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ARAC UPDATE—1979

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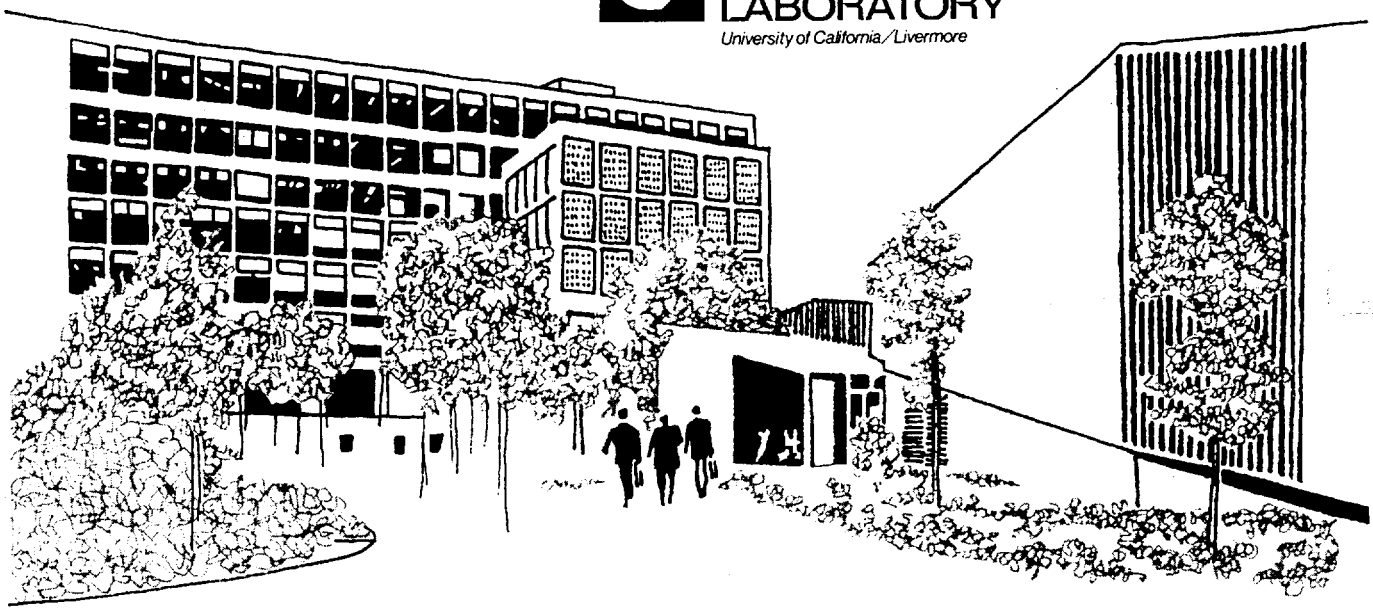

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ARAC UPDATE—1979

ABSTRACT

The Atmospheric Release Advisory Capability service (ARAC), initiated in 1972 by the Atomic Energy Commission and directed by the Lawrence Livermore Laboratory, has three main functions: (1) To provide support to designated Department of Energy facilities during an accidental atmospheric release of radionuclides; (2) to support the DOE Emergency Response Team in the event of potential or actual releases of radionuclides; and (3) to provide the Federal Aviation Administration with dose assessments whenever aircraft could possibly intercept a nuclear debris cloud from a Chinese atmospheric nuclear test. A computer network linking the central facility at Livermore with the Air Force Global Weather Central and the remote DOE sites allows rapid data transmission and analysis. Future ARAC services will include emergency preparedness planning, as well as assessments of atmospheric releases caused by spills of nonnuclear hazardous materials. We may also expand to include additional DOE facilities and provide routine site environmental assessments.

INTRODUCTION

The DOE charter provides for the protection of public health and safety in the event of an accidental atmospheric release of radioactive or other hazardous materials. In 1972, the AEC perceived that emergency response to nuclear accidents could be improved by developing better communications, dispersion modeling, modeling of regional-scale flow systems, and pathway modeling. Lawrence Livermore Laboratory was requested to review these areas of research and develop a concept for an improved advisory service.

Since the adoption of ARAC in 1973 after a thorough technical and scientific review, LLL has directed the research, development, and implementation of the ARAC advisory service as part of the DOE Emergency Response Capability. The DOE office of Health and Environmental Research and its predecessors have sponsored the research base for the project. The ARAC implementation plan developed by LLL is detailed in Ref. 1.

DESCRIPTION AND HISTORY OF ARAC

ARAC was originally designed in 1973 to provide DOE nuclear sites with the capability to monitor real-time dose levels during accidental atmospheric releases of radionuclides. ARAC has since been expanded to assess, on a global basis, the actual or potential release of radionuclides resulting from nuclear extortion threats or nuclear weapons accidents, and to provide the Federal Aviation Administration with estimates of the radiation dose to passengers on aircraft that may intercept a debris cloud from a Chinese atmospheric nuclear test.

In addition to the real-time response to actual or potential radionuclide releases, other future uses of the ARAC service are:

- Surveillance of nuclear facilities to determine environmental impact.
- Routine environmental site assessments.
- Site emergency preparedness planning.
- Improved emergency response to actual or potential incidents or accidents.
- Application of the service to nonnuclear hazardous material.

ARAC provides the user with results from numerical models that estimate the fate and temporal distribution of pollutants released to the atmosphere. The geographical scale varies from regional (up to 100 km) to global, depending on the type of release involved.

