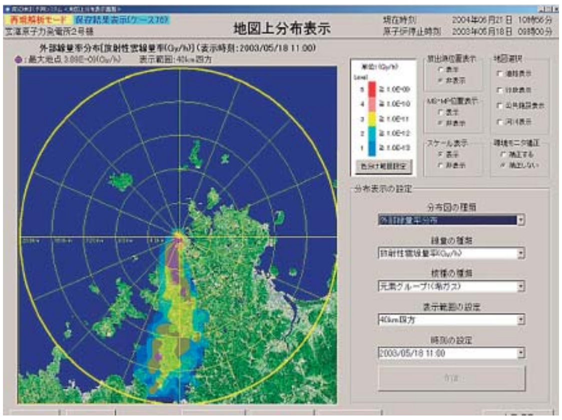

Development of a Nuclear Preparedness Support System

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1. Introduction

The words 'nuclear emergency' refer to a situation in which unusually large amounts of radioactive materials or radiation are released from facilities such as a nuclear power station to the outside. In the event of a nuclear emergency, utilities must immediately report its occurrence and subsequent events to central and local governments, as illustrated in **Fig. 1**. They also must conduct analyses of the accident, and must predict/assess its trajectory and how it will affect the environment around the facility and provide the information thus acquired to the concerned organizations.

Mitsubishi Heavy Industries, Ltd. (MHI) developed MEASURES (Multiple Radiological Emergency Assistance System for Urgent Response), which, under any such circumstances, assists the utilities in implementing nuclear emergency response activities and supports the plant's emergency personnel in making decisions or forming judgments. What is important in coping with a nuclear emergency is to carry out a precise analysis of the accident, to grasp the course it will follow, to make an exact prediction of its impact on the surrounding environment, and to ensure the safety of local residents.

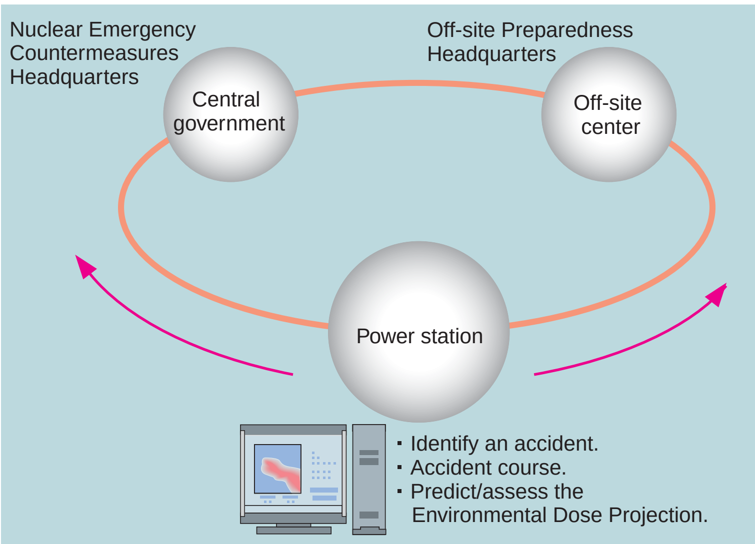

Fig. 1 Basic concepts behind emergency management system

2. Configuration of MEASURES

MEASURES is equipped with the following four subsystems to assist in an effective response to a nuclear emergency. This system involves a simple configuration that makes full use of personal computers while realizing a significant cutback in the data-handling time by assigning time-consuming operations, including 3-D Air Flow Distribution Analysis, to parallel-processing computers. **Fig. 2** shows the data processing flow that is undertaken by the subsystems.

(1) Accident Identification & Processing System (AIPS)

AIPS fulfills the following three functions: 1) data acquisition, 2) plant status indication, and 3) identification of an initiating event. The data it processes include plant status data (plant parameters), environmental monitoring data (environmental parameters), and meteorological data, such as wind directions and speeds.

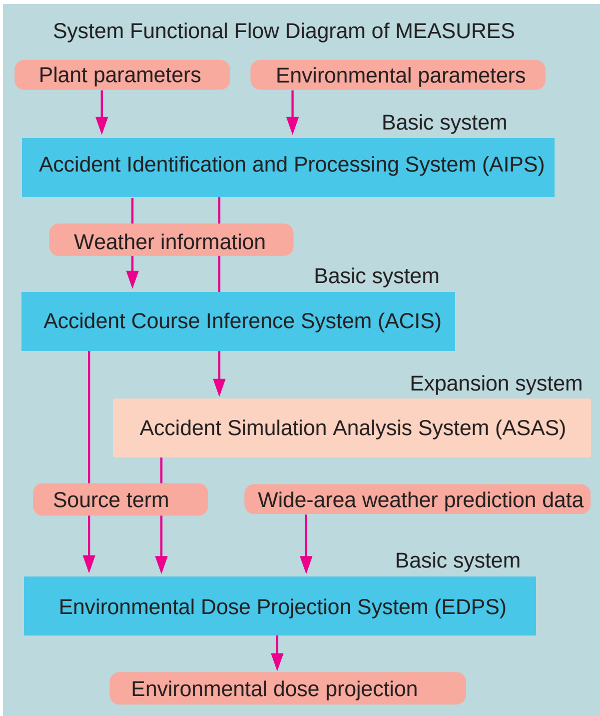

Fig. 2 Process flow of subsystems under MEASURES

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This system displays data it has acquired in a clear concise format, as shown in **Fig. 3**. Furthermore, AIPS identifies an event having triggered an accident (like, for example, a piping failure) by checking the plant status data it has received using an Accident Diagnostic Table, provided based on previously accumulated knowledge and data.

