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MURRAY R. EDELMAN
VICE PRESIDENT
NUCLEAR

October 25, 1984
PY-CEI/NRR-0148 L

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Perry Nuclear Power Plant
Docket No. 50-440; 50-441
Meteorological Information
Dose Assessment System

Dear Mr. Youngblood:

This letter is provided in response to your letter dated August 22, 1984 which forwarded your evaluation findings on the use of meteorology at PNPP.

An April 4, 1983 letter (PY-CEI/NRR-0034) submitted the report titled "Description of the Perry Nuclear Power Plant Emergency Offsite Dose Calculations" (NUS-4336 dated April 1983). Chapter Three of the report described the dose assessment modeling tool planned for use at PNPP. Since that submittal we have revised the dose assessment modeling system. Included as an attachment to this letter is a summary technical description of the system presently planned to be used for dose assessment at PNPP.

Review of the comments forwarded in the August 22, 1984 letter is underway and a response will be forwarded as a revision to NUS-4336. This revision will be submitted by December 7, 1984, and will consider the recommendations as presented in your letter.

It is anticipated that the attached technical description and the upcoming revision to NUS-4336 should resolve any questions on the use of atmosphere dispersion models at PNPP. If there are any further questions, please feel free to contact us.

Very truly yours,

A. Kaplan for M. Edelman

Murray R. Edelman
Vice President
Nuclear Group

MRE:njc

Attachment

cc: Jay Silberg, Esq.
John Stefano
J. Grobe

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TECHNICAL DESCRIPTION OF THE COMPUTERIZED METEOROLOGICAL INFORMATION AND DOSE ASSESSMENT SYSTEM (MIDAS) INSTALLED AT THE PERRY NUCLEAR POWER PLANT

BACKGROUND

Dose assessments in the event of an emergency at the Perry Nuclear Power Plant will be accomplished utilizing a computerized system that receives data automatically from the meteorological tower and plant radiation monitors. Two plume dispersion models are available. One that utilizes the straightline Gaussian and a second that estimates plume trajectory utilizing a plume segment approach. The plume segment model incorporates methodology for approximating dispersion conditions during lake breeze situations. Results are displayed as dose rates or dose projections for comparison with the EPA Protective Action Guides (PAGs) and is referred to as MIDAS (for Meteorological Information and Dose Assessment System). The software package was provided by Pickard, Lowe and Garrick, Inc. (PLG).

HARDWARE

The software package is operational on a VAX 11/780 and two disk drives totalling 248 MG capacity. A magnetic tape drive is provided for data archive functions and system utilities. A 300 line per minute printer is available for development and system management use. The computer runs in a multi-tasked environment under a virtual memory operating system which can accommodate many users simultaneously via local or remote terminals. Tektronix 4113 19" color graphics terminals with hard copy devices are provided in the EOF and TSC facilities, and a Tektronix 4107 13" color terminal is provided in the Control Room. All terminal communications operate at a speed of 9600 baud or greater.

GENERAL SOFTWARE CHARACTERISTICS

The software is entirely menu driven and is configured to supplement the emergency plan for rapid calculation of offsite doses. Site specific parameters are stored in disc files under system manager control. Security is provided by log-on procedures under control of the system manager. Dispersion and dose calculations can be initiated by a single operator action on the CRT keyboard.

The Gaussian model is used for rapid initial dose estimates and projections while the plume segment model can be utilized for more refined estimates of plume location and dose history. Results are displayed on site maps extending to a 50-mile distance from the plant. Maps are stored in the terminal to enable more rapid display of results. Printed information is provided to supplement the graphics output. The software provides for manual entry of both meteorological and radiological effluent data if monitor data are unavailable.

Files are available for operator entry of simulated data for use during drills. This enables trainees to practice using predetermined scenarios in a mode that does not interfere with the online emergency mode that would be used during a real emergency.

All software is written in standard FORTRAN. Listings are maintained onsite for use in interpretation or problem solving.

FILE STRUCTURE

Meteorological and radiological data bases are stored on disc for use in making the required dose calculations. Files containing ("constant") information specific to the site-plant situation are changed by privileged edit routines provided in the package. A series of routines perform these calculations using both the "fixed" and "time-dependent" data and in many cases stores the results of the calculations in files used by other routines for system output. The user can schedule runs that automatically read and display results from these files without operator intervention.