ARAC consists of several component parts (see Fig. 1). The ARAC center at Livermore has two-way communication with the LLL computer center, the Air Force Global Weather Central (AFGWC), four DOE nuclear sites, the DOE Emergency Response Team, and the FAA. In addition, the center receives weather data from the National Weather Service (NWS). The solid lines in Fig. 1 represent voice and computer-to-computer links; the broken lines represent facsimile, teletype, voice, or telecopier links.

The LLL computer center has four CDC 7600 digital computers that run both the regional, three-dimensional transport-diffusion models and the long-range transport-diffusion models. The communication system, the ARAC center, and the suite of required models have been tested approximately 35 times since 1974 during tracer releases and simulated and actual accidents.

CENTRAL FACILITY

The central facility (Fig. 2) is ARAC's focal point for data acquisition, assessment, and communication; several minicomputers are devoted to these tasks.[2] During normal operating conditions, every four hours the central facility receives environmental data and any messages from the four DOE-serviced sites. The central facility stores these data for future calculations of routine site environmental assessments.

In the event of a potential or real emergency, data and voice communication links are immediately established between the site and the central facility. At the same time, data are requested from the national meteorological data services, and the regional model computer codes are made available on the large computers. During normal working hours, regional model calculations are available to the user approximately 45 minutes after notification. Off-hours use requires up to three hours for a response. These response times will be accelerated in the future when the ARAC center is fully staffed on a 24-hour basis.

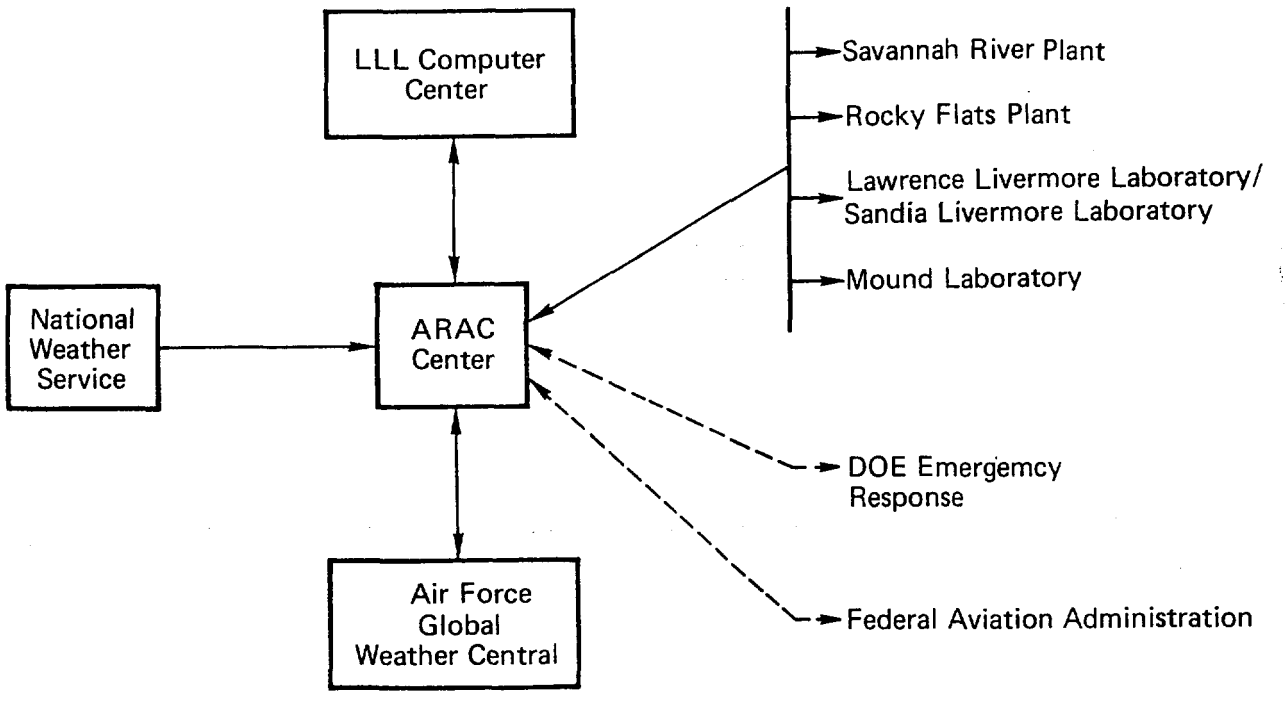

FIG. 1. Component parts of the ARAC service.

FIG. 2. ARAC Central Facility.

METEOROLOGICAL SERVICES

An ARAC central facility minicomputer receives meteorological data from the AFGWC over a high-speed dedicated phone line. Lawrence Livermore Laboratory receives observational and forecast data on a routine scheduled basis; in an emergency, supplemental data are received by special request. The AFGWC meteorological data network is designed so that a minicomputer at a remote location can receive, analyze, display, and store the meteorological data. This feature improves the efficiency of manipulating and using large amounts of weather data. These data are stored and printed on hardcopy for analysis; certain data are selected and formatted as input data for the regional model calculations.

Nationial Weather Service data are presently received on facsimile charts and teletype output; Automation of Field Operations and Services (AFOS) will replace this data service when AFOS is available in the early 1980's. These data supplement and back up the data received from the AFGWC.

NUMERICAL MODELS

ARAC now has operational models that estimate the effects of atmospheric releases of hazardous materials on a regional and global basis for fixed ARAC sites, as well as for off-site responses to nuclear accidents and threats.