(2) Accident Course Inference System (ACIS)

On the basis of the judgment on an accident-initiating event which has been provided by AIPS, ACIS quickly infers the future trajectory of the accident by utilizing an Event Tree Information Retrieval technique, and assesses when the release of radioactive materials will begin and how long it will last and at what rate. Data concerning the course of the accident and the amount of radioactive materials released are analyzed in advance and stored in a database to active quick response of the system inference. ACIS displays the accident progression on an Event Tree screen.

(3) Accident Simulation Analysis System (ASAS)

Whereas ACIS uses data base ingerence in predicting the course of an accident, ASAS is designed to infer the sequence of associated events more realistically and accurately by utilizing a Best Estimate Analysis Program. This system is able to conduct a precise accident analysis at real time speed, from its earlier phase.

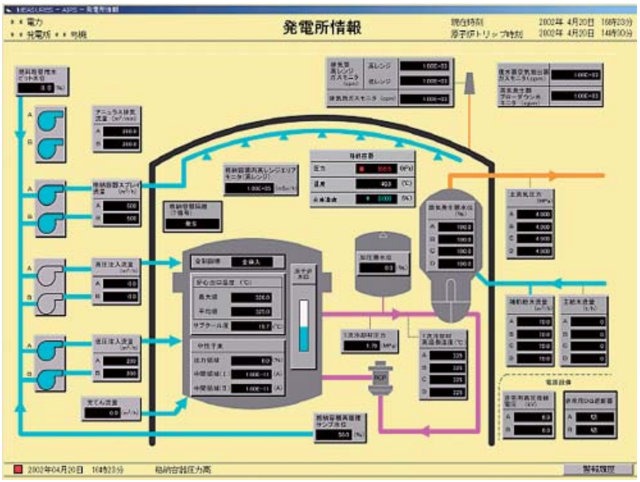

Fig. 3 Example of plant status display

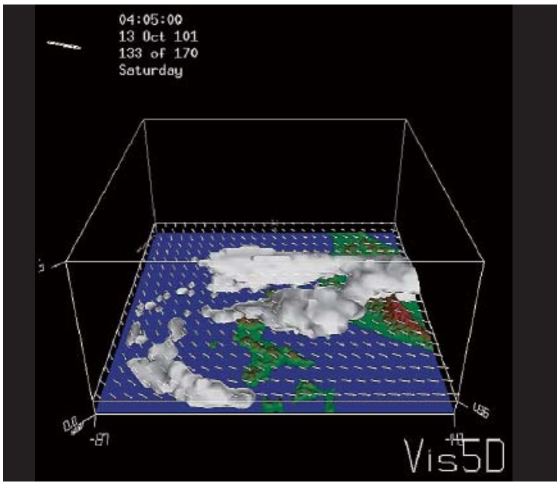

Fig. 4 Example of radioactive plume behavior animation

(4) Environment Dose Projection System (EDPS)

EDPS is a system that makes speedy, precise projections concerning the important parameters in a power plant and its surrounding environments, including variations in atmospheric air flow, dispersion and changes in the concentration of radioactive materials, dose rate distribution or similar. The use of meteorological information such as GPV (Grid Point Value) data and also the adoption of meteorological dynamics and non-steady state 3-D atmospheric dispersion models enable the system to provide detailed projections of variables of interest.

Besides, the system can also determine the kinds of nuclides or radioactive release from the plant concerned automatically by utilizing data from ACIS and ASAS, or alternately, data entered by plant personnel manually. Onscreen displays available from EDPS include a Wind Speed Vector Diagram, Distribution of Airborne Concentration, Radioactivity Distribution Deposited on the Ground, Dose Rate Distribution, and Total Dose Rate Distribution. The system also provides animated tracking of radioactive plume on the screen (**Fig. 4**).

Fig. 5 is a comparison between the measured values from AMeDAS, the Meteorological Agency's regional weather observation system and the projected values from MEASURES.

