RADIATION PROTECTION IN THE DESIGN AND MODIFICATIONS OF INSTALLATIONS

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In accordance with the basic principles of radiation protection, as outlined in the BSS, provisions are required to be made in the design to comply with the Radiation Protection Objective: "To ensure that in all operational states radiation exposure within the installation or due to any planned release of radioactive material from the installation is kept below prescribed limits and as low as reasonably achievable, and to ensure mitigation of the radiological consequences of any accidents, furthermore to ensure with a high level of confidence that, for all possible accidents taken into account in the design of the installation, including those of very low probability, any radiological consequences would be minor and below prescribed limits.

The fundamental role of optimization in the design of a plant and its components is to decide which engineering provisions for controlling radiation doses are practicable. In most cases, the optimization should achieve a balance taking into account the need for dose reduction, the need to ensure reliable energy production and the cost involved. At the design stage of plant, or for a major modification or decommissioning where a major expenditure is involved, the use of a more structured approach is appropriate and decision aiding techniques can be used. More over those decision aiding techniques shall be installed in such a manner that would be opportunity to receive the results of control and monitoring and process them as soon as possible.

From this point of view the Armenian NPP, as it was designed constructed 25 years ago, many of systems for radiation protection and safety control are became obsolete and need to be modernized .

The radiation monitoring of the ANPP internal areas, discharges, personnel dose is performed by several systems do not more meet the present sensitivity and reliability, national and international requirements.

With help of EC -TACIS 2000 PROGRAMME the operational organization submitted to Armenian Nuclear Regulatory Authority for the approval the technical specification prepared by SOGIN organization, for modernization of radiation monitoring system (Improvement of I & C systems. Modernization of Radiation Monitoring System. Project A1.01/00B4).

Purpose of this modernization is the adjournment of these systems by providing new automatic computerized monitoring system, by replacing not more usable radiation detectors, by adding monitoring sub-systems to perform new required functions, by improving the plant capability of monitoring personnel dose and vehicles entering or leaving the plant.

In detail, the following are the objects of modernization:

a) **the automatic monitoring system "8004":** It is a 201 channels radiation-monitoring system designed for the remote management of movable detectors, stationary placed in the monitoring location (see Fig. 1).

   The results of the measurements are numerically presented in specific displays in the Radiation Monitoring Room and manually recorded by an operator that provides also to the calculation of the radiation dose associated to each numerical reading.

One of the purposes of modernization of the 8004 system by introducing a new computerized system. It shall be capable to acquire the pulses/voltages signals from the existing detectors, to convert them into a digital format and to perform all the radiation dose calculations. It will provide also all the pieces of information to the operator through a computer based display system.