Regional Scale

The Gaussian diffusion estimate calculated at the ARAC sites is based on the latest available meteorology (measured at the site), and is always available when required. This calculation is used during the first minutes to estimate concentrations out to approximately 10 km from the release point. In the near future, a trajectory estimate of the plume centerline or the puff out to 100 km will be available to the site within 10 minutes after the ARAC central facility has been notified. This estimate will indicate the initial off-site problems associated with the release.

Within approximately 45 minutes after notification of the release, and *assuming a 24-hour operating staff*, the ARAC regional numerical model assessments are available to the site. These ARAC models (MATHEW and ADPIC, defined below) were used during the ARAC feasibility tests with the Savannah River Laboratory (SRL) in 1974, and have been verified against data from approximately eight field diffusion tests (1974–78).

MATHEW[3] is a meteorological data adjustment model developed to provide ADPIC with input wind fields that are mass-consistent, three-dimensional, and representative of the available meteorological measurements (surface, tower, and upper air soundings). The bottom boundary in this model is determined by the actual topographic features for a given site (and its environs), which can play a very important role in defining or modeling the regional-scale wind patterns.

ADPIC[4] is a three-dimensional Cartesian particle-diffusion code, capable of calculating the time-dependent dispersion of inert radioactive air pollutants under many conditions, including stratified shear flow, calms, topography, and wet and dry deposition. In addition, this computer code has been adapted to simulate fallout patterns of particulates with given particle-size distributions and plume depletion of particulates over various types of terrain. MATHEW and ADPIC are now available to run operationally on the LLL CDC 7600 computers.

During 1974–78, the ARAC research staff designed and conducted, jointly with other groups, eight regional tracer tests to provide information on system performance, communication problems, and data for overall model verification. The field tests included fixed sampling systems, ground surface mobile samplers, and helicopter-mounted systems.

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Data on the three dimensional position of the tracer distribution were obtained and compared to those of the model calculation. Including cases where the transport field was influenced by the presence of terrain, 65% of the time the model-calculated air concentrations compared within a factor of two with the observed concentration. The range, including the near field, extended as far as 80 km.[5]

Global Scale

For global-scale transport and diffusion problems associated with nuclear weapons, the current verified models used for fallout and long-range transport and diffusion are KDFOC2[5] and 2BPUFF,[6] respectively. These models were tested extensively from 1964 to 1970 at the Nevada Test Site. Isotopic airborne concentrations, surface air concentrations, and surface deposition patterns compared to experimental data to within a factor of three at ranges as large as thousands of kilometres.[7-9]

As part of the ARAC research and development effort these models will be supplemented by a version of ADPIC that will provide a full three-dimensional capability for global responses.[10] This version of ADPIC was tested in the beginning of FY 1979 and will be made operational by the end of that year.

CLASSES OF SUPPORT

ARAC presently provides support to (1) those DOE sites designated in advance; (2) to DOE personnel involved in off-site incidents within the U.S. or abroad; and (3) to the FAA. Each group requires a different type of support, particularly regarding developing input fields for the computer codes and selecting the proper codes for assessing the consequences.

DOE FACILITIES

For either production or research DOE sites, data bases are developed that include geography, topography, and location of meteorological measurement stations at each facility. Population distribution and possibly land use will be included in the future. These permanent data bases are stored in the computers and are updated periodically as appropriate. Meteorological data from AFGWC and the site are stored in model input format. In addition, data from each site describing potential source terms, locations of potential releases, and other information are received and catalogued in notebooks, to provide the ARAC staff with substantial detail for each site.

Each DOE-serviced facility has a minicomputer (see Fig. 3), called the site-facility computer.[11] The ARAC site facilities perform several specific functions:

- Multiplex the environmental sensors.
- Provide local data quality control.
- Continuously calculate the display Gaussian diffusion estimates for close-in distances (out to approximately 10 km), using latest local meteorological data.
- Transmit local environmental measurements to the ARAC central facility.
- Receive and display regional calculations from the central facility.

The site facilities perform the following functions without a direct data link to the central facility (in the stand-alone mode):

- Display the listing of last four hours (15-minute averages) of wind and temperature measurements for each sensor.

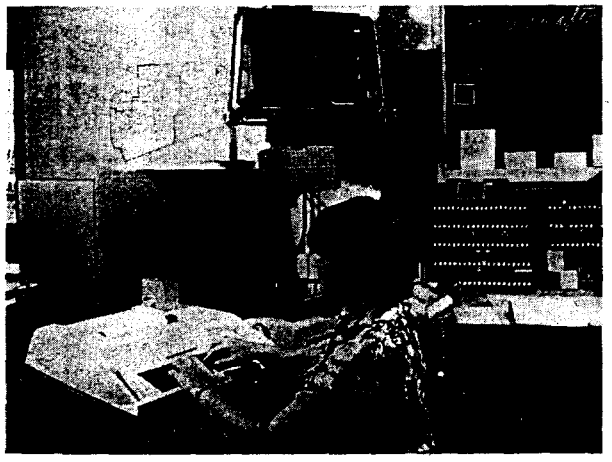

FIG. 3. LLL ARAC site facility located in the five dispatchers' office.

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- Display the wind rose of latest two hours (eight 15-minute averages) of wind speed and direction measurements for each sensor.
- Calculate and display Gaussian diffusion-concentration estimate.

In event of an incident, the site facility becomes an interactive work station for the site personnel charged with assessing the consequences of an atmospheric release and providing guidelines for protective measures.

