection refers to measures aimed to protect workers against ionizing radiation, i.e. use a protective shields, and location of work areas at reasonable distances from radiation sources.

Such action must necessarily consider both the radiation level prevailing in the vicinity of plant systems and equipment, and the time required for workers to carry out relevant operating procedures or maintenance activities.

It is thus necessary, at the very first stage in plant design, to provide for :

- rational equipment lay out, i.e. in large members of differents rooms, whereby high and low activity systems are separated ;

- Installation of permanent biological shields, as required by plant lay out

- use of remote valve control devices

- limiting neutron leakage by confinement of neutron particle emission to the reactor pit.

Other actions are implemented during plant operation. Work planning studies are performed on a case-by-case basis, to identify requirements for any additional protection devices or remote handling tools, needed to restrict work activities to low exposure.

1.3. Reduction of exposure times

In nuclear power plants, such reduction are a vital part of radiation control strategy. Current programms call for the tiered action aimed at :

- reducing stay time
- limiting the number of workers subjected to exposure.

Reduction is achieved firstly, through plant construction features, geared to :

- easier equipment acces,

- use of sophisticated handling equipment (wich entails appropriate design of relevant plant room)

- easy equipment dismantling

- improved reliability, i.e. less frequent maintenance operations, according to the regulatory guides.

These features are supplemented by a program of permanent actions aimed at reducing radiation worker stay times, through :

- better training, wich may, in certain cases (very high radiation levels, complex operations...) include use of non radioactive mock-up equipment, as an adjunct to traditional course material.

- better work planning, based on experience acquired in the same or other similar plants, through generation and use of detailed plant histories.

1.4. In-plant radiation protection

Controlled access area

All areas of the plants in with average radiation level is likely to exceed 0,25 mrem/h, and those involving constant risk of surface contamination, or

airborne radioactivity, are subject to access control restrictions

- green area : radiation level up to 0,75 mrem/h and lower than 2,5 mrem/h
- yellow area : 2,5 to 200 mrem/h
- orange area : 200 mrem/h to 10 rem/h
- red area : more than 10 rem/h

Safety of contractor workers

French law clearly defines the responsabilities between the plant manager and the contractors.

The plant manager must provide the contractor with any information required to assume his assigned responsabilities.

The contractor is responsible for the safety of his employees, and for any hazards generated by their activity.

He is responsible also for the individual medical surveillance and the individual dosimetry.

Personnel dosimetry program

The personnel dosimetry program involves two separate but interelated means of surveillance

- electronic dosimeter and computer processing
- statutory individual photographic film badge.

2 - USE OF FEEDBACK

2.1. - Main parameters influencing the collective dose

It is clear that the main parameters influencing the collective dose are, for a plant wich is running (except the work organisation) :

- the deposite activity on the out of core surfaces

In french NPP, primary coolant treatment is called "with coordonate lithium". It optimize both, the mass of corrosion products deposited, and the location where they are deposited.

- the way to decrease the temperature of the primary coolant

The french procedure uses an anticipated oxygenation, as early primary coolant temperature is about 120°C, without oxygene peroxyde, but only with an injection of air.

In this way, the advantage of the control of corrosion products, during the cycle is preserved, according to the respect of the planning of work.

2.2. Qualitative and quantitative decision aiding techniques

Activity index

About 12 hours after the reactor has been stopped, the radiological protection service performs a serie of measurements of dose rates, at the contact of the primary pipes, and determines an "activity index", in mrem/h.

It is obvious it exists a correlation between the value and the collective dose will be taken during the shutdown. More the activity index is high, higher will be the collective dose, and more the maintenance teams will must be carefull.

It will perhaps be interesting to perform complementary measurements, to know where are the highest dose rates. Thus, maintenance team will be aware and will can protect itself with shield, organizes its worksites to save more time and personnel to decrease the collective dose.

Knowing the "potentiel collective dose", the maintenance team can give itself a target.

Also, it will be interesting, for the future cycles, to know why, for example, the activity index is higher than the average value of all the NPP (anormal deposite, bad primary coolant treatment, failure on purification systems, etc...)

- Analyse of dosimetry during outage

For all the maintenance works during a shutdown, the collective dose is known. Everybody entering in nuclear island bears an electronic dosimeter, and it exists a computerized counting of the doses.

Works are divided in groups :

- reactor
- steam generator
- primary circuit
- auxiliary circuits RCCS, ...
- in service inspection
- electric works
- cleaning, scaffolding

At the Radiation Protection Department, all the values are collected, and the most probable value is evaluated, according to the experience.

Each power plant must be analyse its results and compares at these values.

All the differences will be explained, and it is probably a big progress factor.

To perform this job, we have centralised all the data concerning :

- collective doses (job related)
- dose rates
- deposite activity

on a date base called TIGRE RP.

3 - RESULTS OF FRENCH NPP

The graphics showing theses results are note joigned to this paper. These will must include the doses of 1987.

The themes wich will be presented are :

- collective dose (per reactor, MWyear, ...)
- comparizon EDF and contractor workers,
- international comparizons
- outlook for the future
- exposure data for EDF personnel.

Nevertheless, the most important results we already can show, are :

- about 130 reactor year cumulated in operation

- for 1986 :

  - 2,3 man.Sv/reactor (reactors having an outage during the year)

  - 3 10^{-3} man.Sv/MW year generated for the three last years.