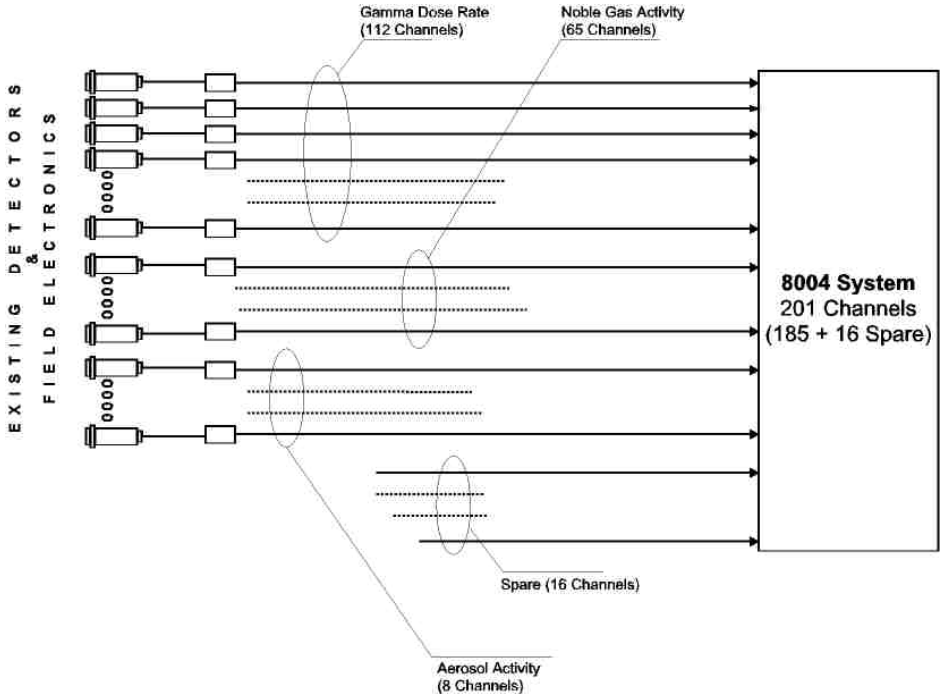

Figure 1 - 8004 Radiation Data Acquisition System Present Layout

The modernization equipment to be supplied takes the input signals from the existing "8004" RMS input rack in form of voltage pulses for the functions and the characteristics reported in Table 1.

These signals need to be converted in a format suitable to be processed by a computer system, i.e. in digital format. This conversion can be done directly by a single component (Acquisition/Conversion Unit) or, more commonly, by two separate components (A/D Conversion Unit (ADCU) and Digital Acquisition Unit (DAU)). The ADCUs will perform the interface function between the existing system and the new equipment. They will perform also the conversion of the input signals in digital format to be used more properly by the following DAUs and will be suitable to the type of radiation measurement performed by the detectors connected to them. The DAUs will acquire the digital signals and will make them available to the Microprocessor Unit (μPU). The conceptual layout of the interface between old "8004" and new system is reported in Figure 3.

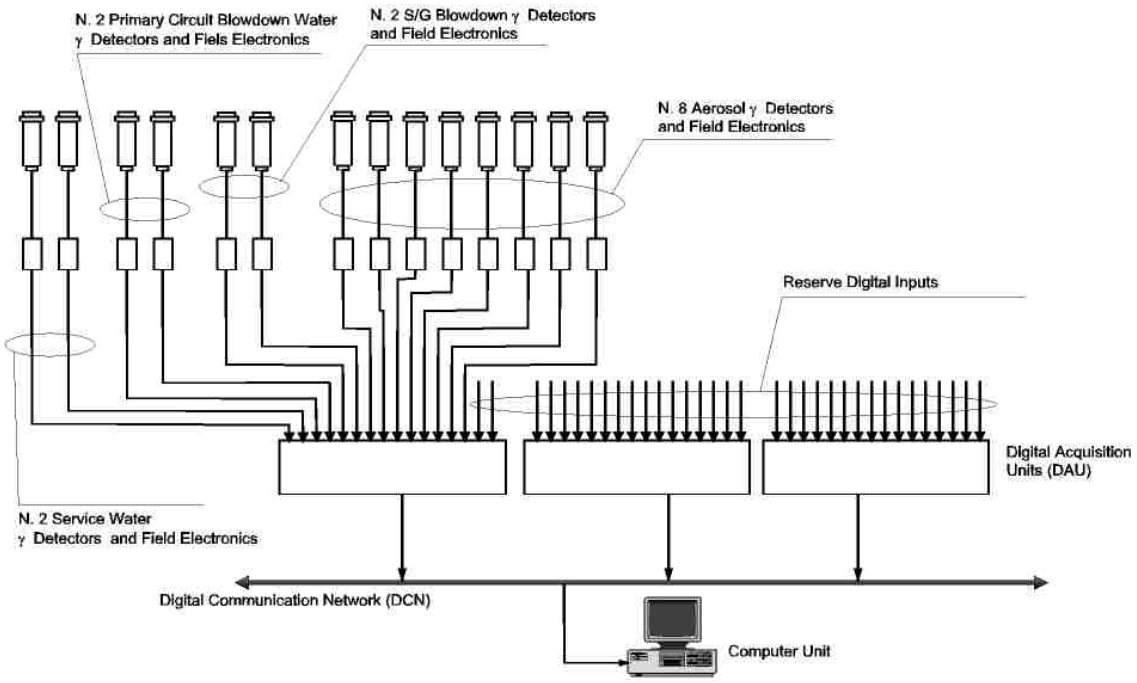

Figure 3 - Radiation MonitoringSystem - Connection of New Monitors to the new Computer System

