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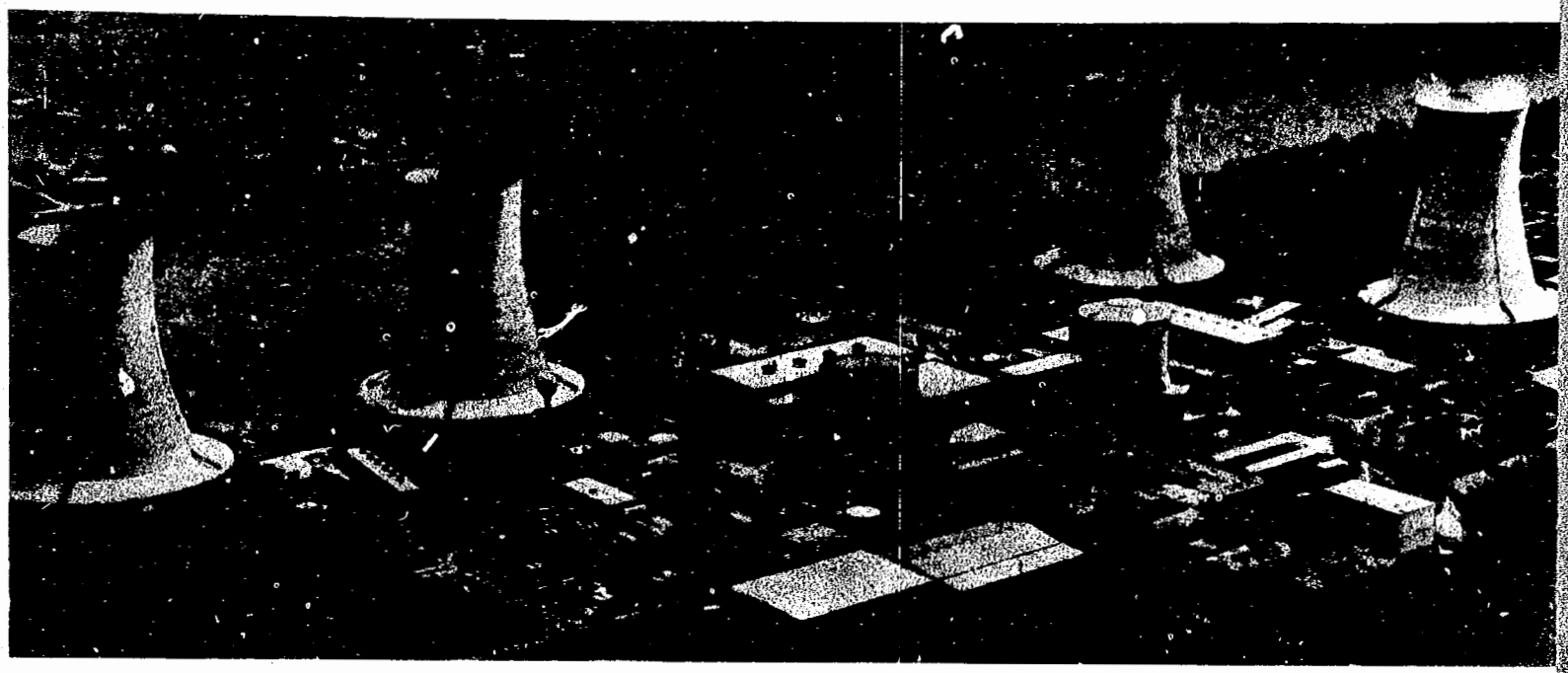

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GEND

General Public Utilities • Electric Power Research Institute • U.S. Nuclear Regulatory Commission • U.S. Department of Energy

TASK PLAN FOR THE U.S. DEPARTMENT OF ENERGY TMI-2 PROGRAMS

Technical Integration Office

Prepared for the
U.S. DEPARTMENT OF ENERGY
Three Mile Island Operations Office
Under DOE Contract No. DE-AC07-76ID01570

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ABSTRACT

The Task Plan for the U. S. Department of Energy (DOE) Three Mile Island (TMI) Unit 2 Programs identifies the tasks to be planned and administered by the DOE Technical Integration Office (TIO) in a manner which will maximize the use of available resources, obtain the maximum benefit from the opportunities associated with the TMI-2 cleanup effort, and retrieve generically useful information for addressing some of the key problems and issues facing the nuclear power industry. The Plan identifies tasks in three major program areas where DOE has assumed implementation responsiblity. The DOE TMI-2 Programs are: Data Acquisition Program, Waste Immobilization Program, and Reactor Evaluation Program. The plan is intended to serve as a management overview by defining the task objective, benefits, and work scope with respect to prioritization of tasks and utilization of resources.

ACKNOWLEDGMENTS

This document was produced through the combined efforts of the technical coordinators, program managers, and staff at the Three Mile Island Department of Energy/EG&G Idaho Technical Integration Office. In addition, we would like to express our appreciation to industry and government personnel for their review efforts, since their comments made valuable contributions to the preparation of this document.

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INTRODUCTION

One of the most severe integral tests of nuclear plant safety philosophy and of safety and nonsafety systems performance ever encountered in a commercial light-water reactor occured during the March 28, 1979, accident at Three Mile Island Unit 2 (TMI-2). The resultant damage to the reactor core and subsequent release of fission products to the primary system, reactor building, and elsewhere in the plant was more extensive than previously experienced in any such plant or system.

The unique post accident condition of the TMI Unit 2 plant provides unprecedented opportunities to acquire information of benefit to nuclear technology. This information can enhance nuclear power plant safety, reliability, and knowledge of accident sequences and their effects in a light water reactor (LWR) in ways that are not available through normal research, development, and test programs. Recognizing these opportunties, four organizations, the General Public Utilities (GPU), the Electric Power Research Institute (EPRI), the Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE), signed a Coordination Agreement to ensure this information is obtained during the course of the TMI-2 cleanup. These organizations are identified by the acronym GEND from the initial letters of their names. The Coordination Agreement established the TMI-2 Technical Information and Examination Program and identified the objectives to which the signatories subscribe and defines, in broad terms, methods to achieve these objectives.