Interaction between personnel in the ARAC center and at the site depends on the local capabilities at each site. For the Savannah River Plant (SRP), the Atmospheric Science Group at SRL provides excellent support for local consequences within and around the plant boundaries. In this case, the Gaussian calculation provided by the ARAC site facility backs up the SRL local capability, which also provides an initial estimate of the regional consequences with a trajectory-puff calculated on their minicomputer.

In the event of an accidental release, the ARAC assessment meteorologist would confer with the meteorologist at SRL to establish concurrence on the weather forecasts and the initial calculations. Regional model calculations would then be available from the ARAC center to provide a detailed assessment of the consequences to about 100 km from the source. These calculations would be used to supplement and expand the assessments generated at SRL. The initial set of regional model calculations would be updated approximately every hour until a complete assessment were made.

At Rocky Flats and Mound Facility, which have neither an atmospheric sciences group nor an inhouse minicomputer capability, greater dependence is placed on the local capability of the ARAC site facility and the weather forecasts from the ARAC center. The regional model calculations serve essentially the same function as at SRL.

Because the data bases for these DOE facilities are stored in the computers at LLL, the regional model calculations can be available to the site personnel within about 40–45 minutes after the ARAC center is notified (assuming a *full* operating staff at the ARAC center). Within about 10 minutes a trajectory showing the path of the release beyond the site boundary can be available to bridge the gap between the Gaussian and regional model calculations.

OFF-SITE INCIDENTS

Off-site responses—i.e., nuclear weapon accidents, nuclear extortion threats, or incidents at facilities not regularly serviced by ARAC—require a different method of operation, especially in the data collection for model input files and source term definitions. The AFGWC computer link is used to obtain surface and upper-air observational data; it is also used to forecast and analyze on a global or regional basis. Within minutes, AFGWC provides access to measurements routinely collected and centrally stored for approximately 12,000 locations. With the possible exception of wind speed and direction measurements at the incident location, the input meteorological data for an off-site response are similar to those for a DOE-serviced facility. The major difference is that input files and measurement locations must be established.

The ARAC center has on file a complete set of USGS 1:250000 global topographic maps, which are presently used to define the major geographical and topographical features of a given area. From these maps, a digitized geographical background for the computer products is generated and the major topographical features of the area are defined to calculate a crude topographical input file for the MATHEW and ADPIC computer codes.[4,5] Tapes of terrain for the entire continental U.S., received from the USGS, are on file in the ARAC center and data can be extracted within a couple of hours. Input terrain data will be more readily available for the MATHEW and ADPIC calculations when these data are eventually stored on disks in the ARAC center.

Off-site responses can vary considerably in assessment needs and operational model requirements. For areas of flat terrain and for an initial assessment for most regional problems, PATRIC[1] is used because it is fast-running and requires less input file preparation. For assessments associated with a possible nuclear yield, KDFOC2[6] is used to estimate fallout, and 2BPUFF[7,9] to estimate air concentrations. In the future, the FAA will sponsor an extension of PATRIC to provide a capability for calculating long-range (thousands of kilometres) doses for nuclear debris clouds with the explicit inclusion of wind shear.

As a result of recent work done in Canada, a variation of the KDFOC2 model is now available to

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calculate the expected ground distribution of large particles (from 50 to 1000 μm) released at altitudes of 40 to 50 km.

If an off-site incident is critical, an ARAC representative is prepared to go to the incident location to help obtain input data for the model calculations, and to serve as a liaison to the personnel charged with establishing protective measures. A portable telecopier provides the data communication link between the field and the ARAC center. In the future, it should be feasible to field a remote ARAC terminal with capabilities similar to those provided to the DOE sites.

Off-site accidents include those incidents that require the response of either the DOE Nuclear Emergency Search Team (NEST) or the Aerial Measurements Systems (AMS). In either case, the response is intended to cover the dispersal of radioactive material, particularly in or near a metropolitan area.

NEST and AMS are equipped with mobile minicomputer data processing systems, used primarily to process data from the NEST and AMS measurement systems. Any measurements of radioactive concentrations or depositions can be fed back into the model assessment calculations to provide checks, balances, updates, and source-term estimates.

FAA SUPPORT

The FAA has requested that DOE provide ARAC support whenever aircraft could potentially intercept debris clouds from Chinese atmospheric nuclear tests. Since 1976, ARAC has calculated and provided estimates to the FAA on the dose to passengers and crews of aircraft that might intercept these radioactive clouds. These calculations are now based on the 2BPUFF long-range transport and diffusion computer code, using input data from AFGWC. Every 12 hours, calculations based on analyzed and forecast winds at the appropriate levels in the troposphere and/or stratosphere are sent to FAA headquarters by telecopier. The FAA uses these calculations to determine whether any deviations from normal flight operations are required to minimize the dose to passengers and crew.

The FAA is presently funding work to incorporate a version of the PATRIC computer code in the ARAC operation mode, which will provide an improved long-range dose calculation by including vertical and horizontal wind shear as part of the simulation. This improvement is feasible because gridded, analyzed, and forecast windfields for various levels in the atmosphere are available through the computer link to AFGWC. When developed, this capability can also be used for DOE-related problems associated with potential nuclear yields.

ARAC RESPONSES

Table 1 lists the different tests and responses of the ARAC system and models during the past five years. The 72-hour NEST training exercise was one of the most realistic and caused us to reconsider how the center's operations should be structured for a multiday response. Among all the ARAC responses and tests summarized in Table 1, the events with the highest public visibility were the reentry of Cosmos 954 on January 24, 1978, and the reactor accident at Three Mile Island on March 28, 1979.

The Cosmos 954 operation lasted almost two months, of which relatively few days were intense. ARAC provided support by locating areas for making air concentration measurements as well as for calculationally determining the most likely boundaries of areas contaminated with radioactive particles.

