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ELEMENTS OF A NATIONAL EMERGENCY RESPONSE SYSTEM FOR NUCLEAR ACCIDENTS

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INTRODUCTION

The purpose of this paper is to suggest elements for a general emergency response system, employed at a national level, to detect, evaluate and assess the consequences of a radiological atmospheric release occurring within or outside of national boundaries. These elements are focused on the total aspect of emergency response ranging from providing an initial alarm to a total assessment of the environmental and health effects. Elements of the emergency response system are described in such a way that existing resources can be directly applied if appropriate; if not, newly developed or an expansion of existing resources can be employed. The major thrust of this paper is toward a philosophical discussion and general description of resources that would be required for implementation. If the major features of this proposal system are judged desirable for implementation, then the next level of detail can be added.

The philosophy underlying this paper is preparedness — preparedness through planning, awareness and the application of technology. More specifically, it is (1) establishment of reasonable guidelines including the definition of reference and protective action levels for public exposure to accidents involving nuclear material; (2) education of the public, government officials and the news media; and (3) the application of models and measurements coupled to computer systems to address a series of questions related to emergency planning, response and assessment. It is the role of a proven national emergency response system to provide reliable, quality-controlled information to decision makers for the management of environmental crises.

EDUCATION

Clearly defined reference and action levels should exist for various dose pathways expected from an accidental release of nuclear or toxic material. These levels should represent values below which there is no health concern, values above which there are health concerns, and an area in-between where discretionary actions may be appropriate depending on the circumstances of the accident and exposures. An example of these levels is given for nuclear accidents by the International Commission on Radiological Protection publication (ICRP) 40–which suggests 0.5 Rem whole body dose as the lower limit number where no action is required and 5.0 Rem as the upper limit above which protective actions would be required.

MASTER

Once the reference and protective action levels have been established then the educational process should begin first with government officials not directly involved in establishing the reference and protective action levels, followed by the news media and then by the general public. The absolute values of the reference and protective action levels are not as important to convey to the public in the beginning as is the methodology used to develop the guidelines and plans for implementation during an accident.

As part of an education and training process the national center can be used to help plan and execute exercises and drills that test the components of the system. This process will help various government agencies to communicate with each other and interpret the advisories produced by the center.

TECHNOLOGY APPLICATIONS

Radiological Measurements

Three levels of ground based environmental monitors used for measuring airborne and deposited radioactivity are suggested for the emergency response system. These levels are national, regional and local.

a. National System. This is a real-time continuous measurement system with a centralized data collection, interpretation and data basing facility. The major purpose of this system is to provide a "first alert" for either a national or international incident that releases nuclear material. Through the use of modeling, climatology, land use and terrain studies a limited number of measurement stations can be located near facilities within the country that have a potential for an atmospheric release of nuclear material and in other areas for intercepting nuclear material crossing international borders. A minimal number of stations should be deployed and the number of parameters measured should be limited to a selected group to identify and initiate an alarm.

b. Regional System. The next level should be designed to supplement the national system, provide more spatial resolution, and quantify the measurements more than would be practical for a national real-time system. The regional systems should be developed and implemented by laboratories, universities or other responsible agencies under the supervision of a central governmental agency. These regional offices would be responsible for purchasing instrumentation, calibration and distribution to groups or individuals charged with making the measurements. Should an accident occur these regional centers would be responsible for monitoring the measurements, collecting the data, quality control and transmission to the central agency for further interpretation and inclusion in a master data base.

c. Local System. These systems would be designed to address local concerns particularly as they relate to more detailed definition of the space and time variability of material on the ground. The point of contact for calibration and data dissemination should also be under the control of but not necessarily in direct contact with the regional center. The path for information transfer between these measurement systems and the national agency in charge of the technical evaluation should involve the regional centers. The national agency should insure that a standardized protocol is established for all radiological measurements e.g., time intervals, calibration, etc.

In addition to these ground based systems an airborne monitoring system supported and administered by the central authority should be available to (1) directly measure airborne material emitted from nuclear facilities within the country and (2) measure ground contamination caused by etiher an accident within or outside the country. Through a combination of these systems the environmental measurements aspect of emergency response can be handled efficiently.