METEOROLOGICAL AND EFFLUENT DATA MAINTENANCE TASKS

A series of tasks is provided to inspect, maintain and archive the data bases created by the system. Examples follow:

(1) A task is provided to print the hourly or 15-minute meteorological parameter averages over any specified time period (within the bounds of the file).

(2) The "bad data" task can display the areas of bad data recovery for quick inspection.

(3) The "joint frequency" task categorizes and prints the meteorological data (in joint frequency form) by direction, speed group and stability class for use in Regulatory Guide 1.21 reports.

(4) Summaries of total release by isotope can be printed.

(5) The "trend plot" task can be used to plot meteorological or radiological effluent data which enables checking for problem areas in the data.

(6) Other tasks can be used to summarize the delta-T and wind rose data.

INPUT DATA REQUIREMENTS

The computer interrogates microprocessors periodically to determine 15-minute averages of meteorological and radiological effluent monitor signals. Wind speed and wind direction at the 10 and 60 meter levels along with vertical temperature difference between the 10 and 60 meter levels is derived from redundant instruments on the meteorological tower. Digital signals are sent to the computer via redundant data links. Radiological data are received from the monitors in the plant vent, the condenser offgas system and the heater bay/turbine building. Releases can be assigned to any of four release points from which a release rate (microcuries/sec) is computed. Since these effluent monitors do not provide an isotopic breakdown, the fraction of the total release for each isotope is determined from default multi-channel analyzer (MCA) spectra as a function of accident type. Manual entry of the isotopic breakdown is also provided.

ACCIDENT DISPERSION AND DOSE CALCULATIONS

Results of real-time atmospheric dispersion and dose calculations for accidents are available in printed and graphical form. MIDAS software is available for the models referred to in NUREG-0654, Appendix 2 as Class A and or enhanced Class A. The following two sections describe these models.

The Class A Model

The Class A model used for real time assessment of dispersion is the standard Gaussian model. The graphical isopleth output, representing a straightline Gaussian shaped plume, was designed to replace the plastic overlays (for maps of the same scale) currently found in the emergency kits in many control rooms. A background map of the site is plotted along with the isopleths so that both appear on the same plot.

All accident calculations are under menu control for ease of use by the operator. The map scale, release point (along with vent flows), level for data on the meteorological tower and terrain height (subtracted from plume height for elevated releases) can all be preselected or selected during the run by the user. Any previous hour (or the last 15-minute average) can be selected for the calculation.

Certain self-checks are provided to warn the user of problems. For example, if meteorological data are "bad" the user is notified and asked if data from some other source are available. If so they are entered by the operator. Likewise, if dose results are selected and there are no effluent release values present (from real time effluent monitors) or the data are bad, the user will be prompted for input. Beta, gamma and/or thyroid-inhalation doses are computed after all input data have been entered. A calculation will not be completed without contemporaneous meteorological and effluent data. Results are in printed or plotted form.

Several choices are available to the user for the source term. If the accident classification is known, but the release is unknown, preset release scenarios can be used for up to ten accident categories. Otherwise, real time data from effluent monitors can be used.

Enhanced Class A Model

NUREG-0654, Appendix 2 also refers to a more complex model for estimating diffusion and exposures out to greater distances. The model currently programmed and operational in the Perry Plant MIDAS package is a plume segment model based on a program developed by PLG called CRACIT (For Calculation of Reactor Accident Consequences Including Trajectory) which is similar in concept to that of the CRAC program which was written for the Reactor Safety Study (WASH-1400). The "front end" source term and "run" menu options provided for the class A model are also used to drive the enhanced version, thus the operator interface is essentially unchanged.

THE PLUME SEGMENT MODEL

The basic functions of the plume segment model are the calculation of meteorological dispersion of the released radioactive material as it travels downwind and the estimation of the resulting doses from this material. The meteorological dispersion is modeled assuming Gaussian diffusion and variable trajectory transport.

The transport portion of the dispersion model allows the plume travel direction to vary as the wind direction varies. The model divides the plume into segments called spatial intervals according to the travel distance for each hour (or quarter-hour). The standard Gaussian model is used to estimate plume dispersion based on the wind speed, wind direction and delta temperature measured on the weather tower. The plume, therefore, is represented by a series of segments, each of which has different characteristics based on the meteorology at the time the segments are in their respective locations.

The model simulates plume rise, building wake effects, dry deposition and wet deposition as a function of rain rate. The model can be run using hourly or quarter-hourly wind averages.

