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THE ARAC SYSTEM

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Abstract

In spite of the remarkable safety record of the nuclear industry as a whole, recent public concern over the potential impact of the industry's accelerated growth has prompted ERDA to expand its emergency response procedures. The Atmospheric Release Advisory Capability, ARAC, is a computer communications system designed to enhance the existing emergency response capability of ERDA nuclear facilities. ARAC will add at least two new functions to this capability: centralized, real-time data acquisition and storage, and simulation of the long range atmospheric transport of hazardous materials. To perform these functions, ARAC employs four major sub-systems or facilities: the site facility, the central facility, the global weather center and the regional model. The system has been under development for the past two years at the Lawrence Livermore Laboratory of the University of California.

I. INTRODUCTION

The nation is beginning to expand its commercial use of nuclear energy. With this expansion comes an increasing likelihood of nuclear accident with the attendant danger to nearby population. One type of accident which is particularly insidious is the release of radioactive gas. ARAC (Atmospheric Release Advisory Capability) will assist in determining the evolution of events if a release of this type occurs.

ARAC is a system whose function is collection of radiological and meteorological information, calculation for the prediction of cloud motion and dispersion, and display of this information in such a way that quick assessments can be made of potential hazards.

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ARAC is composed of several components:

1. The Site Facilities - each Site Facility is a minicomputer system with meteorological and radiological sensors.
2. The Central Facility - the Central Facility, another minicomputer system, is the hub of the ARAC system. Each site can communicate with the Central.
3. The Global Weather Center - the Weather Center is a minicomputer system with communications both with the Air force Weather Network (AWN) and the Central Facility.
4. Regional Model - the Regional Model is a set of computer codes which run on the 7600 and compute the evolution of a cloud of radioactive gas after it has passed into the atmosphere. These computations use data

communicated to the central facility by the Site.

In the normal course of events each Site will dial up the Central once every four hours and send to the Central all the meteorological and radiological data which it has collected and stored over the last four hours. The Central will then send back to the Site standard system time so that the Site can correct its local clock.

The Central Facility then stores this information as a backup in case an emergency occurs with that particular Site down. The information is also put into long term storage for historical purposes.

In an emergency, the Site will dial up the Central on a special line. It will then dump the data accumulated from the last routine transfer until the time of the emergency.

The central, recognizing the emergency, will then request local weather data from the Weather Center. From the Site data and the Weather Center information it will make up a data tape for input into the Regional Model. After making the tape, the Center will then do an interpolation on the wind data to produce a wind field from which the Central can calculate a cloud trajectory.

Results from the Regional Model, the trajectory and a Gaussian diffusion model will then be available for display or plotting as required by the Central personnel. As these results are completed, they will also be transmitted over the open telephone line to the Site where display and plotting equipment is also available. Thus assessment can go on at both the Central and the Site.

As the emergency evolves, these calculations will be repeated to account for changing weather conditions. The telephone line will be kept open continuously during the emergency. A hard copy will be made of all data with appropriate dates and time so that a complete history of the event will be available for analysis.

2. THE SYSTEM

2.1 THE SITE FACILITY

In routine operation, the Site Facility minicomcomputer system will collect meteorological and radiological data from sensors located appropriately around the site. This data will then be stored and transmitted every four hours to the central over a dial-up telephone line.

Concurrently, the system will compute a set of contours of normalized radiation intensity based on the Gaussian diffusion formula. This calculation is useful for the first few minutes after a release in predicting radiation dose at various positions downwind from the release.

All of this information including several maps of the site will be available for display on demand by the operator.

In an emergency the Site Facility will dial-up the Central facility at the emergency number provided and send off its latest accumulation of data. It will then wait for trajectory and regional model data which it will then display, again on demand, on appropriate maps. Hard copy output of maps and other displays will also be available for historical analysis.

2.2 THE CENTRAL FACILITY

The central facility serves as the focal point for data acquisition, assessment, and communications for the ARAC service. During normal operating conditions, site environmental data together with any site messages would be transmitted to the central facility on a scheduled 4-hour basis. The central facility would manipulate these data for storage and for making routine site environmental assessments.

In the event of a potential or real emergency, a data and voice communication link would immediately be established between the site and the central facility. At the same time, data would be requested from the meteorological data acquisition facility, and the regional model computer codes would be made available on the large computers. The meteorological data are stored in a computer-

compatible format and can be retrieved, analyzed, and used to compute a trajectory within approximately 5 minutes after notification. These data would then be transmitted to the large computers and used for the regional model calculation which would be available about 35 minutes after the trajectory calculation. These calculations would be repeated with updated environmental measurements and transmitted to the site until the requirement no longer exists. During the post-emergency period more detailed numerical model calculations can be made to assess the total environment consequences of the toxic material release.

2.3 THE GLOBAL WEATHER CENTER

Meteorological data from the National Weather Service (NWS) and/or Air Force Global Weather Central (AFGWC) would be received by the central facility minicomputer on a routine and special-request basis. These data would be stored and printed on hardcopy for analysis; certain data would be selected and formatted as input data for the trajectory calculation and the regional models. LLL is now serviced by NWS; we anticipate that our meteorological data acquisition facility will link to AFGWC to obtain grid-point-forecast meteorological data from their fine-mesh and boundary-layer models. AFGWC would also send us the lastest global observational data and general forecast information for specific areas. Certain observational and forcast data would be received at LLL on a routine scheduled basis; in an emergency, supplemental data can be received by a special request. The design of the AFGWC meteorological data network is such that a minicomputer at a remote location can receive, analyze, display, and store the meteorological data. This feature tremendously improves the efficiency of manipulating and utilizing large amounts of weather data.

During the next several years the NWS data will be received on facsimile charts and teletypes. These data will be used to supplement and back up the data we expect to receive form the AFGWC. However, the NWS plans to automate its meteorological service with the Automation of Field Operations and Services (AFOS) system within the next several years. When this system becomes operational, we plan to include it as part of our meteorological data acquisition facility.

2.4 THE REGIONAL MODEL

The regional model calculations are performed on the central computing facility at LLL. This large scale computer facility is composed of four CDC 7600's and two CDC Stars. Communication between the computers is via a high-speed, disk buffered file transport channel. User control access is via teletype channel, through a concentrater to any of the computers. The ARAC central facility will transfer bulk data from its disks via the file transport while controlling transfer and program execution automatically via a user teletype link.

3. IMPLEMENTATION

The initial three-phase study started at LLL in FY 1973 provided for concept, prototype, and plementation of ARAC. The prototype phase ended in FY 1975, and a three-year implementation phase is now scheduled to establish the service with ERDA operations sites. This three-year plan contemplates an incremental building of the component parts of ARAC system until a fully operating network of ERDA nuclear sites with the LLL central facility would be complete in FY 1978. The ARAC service may then be offered to additional sites.

If current projections for nuclear energy generation are realized, additional emergency response capabilities may be desirable. Of particular value would be water transport simulation and real-time monitoring of nuclear fuel and waste transportation. ARAC is designed to handle the resulting increase in data volume with the installation of regional communications concentrators and increased central facility storage.