Meteorological Measurements

Two levels of meteorological measurements are suggested for an effective emergency response system. These levels are national and local.

a. National System. This system is normally in-place and is managed by a national or federal meteorological service. In most cases hourly or 3 hourly surface wind speed and direction, temperature, pressure, humidity, visibility and cloud cover observations are reported through the national network to a central office. In addition, 6 or 12 hourly vertical profile measurements of windspeed and direction, temperature and moisture are reported through the national network. A computer link from the national meteorological service to the central government agency responsible for estimating public health effects would be required. Agreements and procedures should be developed to increase the measurement frequencey, if required, for an accident assessment.

b. Local System. Each nuclear facility within a given country should provide a meteorological measurement system located near the facility to provide wind speed and direction and temperature data. In case of an accident these data would be used to define the path and diffusion characteristics of material as it moves away from the nuclear facility into a regional transport and diffusion regime defined by the national meteorological network. Data from these local sources would be required at the government facility responsible for assessing public health and safety as well as the local facility changed with implementing immediate actions to protect public health.

Modeling

The intent of the atmospheric transport and diffusion modeling aspect of this proposal is to act as a planning, real-time response and assessment tool (analysis) when effectively integrated into the national emergency response system.

a. Planning. For areas around specific facilities, e.g. nuclear power reactors, modeling can be used in conjunction with land use and climatology studies to define measurement locations that have a high probability of intercepting material released from a particular nuclear site, thus limiting the number of instruments required. (e.g., the state of Illinois, USA, has an excellent monitoring system around each nuclear power plant site in the state). In addition, if the same or similar model is used for the emergency response, then emergency response managers and staff members have the benefit of familiarity with the techniques employed for assessments. This planning activity also can help insure a compatibility between models and measurements, e.g. averging times of measurements that are suitable for comparing to model calculations. A similar study, on a larger national scale, can be used to define measurement locations for intercepting material, released in other countries, that has crossed the border and poses a potential threat to public health and safety.

b. Real-Time Emergency Response. Models should be developed or transfered to a central agency's computers that can provide the following functions to the emergency response manager or decision member during an emergency:
   - Determine the amount of material escaping into the atmosphere (source term).
   - Provide guidance to measurement teams as to where measurements should be made.
   - Bracket potential consequences using normalized calculations.
   - Check consistency of measurements to determine possible extremes due to either measurement errors or unrepresentativeness of the measurements.
   - Interpolate and extrapolate measurements.
   - Provide updated time integral for total dose.
   - Help implement protective action guidelines; if needed.

c. Assessments. After an accident has terminated the government and the public need to know (through the news media) the total effects of the accident on public health and safety, and the economic impact. To help estimate the impact on public health and safety a combination of dose modeling and measurements is needed for a creditable assessment. The credible assessment should be made public by a single-government decision maker (e.g., Mr. Harold Denton, USA Nuclear Regulatory Commission, during the TMI accident). For a radiological accident this assessment amounts to estimating both individual and person-rem doses for the affected public.

Computers and Data Handling Systems

To integrate the components of a national emergency response system into a reliable service for public health protection requires the development and implementation of a computer network devoted to data collection and analysis, model simulations and the publishing of health and safety advisories. Such a system could be developed and implemented largely through the use of technology that is presently available from commercial computer and research and development organizations. Attributes of such a system should include:

- Real-time Data Transmission
- Data Basing Techniques
- Quality Control Measures
- Analysis Techniques
- Model Simulations

This system should focus on the integration of modeling and measurements through the use of modern analysis and graphical techniques.

ADVISORIES

The major output of such a national emergency response system is a series of health and safety and economic advisories regarding impacts associated with an industrial accident that releases radioactive (or toxic) material to the environment. These advisories should be easily understood by government officials and the public. They should be based on the established reference and guidance levels and provided to the public through the governmental agency charged with protection of public health. Close cooperation between governmental agencies responsible for the technical evaluation and those relaying the assessments to the public will ensure a consistent and informative information flow to the public sector through a single voice of authority.

OTHER USES

The national emergency response system can be used for other related purposes to enhance its utility beyond nuclear accident assessments. A natural extention of this system involves the direct inclusion of toxic chemical releases in the emergency planning, response and assessment aspects of the system. Although many features of toxic chemical releases are different than those for nuclear releases, many similiarities also exist. The release and atmospheric disperison of some chemicals can be modeled in a manner similar to that employed for nuclear material while other toxic substances, e.g. heavy gases, could require different modeling techniques depending on the particular physics/chemistry of the release conditions. On the other hand measurement techniques for detecting an array of different toxic chemicals is considerably more complex than techniques used to measure radionuclides.

Another extention includes monitors for measuring air concentrations of conventional pollutants which could be co-located with the national monitoring system. These measurements could be used to establish a baseline (background) for conventional pollutants, and then can be used in conjunction with models for future industrial planning and implementation studies.

The data base established by this system can be used for managing responses to other emergencies, e.g. earthquakes and fires. These data bases can also be used for the design and analysis of railways, communication systems and other studies requiring a knowledge of terrain, climatology, geography and river flow rates.

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