On January 23, 1978, ARAC was alerted to a possible release of I^{131} from the Ft. Saint Vrain nuclear power reactor in Colorado, which provided ARAC the experience of handling two simultaneous events. Figures 4 and 5 show ADPIC calculations of integrated air concentration and ground deposition of I^{131} valid at 1330 hr local (MST) time based on a one-hour unit-rate release beginning at 0930 hr. Assuming a Ci/s release rate for the first hour, the innermost contour in Fig. 4 corresponds to approximately a 1-Rem dose to an adult and a 3-Rem dose to an infant thyroid. The innermost contour of Fig. 5 relates to 1×10^{-4} Ci/m^2 on the ground, given the same source term assumptions. Final analysis showed that the total release was a few millicuries, and it was deemed no health hazard to the public.

At 0820 PST on March 28, the DOE Emergency Operation Center alerted ARAC to the fact that the Three Mile Island Unit No. 2 in

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TABLE 1. ARAC responses and tests.

Date	Event type	Event and response
		Accidents or potential accidents involving releases of radioactive material
May 1974	SRP tritium release	Transmitted SRP wind data to SRL and calculated Gaussian estimates of concentration. Also provided estimates of uptake in vegetation based on LLL release in 1970.
Dec. 10, 1975	Potential accident	Simulated accident while off-loading weapons from USS Balknap in Augusta, Sicily. ARAC model calculations were made which included topography.
Mar. 31, 1977	Train accident	Train accident involving UF_6 occurred at Rockingham, NC. We were called by SRL to respond. We estimated air concentrations via Gaussian and ARAC models. ORNL confirmed that the containers were not breached so ARAC was turned off.
Aug. 20, 1977	DOE request	DOE support during Voyager II launch by providing estimate of consequences associated with a low probability launch pad accident resulting in a release of plutonium to the atmosphere.
Sep. 4-5, 1977	DOE request	DOE support during Voyager I launch as stated above for Voyager II.
Jan. 23, 1978	Reactor accident	Called by DOE EACT to respond to accident at Fort St. Vrain Nuclear Power Plant. Calculated dose-to-adult and infant assuming ^{131}I was released to the atmosphere. Final analysis showed that minor quantities escaped the filter system and no health hazard existed for the public.
Jan. 16-Feb. 15, 1978	Satellite reentry	Assisted NEST in post-analysis of the COSMOS 954 satellite reentry. Calculations of air concentration and deposition were prepared for different modes of destruction as the satellite entered the earth's atmosphere. These modes ranged from high-altitude burn-up in the lower atmosphere to ground impact and disintegration. Information on possible cloud movements was also requested to help locate areas for making air concentration measurements. Provided dose calculations to FAA for passengers and crews flying in the stratosphere.
Mar. 28-Apr. 18, 1979	Three Mile Island	Assisted EACT in the emergency response to the Three Mile Island nuclear accident. ARAC regional maps of radioactive isotope distributions were key to effective deployment of ground and aerial monitoring team, and to estimating the time dependent source term by interpretation of close-in measurements with models.
		Nuclear tests
Nov. 19-26, 1976	Chinese atmospheric nuclear test	Provided dose calculations to FAA for passengers and crews flying on SST's across the North Atlantic.
Sep. 17-23, 1977	Chinese atmospheric nuclear test	Provided dose calculations to FAA for passengers and crews flying on 747SP's over the eastern Pacific.

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TABLE 1. (continued).

Threats involving nuclear material

During the past five years the DOE emergency response structure has responded to a few tens of nuclear extortion threats. ARAC center was activated on several occasions as standard operating procedure. Although these threats were eventually proven to be hoaxes, the DOE organization deemed it prudent to manage them conservatively; hence, the need for ARAC type advisory information emerged on several occasions.

Field tracer tests used for model verification studies

Date	Test type	Event and response
June 11, 18, 20, 1974	LLL/SRL test	Three real-time, 4-hour tests using ^{41}Ar as tracer. ARAC model calculations and measurements conducted simultaneously and compared in real-time.
Dec. 10, 1975	LLL/SRL test	Real-time, 12-hour test using ^{41}Ar and SF_6 as tracers out to 80 km. ARAC model calculations and measurements were conducted simultaneously and compared in real-time.
Dec. 18, 1975	LLL/SRL test	Real-time, 4-hour test using ^{41}Ar as a tracer. ARAC model calculations were made for 2 hours and measurements for 4 hours. No real-time comparison.
Dec. 19, 1975	LLL/SRL test	Real-time, 8-hour test using ^{41}Ar and SF_6 as tracers. SF_6 was turned on for 4 hours to simulate a real release. Wind switched and we were still able to direct sampling aircraft into plume via ARAC model calculation.
July 19, 1977	LLL/SRL test	Conducted test using ^{41}Ar as a tracer. Measurements were made out to 30 km downwind and compared to ARAC model concentration calculations. Report in progress.
Oct. 10, 1977	Tracer test	Participated in the DOE MAP3S AMBIENS tracer experiment by providing air concentration calculations to project director using ARAC transport and diffusion models.

Scenarios designed to test response capability

Date	Event type	Event and response
May 1975	Threat assessment test	Complete DOE response to simulated threat at San Francisco airport. ARAC model fallout calculations and Gaussian air concentration calculations were made and transmitted to response team headquarters at airport.
March 1976	LLL/SRL test	Simulated release of H_2S. Performed ARAC model calculations for 2 hours and transmitted results to SRL.
June 1976	Threat assessment test	Simulated release of plutonium by HE in San Francisco. ARAC model calculations were made up to 5 hours after release. Test conducted jointly with health physicist in Hazards Control Department.