A Technical Integration Office (TIO) was established at TMI according to the terms of the Joint Coordination Agreement. The TIO is staffed by EG&G Idaho, Inc., and reports to the DOE-ID TMI Site Office. The Coordination Agreement charges the DOE/EG&G TIO with the responsibility for implementation and daily management of the DOE programs. The TMI-2 Technical Information and Examination Program (TI&EP) planning was initiated shortly after the accident and is documented in Reference 1.

Because of the absence of information pertaining to data acquisition costs and possible interferences with base recovery program efforts, this early planning activity resulted in a relatively extensive list of tasks which might logically be pursued at TMI-2 without reguards to financial resources and other practical constraints. Hence, an important step in the implementation of the TI&EP became a judicious selection of tasks from this list to maximize information obtained relevant to the solution of current issues and problems in the light water reactor industry commensurate with available resources.

Some of the issues and problems in the areas of plant accident response and recovery are presented in Figure 1. By addressing these specific issues and problems, the data potentially available at TMI-2 will contribute to progress in the general areas of (a) future licensing criteria, (b) analytical model development and verification, (c) accident consequence mitigation, safety system design, system operation, (d) system reliability, and (e) requalification of key LWR components and equipment.

The Task Plan for DOE TMI-2 Programs (hereafter referred to as the Plan) provides documented descriptions of the various program tasks that are currently ongoing under the cognizance of the TIO or are proposed for implementation. The Plan indicates the relationship of these tasks in contributing significant input toward solving current industry issues and problems.

The Plan emphasizes questions associated with the information required to resolve current issues and problems within the nuclear power industry, and considers which of these issues and problems can be partially or completely resolved by gathering and developing information during the cleanup and recovery of TMI-2. By addressing the intent, justification, and benefit for each TIO-managed task, the Plan will be of substantial assistance in reaching sound program management decisions regarding such concerns as task prioritization and utilization of resources.

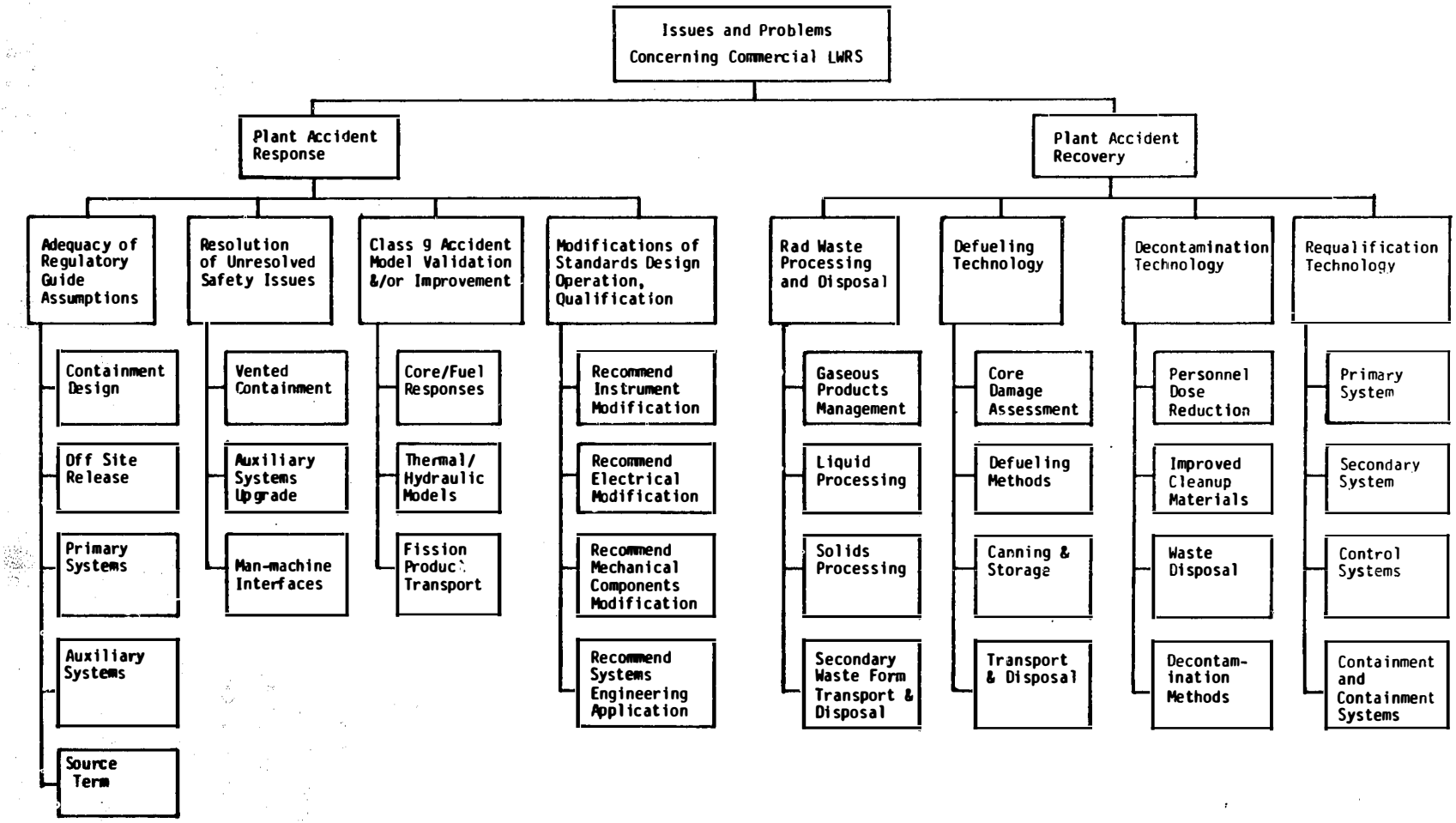

Figure 1. Issues and problems breakdown structure.