Short-term Releases

The dose calculation in the plume segment model provides information necessary for use in making immediate protective action decisions. Projected integrated organ doses for the whole body, thyroid, and lung are computed for each plume segment for a given short-term (usually 15-minute) release. Three pathways are used including plume shine, inhalation and ground shine. The whole body dose consists of the sum of plume shine dose due to plume passage overhead, inhalation dose due to inhaling airborne radioactive material and to ground shine dose from particulates deposited on the ground. The thyroid inhalation dose is reported separately for use in comparison with the PAG's, although the plume shine and ground shine components are available in printed tables. The average dose rate (rem/hour) to each of the three organs is also estimated from the three pathway components.

The model can be run in a predictive mode using the most recent data from the tower. After the first hour, persistence is used for all dose projections. The lake breeze processing if in effect will cause changes to the otherwise straightline plume trajectory.

The results of the plume trajectory and dispersion modeling and the calculated doses can be plotted on the graphics CRT overlaid on the site map. The widening of the plume as it moves away from the site is a function of the atmospheric stability. The changing plume direction is controlled by the changing wind directions based on information from the meteorological data files. Characteristics of each spatial interval can also be printed in tabular form.

Long-term Releases

The same calculation routine is used for making longer-term dose estimates (for more than one 15-minute release). In this program a release is simulated as several short-term releases. Each of the releases is treated as a separate plume moving away from the site according to the meteorological conditions for that time. Therefore, each successive release is controlled by a different weather sequence. The dose over the area is accumulated separately on a fine mesh grid for each release. The total dose over all releases for each of up to four requested projection time periods can be displayed graphically as isopleths on the CRT.

LAKE BREEZE PROCESSING IN THE PLUME SEGMENT MODEL

During warmer seasons, wind patterns caused by "lake breeze" effects can occur at the Perry site. The lake breeze phenomenon is well-known along the shores of the Great Lakes and has been the subject of extensive field studies for many years. Several lake breeze characteristics are of note which affect atmospheric dispersion and plume trajectory. During onshore flow, a parabolic shaped boundary or lid (referred to as a TIBL) can be formed starting near the shoreline and increasing in height with distance inland. This lid can result in plume trapping or fumigation with associated high ground level concentration. The flow from the lake penetrates inland to a certain distance where turning and also uplifting occurs. These phenomena are the result of air density effects caused by temperature differences between the warm land and colder water. A reverse condition can occur at night causing a "land breeze" that flows out over the lake.

Since releases are from the plant vent essentially at ground level below the TIBL boundary only, modelling of the fumigation conditions is not appropriate for the Perry site.

Plume trajectory changes may occur when the plume reaches the "convergence zone" or the inland location where the lake breeze stops. Thermal convection can actually form a "cell" which results in a return flow aloft back toward, and generally moving (spiraling) parallel to, the shoreline. This 3-dimensional phenomenon, after reaching the convergence zone, is extremely difficult to characterize. However, plume dispersion under these circulating conditions is very good. To account for these phenomena, methods for estimating plume dispersion and location are applied in the MIDAS model. They are based on algorithms which use conditions measured on the meteorological tower at the site as well as lake water temperatures and time of day as described below.

The lake breeze submodel is incorporated in the MIDAS plume segment model using a series of preprocessors in the software which provide three basic functions as follows:

(1) Determine whether meteorological conditions meet the criteria established for the existence of a lake breeze.

(2) Estimate future meteorological input parameters using existing meteorological conditions.

(3) Estimate the depth of lake breeze penetration inland and estimate changes in wind flow patterns as a function of time.

These functions are accomplished by a series of logic checks on the available data to categorize current weather conditions. These checks require use of the previous few hours of data which are stored in the computer to determine when lake breeze conditions started. Since the plume segment model is time-dependent (i.e., it steps into the future) and is used to project doses, lake breeze input to the model must be prepared for the future as well. For example, it would not be correct to assume lake breeze conditions exist after sundown. Projections beyond that time would, by necessity, be made using the tower data without lake breeze preprocessing or dispersion equations.

The following data are used in the preprocessors:

(1) date (season)

(2) time of day

(3) lake temperature

(4) air temperature

(5) wind speed

(6) atmospheric stability

(7) wind direction

REMOTE USER EMERGENCY REPORTS (the Broadcast Function)

Software is provided which automatically sends reports to predefined remote terminals. The "Broadcast" reports include meteorological data in the format specified originally in NUREG-0654. The remote terminal operator does not have to constantly monitor the terminal and schedule tasks to receive 15-minute updates.