TABLE 1

Type	Measurement		Measurement	Input signal amplitude (Volt)	Duration (μs)	Input Impedence (ohm)	New System Input signal range (cps)
	Unit	Unit					
γ–1	μr/s	μr/s	-0.8	5	150	3.5 – 700	10
γ–2	μr/s	μr/s	-1.5	2	150	3.3 – 1100	95
γ–15	μr/s	μr/s			150	$1.8x10^3$-$1.8x10^6$	1
β–gas1	Ci/l	Ci/l	-1.8 – 3	5	150	4 – 800	52
β–gas2	Ci/l	Ci/l	-2 – 4	5	150	3.5 – 3500	13
γ	μr/s	μr/s	-4.5	5	150	2.4 – 2400	6
γ	μr/s	μr/s	-4.5	5	150	45 – 45000	0
Aerosol γ	Ci/l	Ci/l			150		8
						Total	185

b)Enhancement of aerosol radiation monitoring: The detectors that are in charge of the monitoring of gaseous aerosols through stack releases have accumulated more then 25 years of operation, are quite obsolete and do not more meet the present safety requirements. Therefore a new set of aerosol detectors shall be added to the system.

This activity consists essentially on the replacement of the existing equipment with 8 complete devices for the continuous monitoring of the beta specific activity of the particulate phase in the air sampled in eight release points, called Continuous Air Monitors (CAM). The air pumps and

the associated piping to transport the air to the collection devices are already operating in a satisfactory manner at the plant and are not included in the scope of supply.
The Functional Characteristics of the new equipment shall be the following:

1. Measurement range: $10^{-10} \div 10^{-7}$ μCi/ml
2. The CAM's volumetric activity values shall be updated every 5 - 10 minutes in normal operation.
3. Since the existing air pumping system shall be used, the functional characteristics of the CAM shall cope with existing pumping system features.
4. The volumetric activity values of eight CAMs, updated every 5 - 10 minutes in normal operation, must be shown locally and sent to the new 8004 computers for data management and storage.

c)Replacement of the blow-down water radiation monitoring system: The same obsolescence phenomena affects also the system for the monitoring of the blow-down water of the primary and secondary circuits and of the service water.
The monitoring of the SGB and Service Water (SW) lines, shall be performed by two separate systems, each based on two detectors (GM tubes) as follows:
N. 1 detector for the lower part of the detection range ($10^{-10} \div 10^{-8}$)
N. 1 detector for the upper part of the detection range ($10^{-9} \div 10^{-7}$)
The two GM tubes, the reading of which shall cover all the measuring range, shall have distinct connectors for high-voltage input and for signal outputs.
The Alarm capability of the system shall be the following:

- The alarms must be user-configurable, with thresholds set-up by software over the entire operating range.
- The audible warning will take place anytime the alarm set points have been exceeded.
- Energy backup for the alarm indication and the reporting function of the system must be assured for about 15 minutes, after a loss of main power.
- Low number of the false alarms (less than 1 ÷ 2 per month) for any chosen counting time.
- The alarm must be displayed on a digital display both locally and in the ANPP Control Room.

d)Improvement of the personal dose monitoring: Full adoption of the TLD technology to rapidly and efficiently monitor the dose to the ANPP and visitors personnel.
To integrate the present supply of personal dose monitoring devices, a lot of Thermo-Luminescence Dosimeters (TLD) badges must be provided completed by a specific reading equipment.
c)Implementation of a vehicle monitoring system: Presently no monitoring is performed on vehicles entering of leaving the ANPP.
The Vehicle Monitoring System (VMS), as shown in Fig. 4, shall be constituted by:

- N. 2 (or more) shielded large surface detectors (normally plastic scintillator) on both side of vehicle portal;
- The needed pre-amplifiers and other detector electronics;
- The processing unit
- The traffic light operated both by the operator and automatically by the process unit.
- Audio and Visual alarm in case of threshold exceeding.
- The servomechanism to unlock and open the door both by the operator and automatically by the process unit.
- The software to automatism the scanning, to manage the data and to command the signaling and opening devices.