PLAN DEVELOPMENT METHODOLOGY

To ensure that a broad spectrum of input was included in this document, representatives of the nuclear power community were asked to review the document considering the following points:

- What information is required to resolve current issues and problems within the nuclear power industry?
- Are the issues and concerns identified by this document pertinent to the nuclear power industry?
- Which of these needs can be partially or completely resolved most effectively by gathering and developing information during the cleanup and recovery of TMI-2?
- How significantly does each task contribute to resolving an industry problem and concern as currently defined?

The nuclear power industry review of the plan was conducted in August 1981 and generally concluded that the plan is well conceived, addresses many current issues and concerns confronting the industry, and is a valuable tool for providing guidance for the DOE TMI-2 Programs. The review also indicated that a high priority should be given to areas that would improve future licensing criteria, accident consequence mitigation, and safety system design.

The research and development efforts conducted during the TMI-2 cleanup and recovery yields a dynamic situation. Completion of one task may cause subsequent tasks to be modified, executed as planned, or cancelled. To accommodate this situation, Technical Evaluation Groups were established in accordance with the guidelines stated in Reference 2 and perform the following functions:

- Advise on the implementation of individual tasks,

- o Review interim task results and related technical developments,

- o Suggest technical changes and/or additions based on progress of work and interim results, and

- o Suggest application of the results to the implementation of objectives, such as modifying standards and resolving safety issues.

Technical Evaluation Groups were created for the major technical areas of the TMI-2 Programs. These programs and their elements are:

- o Data Acquisition Program
  - -- Instrumentation and Electrical
  - -- Radiation and Environment
  - -- Off-site Core Examination

- o Waste Immobilization Program
  - -- Zeolite Disposition
  - -- Resin Disposition
  - -- Abnormal Wastes

- o Reactor Evaluation Program
  - -- Pre-head Removal Core Damage Assessment
  - -- Reactor Disassembly and Core Removal Technology Development

In addition to the TEGs, a special task force, called the Technical Assessment and Advisory Group (TAAG), was also established to achieve the following objectives:

- o To serve as a means of accumulating, developing, and distributing decontamination and defueling technology that is of generic use to the utility industry for possible future use in maintenance, refueling, and accident recovery operations

- o To provide GPU independent technical assessment and advice on decontamination and defueling of TMI-2, including access to relevant DOE and industrial expertise.

DATA ACQUISITION PROGRAM

The purpose of the Data Acquisition Program (DAP) is to: (a) obtain information stemming from the TMI Unit 2 accident for the advancement of light-water reactor plant safety, reliability, and operability; (b) obtain information from the TMI Unit 2 recovery for the advancement of technology in decontamination, waste disposal, and system requalification; and (c) distribute the information and technology gained from the TMI-2 Programs and from GPU's recovery program to the nuclear power community.

Instrumentation and Electrical

The proper functioning of instrumentation and electrical (I&E) equipment during and after an accident is critical for control and operation of a plant. The TMI Unit 2 accident subjected accident-mitigation-related equipment to environments that may have been different from those specified in current design standards. The results of this event have provided the nuclear power industry with the unique opportunity to gather reactor-safety-related information that would otherwise be unavailable. As the lessons of this accident are assimilated, it is becomming clear that much equipment not qualified for a LOCA can be of critical importance in an accident situation.

The objective of the Instrumentation and Electrical task is to assess the ability of specific I&E systems to perform their intended function during and after an accident and to transfer this information to the nuclear power industry.

Benefit. Since the TMI-2 accident subjected certain equipment to environments that were in many cases not specified in current designs, the adequacy of specific instruments to perform their required functions in a severe accident environment can be determined. This information should be valuable to plant owners and operators and architectural and engineering firms responsible for design and modification of plant I&E systems. In addition, the equipment that failed during or since the accident will be analyzed to determine failure modes. The results of these analyses will provide important guidelines for design improvements.

A comparison of expected versus actual performance of loss of coolant accident qualified equipment will assist the development of improved equipment qualification standards. This comparison will evaluate the extent to which present standards apply to an actual accident. The results could involve changes in types and extent of testing as well as the requirements for proof of qualification. Analysis of system performance will also provide information to help assess the applicability of equipment selected for each function.

Equipment failures or damage will be correlated with the time/spatial variations of environmental parameters such as temperature, pressure, humidity, and radiation levels within the reactor building. These data will be useful in assessing the validity of currently accepted estimates of reactor building conditions during and after this type of accident. These data would also be used to help determine the adequacy of environment qualification standards and procedures.

The data obtained from examination of the TMI Unit 2 instrument and electrical components and systems will contain unique information of system values, operational conditions, unit characteristics, and environmental stresses. Properly presented to government and private agencies, societies, manufacturers, architectural firms, and utilities, the data will provide the technical baseline from which improvements can be made in (a) industry regulations and procedures, (b) system and component location and operation, (c) instrument design and development, and (d) equipment configuration and qualification testing under normal, transient, and accident conditions.

Scope of Work. The primary work of the I&E task is to assess the survivability and current condition of reactor building instrument, electrical, and cable system components and to inform the nuclear power industry of any findings with potential to improve current reliability or safety. This work is accomplished by extensive in situ testing and by the removal of selected components from the reactor building for detailed tests and analyses at various national or private laboratories and universities.

The in situ test program involves developing test procedures and performing in-place tests on selected I&E components and systems. Both passive and active testing are planned. Passive testing involves examination of the component under test without applying power to it or causing it to operate. The objective of this type of testing is to determine the physical condition or integrity of the component without the risk of disturbing or damaging it. Passive testing typically includes simple resistance, capacitance, or inductance measurements, and low energy time domain reflectometry techniques. Active testing is conducted when passive tests indicate the component or circuit is operable or undamaged and plant conditions permit. Active tests involve the application of reduced or normal power to devices such as motors, relays, and solenoids while monitoring their operating parameters.

