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EMERGENCY INSTRUMENTATION PREPAREDNESS CRITERIA

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Emergency preparedness has received considerable emphasis during the development of the nuclear industry. Regulations which govern the construction and operation of nuclear facilities include the requirement for containment or confinement systems and for the development of detailed emergency plans and procedures. Redundancy features have been designed into plants to assure the containment of radioactive material under abnormal or accidental conditions. Extensive plans have been developed to cope with the operational accident.

With the exception of the requirement for criticality accident alarm systems, regulations provide no specific criteria to define the kinds of emergency instrumentation required and the appropriate characteristics. Emergency instrumentation is necessary to assure the prompt warning of the occurrence of any radiological accident and the prompt assessment of the consequences. The need for such instrumentation has been demonstrated at the time of accidents. Frequently the need has exceeded available instrumentation or the course of the accident has rendered the instrumentation inoperative. Automatic monitoring instrumentation capabilities have been limited primarily to measuring normal effluent releases or ambient radiation levels. These instruments which usually incorporate extended ranges of a few decades have inadequate capabilities for a major release. Additionally, instrumentation to measure the magnitude of the resulting problem has been limited primarily to portable operational equipment such as GMs and ion chambers.

The development of instrumentation and dosimetry devices has been limited primarily to process instrumentation, instrumentation for measuring quantity of radionuclides deposited internally in people and the measurement of dose received by personnel occupationally exposed. In some instances as a result of an accident, the need for specific instrumentation or facilities has been identified and the necessary development undertaken.

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Few, if any, studies have called out specific criteria for instrumentation performance and placement with respect to characterizing the emergency situation. Most publications on radiological emergencies deal primarily with other aspects than instrumentation, and at best, mention instrumentation performance requirements, needs, and other factors in only very general terms. Again, the one aspect of emergency instrumentation detailed in standards established by the American National Standards Institute relates to criteria for the Criticality Accident Alarm System.

The AEC recognized the need for establishing performance criteria for radiological emergency instrumentation. In 1970 Battelle-Northwest was asked to conduct a study to develop specific instrumentation preparedness criteria. A Steering Committee was established by the AEC to provide guidance to BNW in the development and conduct of the program. Included in this Committee are representatives of AEC Operational Safety, AEC Licensing and Inspections, RDT, EPA. The BNW team includes meteorologists, health physicists and nuclear engineers whose specialties include instrumentation, meteorology, sample collection, source term prediction and consequence analysis.

As the first phase, an extensive review of the status of existing emergency plans and procedures and the capabilities of portable or installed emergency instrumentation systems was conducted to provide background. The results of this portion of the program have been documented in BNWL-1552* available from TIS. From this study there were several suggestions which the team members felt might be useful to industry in reviewing the emergency preparedness capabilities in their own facilities. These suggestions, which are discussed below, are not new and do not necessarily reflect the scope or depth of the instrumentation criteria which are being developed. In most cases they are only minimum considerations.

1. Critical monitoring instrumentation such as stack monitors, which is required for emergency purposes should be examined to determine that it has a high degree of dependability. This equipment should be in a fully operational status

*Technological Considerations in Emergency Instrumentation Preparedness
Phase I - Current Capabilities Survey, J. M. Selby and C. M. Unruh (Jan. 1971)

whenever the facility is operational. The detectors and electronics should be adequately protected from damage which might occur during an emergency and should be designed to permit measurement of abnormally high levels which would result in the accident. All sample lines should be examined with the intent of providing the best kinetics for collection of a representative sample.

2. Instrumentation suitable for making basic meteorology measurements such as wind speed, direction, and temperature profiles should be available. The instrumentation should be properly located rather than placed at convenient locations such as ground level or the roof of a building. Programs to utilize meteorology data from other sources should be established and practiced to assure data access is possible under emergency conditions.
3. An emergency control center equipped with continuous monitoring and meteorological measurement readout capability would appear to be desirable. Many control centers which serve only as communication centers may need additional instrumentation input.
4. Sources of outside help should be identified and methods for contacting this help should be established and practiced on a scheduled basis. Communications with local, state, and federal authorities that may have a role or responsibilities in meeting emergency problems should be established and tested on a reasonable frequency. Provision for medical treatment of highly contaminated and injured personnel as well as decontamination for non-injured personnel should be considered. Those depended upon for outside help should fully realize and accept their emergency assistance role. A general test of the arrangements and faculties should be conducted on a periodic basis.
5. High level portable monitoring instruments (to 10 R/min) and self-reading pocket dosimeters (0-600 R) should be provided at accessible locations for use during the emergency.