TABLE 1. (continued).

Scenarios designed to test response capability		
Date	Event type	Event and response
Oct. 19, 1976	LLL/RFP test	Simulated plutonium and inert gas release. ARAC model calculations were made out to 5 hours after release and results sent to RFP.
Mar. 15, 1977	Weapon accident test	Simulated a weapons accident in Europe to test AFGWC response. Ran Gaussian and ARAC model calculations for one time period.
Apr. 28, 1977	LLL test	Simulated accident at Site 300 where plutonium was involved. Exercised site facility and provided Gaussian estimates of air concentration and deposition.
Aug. 15-19, 1977	Threat assessment test	Participated in the DOE NEST '77 exercise held at INEL, Idaho Falls, ID. Provided dose estimates for both nuclear detonation and HE plutonium-related scenarios.
Apr. 19-24, 1979	Weapon accident test	Participated in the joint DOD/DOE NEWAX exercise held at the DOE Nuclear Test Site in Nevada. Provided dose calculations for postulated nuclear weapons accident.

Harrisburg, Pa., had had a release some four hours previously in the form of steam and an unknown level of radioactivity and total heat content. The center was asked by DOE to respond with regional calculations of the temporal distribution of the radioactivity since the inception of the incident, and to come up to real-time simulation as quickly as possible. Because the alert was late, and because Middletown, Pa. is not a normally serviced ARAC site, meteorological and terrain information was not available immediately. After three hours we produced the past and currently projected temporal distributions of the released radioactivity out to a range of some 60 km. We used these calculations (Fig. 6) to effectively implement the early ground and, later, the aerial monitoring systems to document the environmental levels of radioactivity at the surface and in the air (100 to 500 m) in the region of interest.

Some 12 to 18 hours into this event, the ARAC staff had processed detailed topographic data for the Harrisburg region. These data were then input as boundary conditions to both the regional flow model and the transport-diffusion model for all calculations of temporal radionuclide distribution for the next 20 days.

By the morning of March 29, an LLL ARAC field representative was at Harrisburg to interpret the ARAC maps and to advise the DOE emergency response site commander. On March 31, a second LLL ARAC representative was sent to Harrisburg. These individuals played a role in designing suitable and effective deployment of the monitoring systems that became available during the course of the incident. After one week, representatives from National Oceanic and Atmospheric Administration, Idaho Falls, Id., and SRL were called on to support the DOE on-scene commander.

Monitoring measurements made at the site boundary and further down-range were used in conjunction with the calculations to furnish early estimates of the release rate for the identified radionuclides. This was the second use of the ARAC calculations.

The FAA also used ARAC calculations during this time to determine if low-level flight plans of aircraft in the vicinity of Harrisburg should be modified to minimize exposure to passengers and

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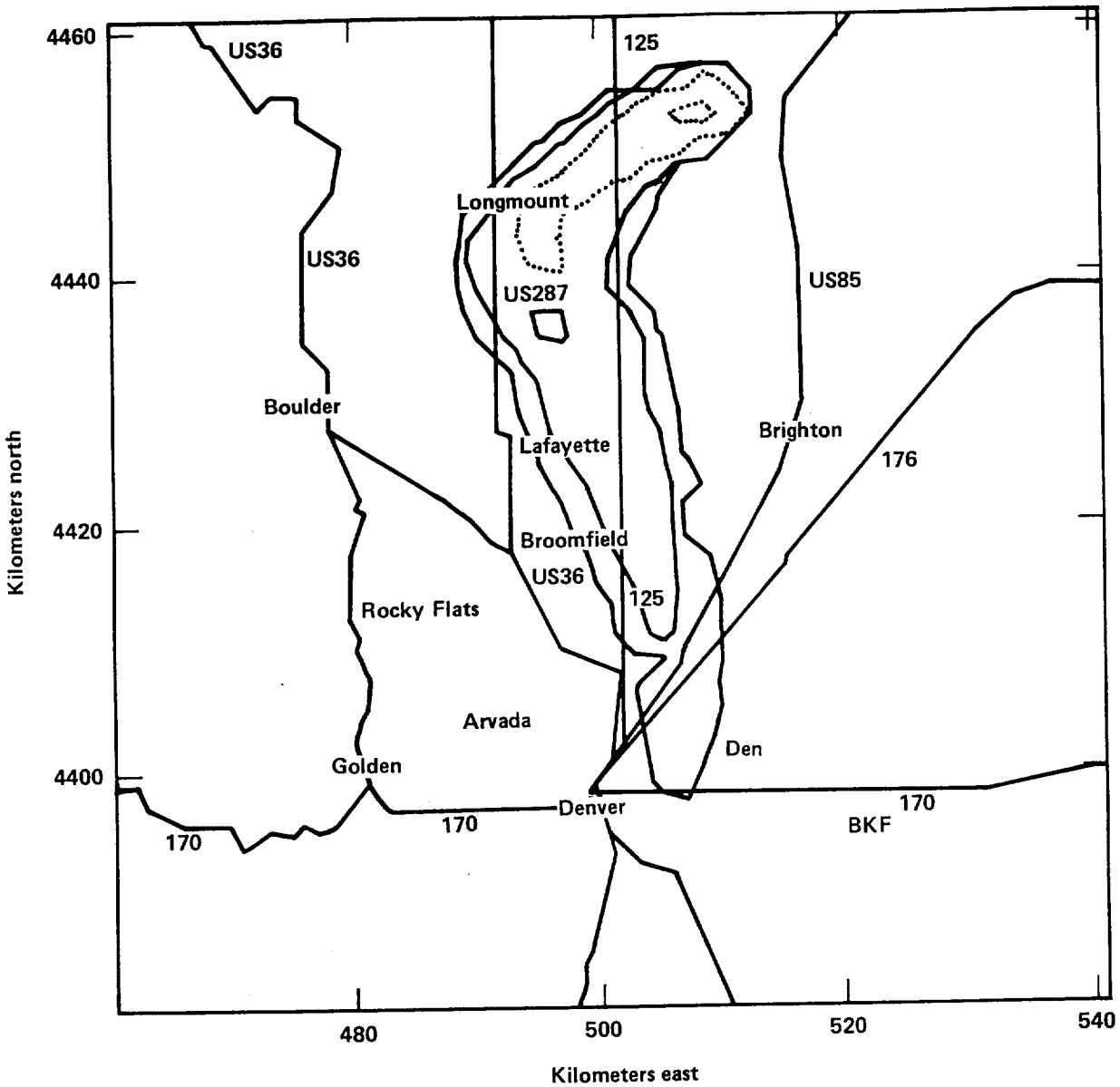