Of the many hundreds of components tested in situ, only a relatively small number can be removed from the reactor building for further examinations. The components, devices, or cable samples chosen for detailed examinations are carefully selected based upon their importance, typical generic classification, accessibility, and other physical considerations. Detailed procedures are written for their removal, after which they are shipped to a laboratory considered best qualified to perform the required examinations. Following the laboratory tests and examinations, detailed reports of the findings are written and distributed.

The data acquired during the above testing activities is evaluated with data currently available from measurements made during the course of the accident to analyze individual devices, loops, subsystems, and systems performance with time correlations to accident events. This approach provides a critical review of the individual system devices, then progressively expands the area of interest through each system. When there are findings of current interest to the nuclear power industry, they are promptly communicated to all operating plants and other parts of the industry via several established industry communication networks.

In addition, failure effects, modes of failure, and potential impacts on plant or system performance will be analyzed. Failure modes will be evaluated to determine if a current practice, guideline, or standard is affected and may require modification. When such an effect is identified, it will be thoroughly documented together with specific recommendations for changes and transmitted to the appropriate agency as quickly as possible.

Radiation and Environment

The purpose of the Radiation and Environment task is to obtain, analyze, and distribute pertinent information associated with three major areas of interest: (a) fission product transport and deposition, (b) decontamination and personnel dose reduction, and (c) accident evaluation.

Fission Product Transport and Deposition

The primary objective of the fission product transport and deposition effort is to obtain and evaluate data on the magnitude of release, mechanisms, and pattern of fission product dispersal during an accident. This information will improve current understanding of accident environments and the phenomena that contribute to those environments.

Benefits. The transport and deposition of fission products is one of the principal factors in predicting the severity and impact of a nuclear plant accident. The results of this effort will: (a) improve current understanding of fission product transport and deposition mechanisms; (b) provide an improved basis for future light water reactor safety analyses; (c) provide guidance in the design of improved plant systems to control fission product transport and deposition; (d) provide guidance in the determination of siting standards; (e) aid the recovery operations by providing the information necessary to minimize personnel exposure before, during and after the decontamination process; and (f) provide equipment environmental information required by the instrumentation and electrical task.

The industry review indicated that improved understanding of fission product transport phenomena and characterization of the source term are of great importance to the industry.

Scope of Work. This work requires the acquisition of data on all fission products released from the core to the plant systems, plant environment, and outside environment. This includes evaluations of gaseous, liquid, and solid samples (including material and surface samples) from the primary system, containment system, the auxiliary systems, and the auxiliary building. The completion of this work will require a mass balance of radionuclide materials to account for all radionuclides released, the release pathways, and the release mechanisms involved. The specific subtasks will provide the data needed to characterize the type and quantities of radionuclides that were deposited or released.

A mass balance analysis will be performed using selected samples and examinations to determine the mass plant distribution of radionuclide materials. Examinations will be conducted and selected samples will be taken from reactor coolant system, fuel, primary system internals, reactor building sump, purification system and let-down coolers, reactor coolant drain tank, air cooling coil, hydrogen recombiner, vent header waste gas decay tanks, reactor building surfaces, reactor building atmosphere, decontaminated areas, reactor coolant bleed tank, decay heat removal system, charcoal filters, auxiliary building sump, and the miscellaneous-waste-holding tank. In addition, radionuclide release and plant equipment operating histories will be analyzed to assist in identifying the dispersal pattern of radionuclide material bearing mass.

Mass release pathways and mechanisms will be identifed and used in conjunction with selected samples in the previous task to develop a mass and radionuclide bearing material map of the facility.

A source term evaluation will be performed using the mass distribution, release mechanism, and release pathways developed in the fission product transport subtasks.

In addition, a separate study of iodine transport and deposition is being conducted to provide timely information on the behavior of iodine during the TMI-2 accident. Tasks associated with this study include: (a) tracking of iodine movement from the fuel to its present location; (b) account for the original iodine inventory in the core in its present distribution; and (c) using analytical techniques to determine the iodine inventory in components at times during the accident when samples were not taken. Calculations will be made to estimate the concentration of iodine in the reactor building atmosphere during and shortly after the accident. The results of this study will be compared with values of iodine concentrations used in the licensing process.

Decontamination and Personnel Dose Reduction

The objective of the Decontamination and Personnel Dose Reduction Task is to develop the necessary data to evaluate the cost and exposure per unit work in contaminated areas within the reactor building and to evaluate the effectiveness of various decontamination techniques. These data are essential for choosing generic decontamination methods and controlling personnel exposures during future cleanup operations. The specific goals of the task are:

- Develop and evaluate a system that will ensure adequate documentation of the successes, failures, time factors, costs, etc. This system will provide cost/benefit analysis data for future decontamination projects.

- Review and document the criteria used to select the decontamination processes and the criteria for terminating decontamination on specific surfaces, items, and systems.

- Test and evaluate new techniques that are believed to have significant potential for improving decontamination of general or specific areas or systems.

- Evaluate and provide for specific component decontamination where reuse or component damage information is of significant value due to cost or procurement lead time in recovery projections.

- Review and evaluate the documented data for tradeoffs of process solution efficiencies as compared with waste treatment compatability, cost and other problems. Document the type of data desired for later evaluation.

- Provide techniques for nondestructive fuel debris identification and dissolution chemistry for decontamination of the Primary Coolant System (PCS).

- Evaluate and use state-of-the-art advances in personnel radiation exposure control technology to ensure levels are kept as low as reasonably achievable (ALARA).

- Evaluate and test advanced state-of-the-art dosimetry systems to accurately measure the doses received in high beta fields such as those at TMI-2, decommisssioning projects, and processing plants.