6. Some type of vehicle mounted sensitive scanning instrumentation may be needed to quickly determine contamination levels on roads and other areas accessible to vehicles.
7. Calibration techniques and calibration equipment including radiation sources should be developed to assure that the calibration procedures used for emergency instruments are adequate for the measurements required for an accident. Particular attention should be paid to the calibration of stack monitoring instruments.
8. Service contractor's capabilities for both emergency and routine external and internal (in vivo examination and bioassay) dose evaluation and environmental evaluation should be determined. The availability (speed) of special service at times of emergencies should be determined. Consideration should be given to auditing the procedures and the results.

In order to define instrumentation criteria it is necessary to define the quantity and characteristics of an accidental release. For the maximum accident case for power or production reactors, the guidelines that were established were those contained in TID 14844, "Calculation of Distance Factors for Power and Test Reactor Sites". Similar maximum cases will have to be assumed for other nuclear facilities such as fuel reprocessing plants, plutonium bearing fuel fabrication plants and radioisotope laboratories with large inventories. To complete this portion it is necessary to define a "minimum" case to be sure that there is continuity between normal process equipment and the emergency instrumentation.

Instrumentation criteria are to be developed to measure the actual release either via a normal effluent discharge route or a breach in the containment or confinement system and determine the direction of the cloud. This data should be readily available for use in assessing the environmental consequences. Criteria are to be developed for fixed or portable instrumentation to measure the resulting consequences in the environs. Additionally, criteria are to be

developed for instrumentation to meet peripheral requirements, such as:

1. Emergency Medical Monitoring
2. Warning System
3. Rescue

When the criteria are complete for a particular type of nuclear facility, it will be necessary to match the criteria with current instrumentation capabilities. In some instances, the criteria may call for instrumentation beyond the present state-of-the-art. If so, special studies would be initiated to develop instrumentation to satisfy this criteria or to define the need for changes in the criteria.

Although the criteria for the emergency instrumentation are still being developed, it appears obvious that the instrumentation systems will be required to operate in both radiological and environmental extremes. Tests and evaluations of two different kinds may be necessary to assure the continued operability of an instrumentation system under these conditions. The first test includes laboratory evaluations of the basic instrument system to establish whether the instrument system is capable of meeting design criteria and performing satisfactorily in the environmental conditions in which it will be expected to operate. The second includes periodic tests of the in-place systems to assure continued operation at the sensitivity required.

The performance criteria for the instruments probably will be divided in four overlapping areas - radiological, environmental, electronics, and mechanical. The radiological area is the most important of these, and the bulk of the criteria would be directed towards the operational performance of various instruments. Included would be range, sensitivity, accuracy, reproducibility, energy dependence and angular dependence.

Included in the environmental portion, as appropriate, would be requirements on temperature and pressure dependence, response to unwanted radiations (including infra-red), effects of humidity and immersion, and effects of wind and dust storms.

The electronic factors include, as appropriate, criteria on linearity, switching transients, capacitance effects, extracamerall effects, and time constants.

The mechanical portion will include physical construction, human factor engineering, sound and vibration effects, geotropic effects, and effects of shock.

During this brief discussion, I have attempted to describe the scope and conduct of the Emergency Instrumentation Preparedness Program. We have been in the process of developing criteria for instrumentation to measure the accidental airborne release from a reactor for the last six months. This phase should be completed in the next few weeks. It is anticipated that an interim report on these criteria will be published by fall and the criteria will be available for discussion at future Health Physics or other scientific meetings. No doubt there will be changes in the criteria as the program develops and we get further into other phases.