FIG. 4. Integrated air concentration at 1330 hr MST based on a unit rate release for 1 hr beginning at 0930 hr MST.

crews. For this purpose, the FAA was in direct contact with the ARAC center for the required information and guidance.

During the entire 21 days of ARAC support, we produced simulations of the temporal regional distribution of the relevant radionuclides so that monitoring systems could be sent to the appropriate places to document environmental levels of radiation. Preliminary reports from the field indicate that the calculations were consistent with both aerial and ground measurements.

To maintain ARAC center shift coverage and to rest the operational teams, more than 30 research staff members of the Atmospheric Science Division participated. This operation lasted the longest, and was the most intensive and the most significant emergency response experience of the 35 to which ARAC has responded. Since then, we have been requested to help assess the post event population exposure to radiation.

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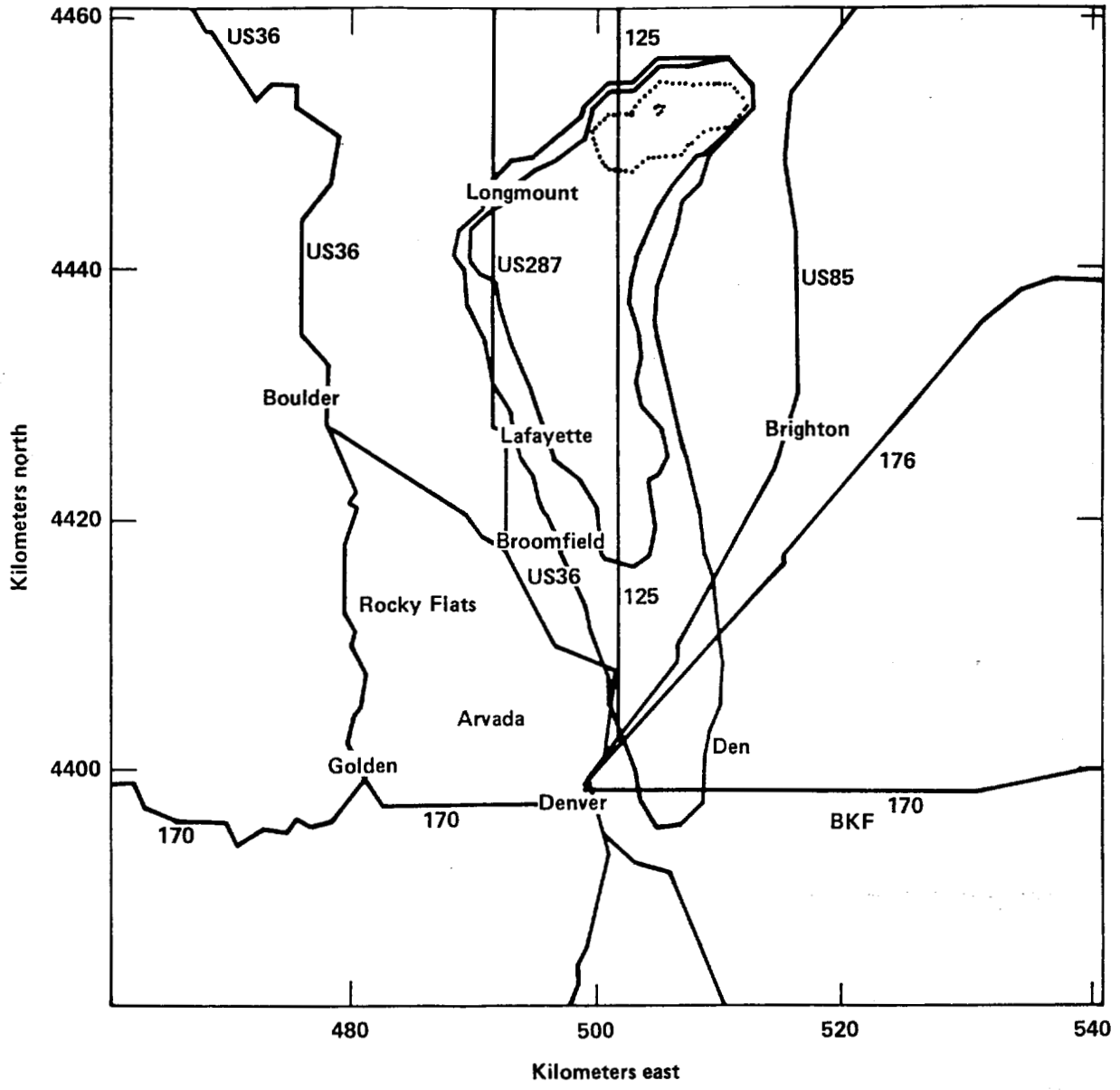

FIG. 5. Deposition at 1330 hr MST based on a unit rate release and a deposition velocity of 1 cm/s for 1 hr beginning at 0930 hr MST.