- Provide information to enhance future decommissioning and decontamination programs via distribution of TMI-2 field control information and procedures utilizing the dosimeters and instruments developed.

Benefit. Following the TMI-2 accident there evolved a realization of the magnitude of decontaminating a full-sized commercial reactor system. One early action was to collect the pieces of decontamination technology that have been developed within the industry over its 30 years of existence. A workshop held in November, 1979, clearly indicated the limited amount of available documented data associated with decontamination technology and decontamination experience.

The decontamination process at TMI-2 presents an unprecedented challenge. However, due to the urgency to complete the work it is difficult to maintain a detached perspective aimed at preserving a documented record of lessons learned for later use. Thus, a documentation process focusing on state-of-the-art methods will be of long range generic value to the industry. In addition, the thought processes used in approaching the decontamination of TMI-2 should be preserved; particularly the criteria, successes, failures, tradeoffs and cost/benefit, and other analyses developed at TMI-2 would serve as guidelines for future decontamination plans. Decontamination techniques, nondestructive examinations, and component reuse demonstrations will be evaluated and documented to maximize the information gained from the unique opportunities at TMI-2.

The dosimetry and portable instrumentation effort is aimed at expanding the state-of-the-art technology to increase the accuracy of recorded personnel exposures and portable instrument measurements in areas where significant beta radiation fields are present. Increased accuracy in field measurement instruments and recording dosimetry will not only help the management of ALARA, but will also prevent the application of overly conservative safety factors when setting worker time limits in high beta-gamma radiation fields. This task will also provide the supporting documentation necessary to demonstrate the extent and success of the effort.

Scope of Work. The decontamination and personnel dose reduction task will require the acquisition of data related to state-of-the-art decontamination techniques, personnel beta sensitive dosimetry, and advances in field measurement instrumentation. These data will provide the basis for evaluations of suggested techniques, equipment requirements, and cost effectiveness. The following tasks are planned to support the task objectives:

- Review and summarize the decontamination criteria used and the rationale employed to develop the criteria.

- Screen, evaluate, and prioritize new ideas for decontamination techniques, nondestructive examinations, component cleaning, fuel debris dissolution, and selective testing procedures that may have future applications.

- Provide an overview evaluation of decontamination process solutions used and waste management impacts to provide data for future systems evaluation studies and tradeoff benefits.

- Perform a large scale decontamination experiment to test and evaluate the effectiveness of the decontamination techniques used.

- Maximize the use of the GEND reporting system to distribute decontamination information in a final consolidated summary, as well as to document the as-developed processes and information.

- Incorporate operational experience gained through work in high beta fields in other DOE programs to assist in creating a comprehensive field exposure control program.

- Perform a state-of-the-art survey of electronics, microprocessors, and detectors currently available for use in these applications. The intent of the initial survey will be to identify equipment and techniques that can be readily utilized for survey instrumentation and those that may be used with proper development.

- Evaluate the most promising detectors, and establish detection characteristics and calibration techniques as applied to portable field survey instrumentation. Choose the detectors proven to be most practicable and refer others for future development.

- Package the detector(s) and electronics into a survey instrument which has been designed with human factors engineering considerations.

- Provide careful documentation of the TMI-2 recovery in man-rem exposure.

Accident Evaluation

Following the TMI-2 accident and the hydrogen burn which occured in the reactor building the NRC issued new rules related to hydrogen control systems and equipment survivability. The intent of the hydrogen burn assessment task is to provide information to increase the understanding of the TMI-2 hydrogen burn and to provide aid to the industry in resolving concerns associated with licensing plants under the new rules. To achieve these objectives, tasks will be implemented to assess the extent of damage in the reactor building attributable to the hydrogen burn, understand the building pressure and temperature response, and correlate the extent of damage with the amount of hydrogen burned.

Benefits. The results of this task will be used to support licensing activities and may provide valuable input to the design and operation of hydrogen control systems. The data obtained will be available for determining instrument survivability during a hydrogen burn and for full scale reactor building hydrogen burn computer code assessments. In addition, determination of the amount of hydrogen burned during the accident will provide an estimate of core damage for use in core removal planning.

Scope of Work. Several tasks are being conducted to acquire and analyze data from the TMI-2 reactor building. The service of expert consultants is being used for task definition, definition of industry needs, and program direction.

A physical damage assessment study is being conducted to document and analyze hydrogen burn damage in the reactor building. Photographs taken in the building are used to determine the spatial distribution of the damage. Samples taken from the building will be analyzed and compared to unburned samples of identical material. Samples of polymers, paper, wood, electrical cables, and some equipment will also be analyzed. Information from the sample analysis will be used to estimate the temperatures and heat fluxes experienced by the damaged materials. Damage mapping and temperature estimates will be used to determine flame temperatures and burn pathways.

Qualification of the data obtained from measurements taken during the accident is underway to assess how accurately the data represent the phenomena measured. The data being qualified include reactor building pressure and temperature, steam generator secondary-side pressure, and building atmospheric samples. The qualification process will assess the calibration history, accuracy, range, response time, and sample rate to determine how accurately the measured physical parameters are characterized by the recorded data. Based on this evaluation, confidence intervals or uncertainty bands will be assigned to the data. Using the confidence intervals in the analysis will allow conclusions relative to the hydrogen burn phenomena that are supported by data.

Analysis of the reactor building pressure and temperature response is being conducted to provide information on the extent of the hydrogen burn, the amount of hydrogen burned, and possibly the point of burn ignition. These analyses include thermodynamic and thermal hydraulic analysis of the reactor building atmosphere using the measured data. Calculations with analytical models will be used to confirm or bound the amount of hydrogen burned, the point of origin, and the flame pathway.

Results from the data qualification and the analysis efforts will be used to define a scenario of the hydrogen and a data base which describe what happened during the accident. It is intended that this information will be used to assess computer codes used in licensing hydrogen control systems.