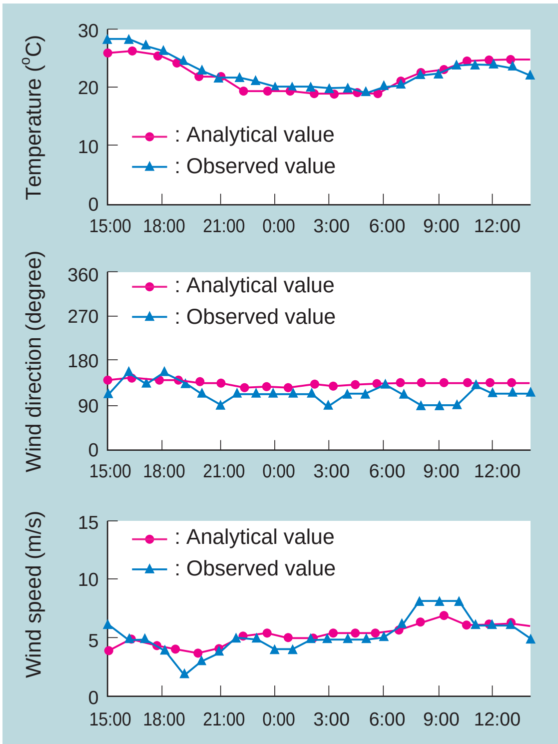

Fig. 5 Comparison of the observed temperature, wind direction, and wind

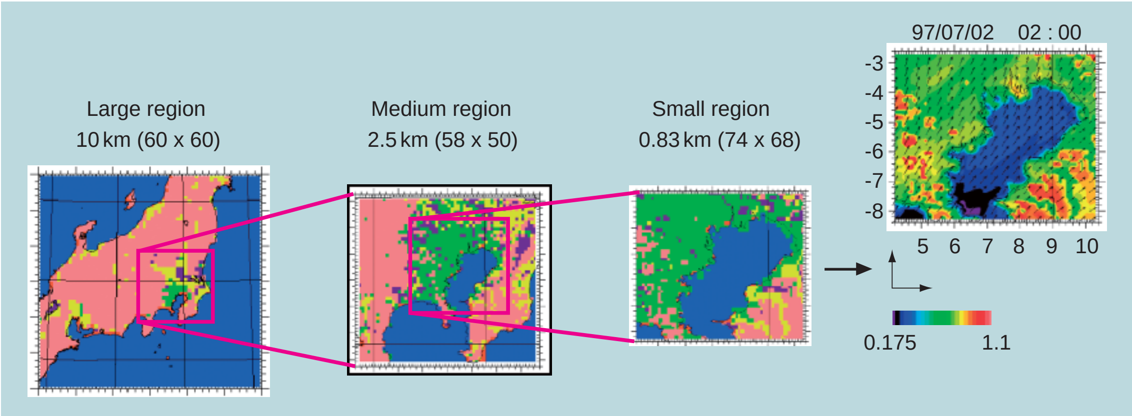

Fig. 6 Multiple Nesting Method which gradually narrows the region of calculation

Analytical results, which MEASURES put out for dates and times which had been specified beforehand (variations in air temperature, wind direction and wind speed at a given observation point), show good agreement with those given by AMeDAS.

To offer the projection results precisely and promptly, MEASURES employs means dedicated to handling time-consuming computations, such as 3-D Air Flow Distribution Analysis. These include a Multiple Nesting Method which, as shown in **Fig. 6**, gradually narrows the region of calculation and parallel processing capability, which permits a reduction in the calculation time.

3. Features of MEASURES

MEASURES has a system configuration which has the ability to operate as an integral system working on the coordinated functioning of subsystems, which not only makes an environmental dose projection but also assists with the response to a nuclear emergency or critical decision-making, while also enabling the subsystems to run as an independent unit. MEASURES can be operated by a single person, thanks to the coordinated operation of constituent systems, and comes with a user interface with excellent visibility and operability that reflects our proprietary Main Control Board Human Machine Interface technology. To allow for system expansion, MEASURES is also integrated to facilitate the incorporation of various analysis codes.

4. Application to preparedness activities

MEASURES has been developed to support the implementation of nuclear emergency response activities. Furthermore, it can be used in relation to situations other than nuclear accidents or for a Full-participation Exercise by Central or Local Governments, On-site Emergency Response Drill, or Routine Training of Personnel in charge of preparedness activities so that effective training may be carried out under assumed contingency conditions.

5. Conclusion

A nuclear emergency response system called MEASURES has been developed by utilizing a parallel processing computer system. A meteorological dynamics model is adopted in MEASURES in which a 3-D Air Flow Distribution Analysis is indispensable. Since this analysis consumes so many computation times to predict the details of environmental impacts precisely, it was difficult to apply this model to the prediction system, like MEASURES, so far. To overcome this shortcoming, we have successfully adopted a parallel processing computer system, a Multiple Nesting Method, and so on, thus substantially reducing the analysis time. This has allowed MEASURES to accomplish 3-D Air Flow Distribution Analysis and the assessment/projection of environmental impacts both promptly and precisely, opening the way for the system to find wide applications as an auxiliary tool, not only as part of a nuclear emergency response but in the projection of the spread of spilled harmful gases or the damage done by varied pollutants, as well.

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