CURRENT ACTIVITIES AND FUTURE PROSPECTS

The ARAC implementation plan developed jointly in 1975 by LLL and ERDA called for a reduced level of research support beginning in FY 1979. This reduced level is to maintain the ARAC system and models in a state-of-the-art status, to implement verified improvements in component models, and to provide some additional response capabilities in the event of an actual emergency.

In 1978, a study panel reviewed the ARAC system, its performance, history, and capabilities. The panel recommended that the system be expanded to other DOE sites, and that the center

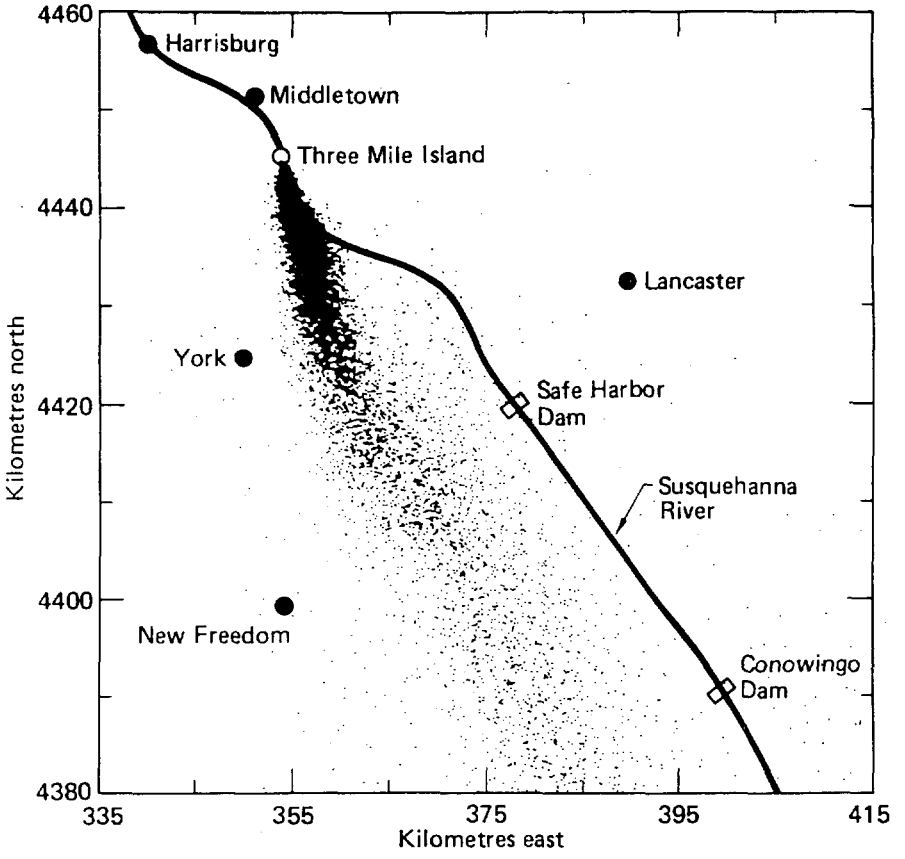

FIG. 6. Typical ARAC projection of the movement of a potential continuous release of one unit of radioactivity per second from the Three Mile Island nuclear reactor. The dots show the movement of the radioactivity after the hypothetical release; dot density indicates relative concentrations. These calculational results come from the MATHEW and ADPIC computer codes.

begin building an operation staff (one shift per day) beginning in FY 1979. In May 1979, LLL received budget authorization for this purpose.

Through the Emergency Planning Branch of its Office of Nuclear Reactor Regulation, NRC is supporting an LLL study of the feasibility of using ARAC services to augment the emergency-preparedness programs at commercial nuclear power plants licensed by NRC.[12] Currently in the last stages of investigation, the first part of this study focuses on the conceptual implementation of ARAC at the Rancho Seco Nuclear Generating Station, operated by the Sacramento Municipal Utilities District. Many of the factors considered in this study are, therefore, site-specific.

A follow-up NRC study, anticipated to be completed in 1980, will investigate the generic factors involved in nationally implementing ARAC services at nuclear plants. This study will enlarge upon a recent preliminary study of the technology transfer aspects of the ARAC service, which delineated three problem areas for a separate contractor: (1) general scientific support; (2) updating of the atmospheric computer codes; and (3) availability of redundant large scientific computers.[13] However, at the remote sites and in the areas of network communication and data collection, technology transfer aspects are more feasible.

As stated previously, many pollutants other than radioactive toxic materials can pose serious health hazards if released under certain conditions. Examples of these releases are chlorine (which can be negatively buoyant), ammonia, and hydrogen sulfide. Because these materials are shipped and stored in large quantities, significant atmospheric releases are possible. We can apply some of the assessment models used for radioactive releases to other toxic substances as long as these substances are relatively nonreactive. The toxicity of these chemicals can be easily factored into the model output calculations on the basis of parts per million for consequence assessment.

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