Off-Site Core Examination

The Off-Site Core Examination task supports analysis, characterization, archiving, and storage of fuel and core debris samples, as well as nonfuel samples, from the TMI-2 accident and cleanup.

This task will provide facilities and plan and manage the archiving, repackaging, and examination of core component samples from TMI-2. In addition, the task will develop procedures, quality assurance requirements, and specialized tooling for sample/data acquisition, shipping, packaging, handling, and storing core samples and components.

A primary short-term objective of the task is to prepare a detailed plan for fuel and core debris sample acquisition, handling, packaging, and detailed examination. The plan will then implement work in several subtasks under the Reactor Evaluation Program.

Benefits. The Off-Site Core Examination will contribute to understanding the nature and extent of the TMI-2 accident and its effects on fuel and core material. The data obtained from these analyses will provide information to:

- Improve upon or validate current reactor design standards
- Evaluate NRC development of regulations and safety guidelines
- Aid the development of degraded core computer code models.

Scope of Work. One of the preliminary activities of the Off-Site Core Examination task will be to identify the data to be acquired during in situ and off-site examinations of core materials and to define the type, range, and level-of-accuracy required.

Other task activities include: (a) setting of facility criteria for fuel and core component examinations and archiving of fuel and nonfuel samples; (b) selecting and modifying the facility; and (c) provide planning and support for identifying equipment and techniques for archiving, repackaging, examination, and disposal of fuel samples and debris.

Ultimately, the major task activity will be to perform detailed examinations of fuel and core debris. This began in FY-82 with the examination of fuel debris samples from the TMI-2 makeup system filters. Work will continue in FY-83 with detailed examinations of control rod leadscrew and other sample material. Various remote handling laboratories will be utilized, depending on the specific data requirements. Key data areas include: (a) estimation of core temperature and fuel redistribution sequences during the accident, (b) location and distribution of control materials, (c) distribution

of retained fission products, (d) characterization and identification of rubble materials, (e) extent of liquified fuel, (f) fraction of zircaloy oxidized, and (g) various materials interaction phenomena. This task provides data directly applicable to code development, future rulemaking, and core design.

In addition, this task will develop and supply an encapsulating material and application techniques to be used for preservation of fuel assemblies and debris. The objective is to retain the post-accident configuration during shipping to off-site examination facilities. Testing of the encapsulant on irradiated fuel debris, development of handling and encapsulating procedures, and design and fabrication of application and removal equipment will be provided. This task supports core characterization work by providing a means for data preservation.

Also included in this task is the development of specialized equipment to meet the needs of in situ data acquisition. The first of this specialized tooling will be designed and and built in FY-83. Specifically the core topography system will be developed to map the cavity in the core region.

WASTE IMMOBILIZATION PROGRAM

The purpose of the Waste Immobilization Program is to: (a) incorporate unique information and technology developed during the TMI-2 cleanup into ongoing government and private waste management programs; (b) provide resources determined beneficial for the near-term transfer of radioactive technology for accident application at TMI-2; and (c) perform research and development and document information and technology of generic value to the nuclear power community in the areas of radioactive waste processing, storage, transportation, and disposal using the cleanup and materials of TMI-2 as a reference base. The program has three major areas of interest: Zeolite Disposition, Resin Disposition, and Abnormal Wastes.

Industry review indicated that the Waste Immobilization Program identified significant problems associated with immobilization and disposal of wastes and is a high priority task from an industry perspective.

Zeolite Disposition

The objective of the Zeolite Disposition task is to provide for the shipment and disposition of the Submerged Demineralizer System (SDS) wastes from TMI-2. The basic approach is to provide technical support to GPU in preparing the SDS Zeolite liners for shipment, provide shipment of the liners to a national laboratory, and conduct of research and development on zeolite immobilization and disposal.

Benefits. This task will provide technology development required to resolve safety related concerns in preparing highly loaded zeolite ion exchange media for shipment. Since there is very little information on the application of the mechanisms to limit the buildup of radiolytic gases during shipment of highly loaded high activity wastes, this task will provide for the application of a catlyst recombiner and water removal techniques and to demonstrate its feasibility on highly loaded SDS liners at TMI-2.

The zeolite disposition task will also provide for the demonstration of the feasibility of immobilizing the zeolite wastes and a demonstration of a safe disposal method.

Scope of Work. This task will require that a shipping cask for the safe transport of the SDS liners be designed, fabricated, and licensed. Safe shipment will also require the design, testing, and fabrication of a catalyst recombiner and vacuum drying system to control the buildup of combustible gases in highly loaded radioactive zeolite liners. After completing the above preshipping tasks, the liners will be loaded and transported to a national laboratory for waste immobilization R&D and disposal demonstration.

The zeolite ion exchange media will be immobilized in a borosilicate glass media. At least three of the zeolite liners will be immobilized using a state-of-the-art in-can vitrification process. The final product will be tested and characterized for such factors as leaching and stability. In addition, safe disposal techniques will be developed for the safe disposition of the radioactive SDS liners. Special overpacks for retrievable shallow land burial will be designed, fabricated, and used to demonstrate safe long term storage of zeolite liners with platinum-palladium catalysts for radiolitic gas recombination.

Resin Disposition

The objectives of the Resin Disposition task are to: (a) provide for the receipt, handling, interim storage, and R&D disposition for highly loaded EPICOR II system wastes from TMI-2; (b) identify shipping requirements, coordinate shipping schedules for casks and services, and establish the interfaces necessary to accomplish safe and legal shipments on schedule; (c) develop a prototype gas sampler for sampling, venting, and purging of organic resin liners at TMI-2 while obtaining safety-related data required for safe shipment of 49 EPICOR II liners from TMI-2 to a national laboratory; and (d) identify cost effective research and development programs for the disposition of highly loaded EPICOR II resin wastes generated at TMI-2.

Benefits. This task will provide technology for handling and disposition of highly loaded accident generated ion exchange media as typified by EPICOR II prefilter liners. This technology will include safe handling and shipping of large quantities of radioactive ion exchange media which generate combustible gases.

The successful disposition of the TMI EPICOR II liners will provide the industry with very useful generic information. Further knowledge concerning solidification of resins, resin degradation, radionuclide behavior in the environmental media, and efficiency of a high integrity container should be valuable to the development of new low-level radioactive waste disposal facilities. Since very little research has been conducted with ion exchange media containing high loadings of radionuclides, the resin research planned in this task will increase the information base of nuclear application ion exchange media and its containers. Specific benefits that can be realized include:

- Demonstration that accident generated wastes can be disposed in a cost effective manner using existing technology and within existing regulatory constraints

- Demonstration that some radioactive wastes which might be disposed at intermediate depths can be safely disposed in shallow-land facilities using High Integrity Containers

- Data on the degradation of ion exchange media and the behavior of carbon steel liners containing high loadings of radionuclides for prolonged periods

- Data on the efficiency of immobilizing organic resins and organic resin with zeolites in Portland cement and synthetic polymers

- Information on the behavioral movements of radionuclides through soils away from highly loaded solidified sample sources.

Scope of Work. The scope of work for this task includes: (a) providing shipping coordination for all EPICOR II radioactive waste shipments from TMI-2 on behalf of the Department of Energy; (b) designing and fabricating a prototype gas sampler for sampling, venting, and purging all the EPICOR II liners stored at TMI; (c) performing research and engineering for interim storage and disposition of the EPICOR II liners at a commerical low-level radioactive waste disposal facility; (d) performing a demonstration disposition in a high integrity container; (e) performing resin degradation and resin solidification research on the contents of EPICOR II liners; and (f) performing liner integrity examinations.

Abnormal Wastes

The accident at TMI-2 resulted in the generation of liquid and solid wastes including some which with respect to their physical and chemical form are representative of low level wastes (LLW) generated in normal operation of commerical light water reactors. However, some of the wastes may present special problems due to the fact that their specific activity is substantially higher than wastes from normal LWR operations. These wastes have been termed special wastes by the NRC in Reference 3. The classification of theses special wastes may not meet existing definitions for low level wastes and may not be suitable for shallow land burial. The NRC has stated, in a memorandum to GPU dated May 1980, that these types of wastes are more typical of high level wastes and will require more care in interim storage and in ultimate disposal than the routine low level wastes from light water reactor plants.

The following combinations of conditions and properties of accident wastes contribute to the classification term special wastes:

- High specific activity in an organic matrix which may lead eventually to unstable waste forms

- o Higher levels of cesium/strontium than are normally encountered in routine LWR wastes and which could pose problems in shallow land burial without additional intruder protection

- o Potentially higher levels of TRU elements pose the same disposal concerns but the extent of this concern has not been fully defined

- o Kilocurie levels of cesium-loaded zeolites which do not have the specific activity of high level wastes but are at least an order of magnitude above typical low level wastes.

The objective of the Abnormal Waste task is to provide technical support for the identification and removal of special wastes from TMI-2 and to provide for the safe shipment of these wastes to a national laboratory for research, development, and disposition.

The short term objective is to provide the necessary technical support for the removal of the TMI-2 Purification System demineralizers resins and to identify other potentially abnormal wastes at TMI and classify these wastes per the proposed 10 CFR 61 criteria for commercial land burial.

Benefits Current practices for the processing of radioactive resins involves primarily sluicing or elution. Since there is very little information available on the methodology to handle resin in a degraded condition, the abnormal waste task will provide information on the possible techniques that could be used for in situ characterization, sampling, removal, immobilization, and packaging of degraded resins such as those found in the TMI-2 Purification System demineralizers.

There has been very little documentation of industry experience and techniques for the removal and decontamination of highly radioactive sludge and debris from systems and components. This task will collect the available information, and make available existing DOE technology to develop the specialized techniques required to decontaminate tanks, sumps, coolers, and piping systems at TMI-2.

Scope of Work. This task will provide technical support for the cleanup and removal of radioactive wastes from the reactor coolant and auxiliary systems, such as the makeup and purification demineralizers and filters.

The technical support will include the development of techniques to perform in situ resin characterization of the letdown demineralizers and to perform conceptual design for processing and the hardware required.

This task will also provide the necessary support to identify shipping and DOE receiving site requirements. This support will include:

- Identification of waste packaging and shipping casks
- Shipping and receiving site safety and environmental assessments.

REACTOR EVALUATION PROGRAM

The purpose of this work is to determine the nature and extent of fuel and core component damage, and to develop generic technology pertinent to safe defueling of severely damaged light water reactor cores. The program has two major areas of interest: Core and Reactor Internals Characterization and Reactor Disassembly and Damaged Core Removal Technology Development.

The industry review indicated that characterization of the TMI-2 core was of particularly high priority with respect to their concerns.

Core and Reactor Internals Characterization

The objective of this task is to characterize the condition of the TMI-2 core and reactor internals. This task will require data acquisition from the fuel, core components, and reactor internals before, during, and after core removal, both on-site and at selected off-site facilities and the development of techniques and equipment necessary to support data acquisition.

Benefits. Characterization of the TMI-2 core and reactor internals will increase understanding of plant accident sequences and consequences. The information obtained will apply to the general areas summarized in the following paragraphs.

As a result of the accident, some current licensing criteria are being reviewed, and new criteria may be developed. Characterization of the TMI-2 core will provide a more complete basis for evaluating proposed licensing criteria.

The consequences of the accident at TMI-2 identified a need to extend the capabilities of current analytical tools to predict core behavior during severe fuel damage accidents. The data that are potentially available from the TMI-2 core examination are necessary to expand present analytical capabilities, since it is impractical to obtain these data in any way other than by core characterization.

Core design improvements aimed at mitigating the consequences of severe fuel damage accidents could be identified through characterization of the TMI-2 core and internals.

Scope of Work. Equipment and procedures will be designed and developed to accurately establish the degree of core slumping. Mapping is crucial to recording the location of the fuel and core components prior to initiation of defueling or other post-plenum removal activities that may alter the present geometry of the core. This task provides data directly applicable to code development and future rulemaking and supports subsequent data gathering tasks related to creating access to the core.

An integrated photo/visual system will be developed to meet the observation, examination, and photographic documentation requirements: (a) during plenum removal, (b) after plenum removal but before defueling, (c) during fuel removal, and (d) during cleanup after defueling. The system will be designed to provide optical access for examination, observation, and coordination of underwater mechanical devices, and photo/visual documentation of conditions for all post-head removal data gathering, reactor disassembly, and defueling operations. This task supports the core characterization work by establishing a basic in-core data gathering and documentation system.

Integration of sampling and in situ data acquisition will ensure representative sampling without loss of important in situ data. Fuel removal operations will also be documented. Data will be obtained before and after removal of loose debris. Data will also be obtained from the cavity left by removal of representative fuel assemblies, using the integrated photo/visual system to photograph damage gradients in adjacent assemblies. Detailed data acquisition during core removal will ensure that no realistically recoverable data of generic usefulness are lost. This task provides data, when reduced and reported, which will be directly applicable to code development, future rulemaking, and core design improvements. This task will be conducted so as not to delay the GPU cleanup schedule.

On-site and off-site examinations will be conducted of the TMI-2 head, plenum assembly, core barrel, thermal shield, lower grid assembly, flow distributor, lower head instrument thimbles, as well as off-site examinations of specimens taken from some of these components. This task provides direct information relative to maximum temperatures and component response in support of code assessment and development.

On-site examinations of the lead screws, bayonet fittings, control rod spiders, brazements, and slotted guides will be conducted on selected TMI-2 control rod drive mechanisms. This task provides direct data to support the identification of possible improvements to control rod drive and control rod system designs.

Reactor Disassembly and Core Removal Technology Development

The objective of this task is to develop generic technology for damage assessment, reactor disassembly, and defueling following an accident. This task will require: (a) development of tooling and techniques for early core damage assessment; (b) development of tooling and techniques for core and reactor internals removal; and (c) development of damaged fuel canning and storage technology.

Benefits. The accident at TMI-2 presents a unique situation. Techniques and equipment required in a number of areas of postaccident damage assessment, disassembly, and defueling of large light water reactors are not available. Development of generic technology supporting the objectives of this program will advance the state-of-the-art of early core damage assessment, defueling technology, and canning and storage technology. Should this type of technology be required again, this advancement will decrease the time and costs of recovery and minimize the risks involved.

Scope of Work. This task will require the design and development of inspection techniques and equipment to inspect the plenum and upper core area prior to removal of the reactor vessel head. This includes development of contingency tooling to provide access in the event that

normal control rod uncoupling is not successful, and logic to evaluate results of uncoupling attempts. This inspection will provide the first confirmation on the degree of damage to the upper internals and to the core itself by identifying fuel and core component debris that may have been deposited in the plenum area and by providing information on leadscrew, spider, and upper end fitting conditions. This task will advance the state-of-the-art of early core damage assessment and will support reactor disassembly and defueling.

Techniques will be developed to move the control rod drives electrically and monitor them for motion by measuring electrial parameters of the drive motors. Lack of motion will be monitored by measuring pole slip electrically and with acoustic devices. This task will advance the state-of-the-art in detecting control rod drive system degradation through electrical characteristics monitoring.

An advanced underwater vacuum collection system will be developed and fabricated to remove fines and small debris from the core and collect them in a suitable container. The system must handle a wide range of debris sizes and types during disassembly and defueling operations. The system will interface with the standard design canisters being developed under another task and with any auxiliary canal cleanup system.

Since current systems do not have the special capabilities required, development of this system will provide new generic technology supporting reactor disassembly and defueling by providing a method for collecting small debris from a damaged core, removing debris too small to be conveniently handled piece-by-piece, and by maintaining water clarity. This system will lower personnel radiation exposure and facilitate disassembly and defueling.

Advanced techniques and equipment will be developed to remove the plenum in the event that normal methods cannot be used. Advanced equipment and procedures will be required if metallurgical bonding with core components or distortion of the plenum occurred as a result of the accident. Included in this task is the development of inspection

techniques and equipment to evaluate the plenum to determine what removal techniques should be applied. These advanced developments may prevent serious delays when disassembling the reactor to remove a damaged core. They will also advance the state-of-the-art of recovering from large light water reactor core damage accidents.

Advanced techniques and tooling will be developed for core removal operations following reactor vessel head and plenum removal. Included are development and fabrication of tooling to accommodate damaged core removal difficulties predicted by available assessments of core damage. Techniques for evaluating core condition will be developed to support procedure selection during disassembly and defueling. The uncertainty of the core condition requires that all reasonable alternatives be covered by tooling and techniques prior to initiation of reactor disassembly and defueling. Since such tooling and techniques are not currently available, their development will provide new technology for defueling damaged reactors by providing a mechanism to expeditiously remove the damaged core.

Canister designs will be developed and prototype canisters will be fabricated for packaging the TMI-2 fuel and core debris inside the reactor building. The canisters will provide critically safe containment for debris and damaged fuel assemblies during transport to the spent fuel pool, interim storage, transportation off-site for examinations, and ultimate disposition. Since canister designs for critically safe containment of severely damaged light water reactor core debris do not currently exist, this task will provide advanced generic technology in handling and storing severely damaged fuel.

REFERENCES

1. GEND Planning Report, GEND 001, prepared for U.S. Department of Energy, October 1980.

2. EG&G Idaho, Inc. Program Management Plan, TMI-2 Technical Information and Examination Program, January 1982.

3. NRC, Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Waste Resulting from the March 28, 1979, Accident at Three Mile Island and Unit 2, Docket Number 50-320, NUREG-0683, February 1981.