

THE U.S. DOE NEW PRODUCTION REACTOR/HEAVY WATER REACTOR FACILITY POLLUTION PREVENTION/WASTE MINIMIZATION PROGRAM

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ABSTRACT

A Pollution Prevention/Waste Minimization Program was established during the early design phase of the U.S. DOE's New Production Reactor/Heavy Water Reactor Facility (NPR/HWRF) to encompass design, construction, operation and decommissioning. The primary emphasis of the program was given to waste elimination, source reduction and/or recycling to minimize the quantity and toxicity of material before it enters the waste stream for treatment or disposal. The paper discusses the regulatory and programmatic background as it applies to the NPR/HWRF and the waste assessment program developed as a phased approach to pollution prevention/waste minimization for the NPR/HWRF. Implementation of the program will be based on various factors including life cycle cost analysis, which will include costs associated with personnel, record keeping, transportation, pollution control equipment, treatment, storage, disposal, liability, compliance and oversight.

FACILITY DESCRIPTION

An artist rendering of the NPR/HWRF as it existed during the fall of 1991 is shown in Fig. 1. This facility design had a 2500 MWt power level and combined safety and environmental protection with the DOE mission of assured production of strategic materials. The HWRF design is based on the fuel/target and Heavy Water Reactor technology developed by more than 35 years of reactor operation at Savannah River Site. The major features of the facility shown are the nuclear island complex, consisting of interconnected buildings on a common mat, and the heat rejection complex, featuring a large water basin and mechanical draft cooling towers. Heat generated in the reactor is normally dissipated to the atmosphere in the four mechanical draft cooling towers. Long term cooling of the shutdown reactor is accomplished with the 95 million Liter (25 million gallon) intake basin. Makeup water to the basin is supplied from existing site systems and blowdown from the basin is treated before release to the environment. The NPR program continues to evolve at this time and improvements will be made to compliment the weapons complex reconfiguration. The design will couple the most advanced safety features from commercial light water reactors, including those recommended by the EPRI and the DOE Advanced Light Water Reactor programs, with lessons learned from operation of the heavy water reactors at Savannah River and at other DOE sites.

REGULATORY AND PROGRAMMATIC BACKGROUND

The regulatory basis for the HWRF Pollution Prevention/Waste Minimization Program comes from a variety of sources. DOE Order 5400.1 "Radiation Protection of the Public and Environment", establishes requirements for the radiation protection of the public and the environment. DOE Order 5820.2A "Radioactive Waste Management" contains requirements for the management of radioactive, hazardous and mixed waste. Chapter IV of the Order "Management of Low-Level Waste" requires that technical and administrative

controls be established to reduce the gross volume of waste generated and the amount of radioactivity requiring disposal. Process designs are required to incorporate waste minimization principles. In addition, operating facilities are required to establish waste minimization programs and prepare annual waste management plans which address radioactive, hazardous and mixed waste. 10 CFR 20 requires that radioactive releases to the environment and to the workers be kept as low as reasonably achievable (ALARA). The goal of the ALARA concept of radiation protection is to reduce doses wherever and whenever reasonably achievable, thus reducing the risk that is assumed to be proportional to the dose. Reasonably achievable is determined by evaluating the state of technology and the economics of improvement in relation to all the benefits from this improvement. Reducing potential radiation exposure while increasing potential for other hazards does not constitute ALARA.

The Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 mandates that generators of hazardous/mixed waste develop a waste minimization program. The regulatory reference to waste minimization in the RCRA regulations is the manifest requirements, which call for generators to certify that the process which generates the wastes being disposed of are subject to a waste minimization program. The Waste Minimization Opportunity Assessment Manual, EPA/625/7-88/003 (1) suggests a methodology for developing and implementing a waste minimization plan. It also provides examples for assessing the value of the program, including economic evaluations. The U.S. DOE issued a Model Process Waste Assessment Plan (2) based on the EPA guidance for DOE facilities.

In addition to the traditional waste management laws, regulations and orders, Congress has recently passed the Pollution Prevention Act. The Pollution Prevention Act states that source reduction is fundamentally different and more desirable than waste management and pollution control. It sets forth a policy that pollution should be prevented or

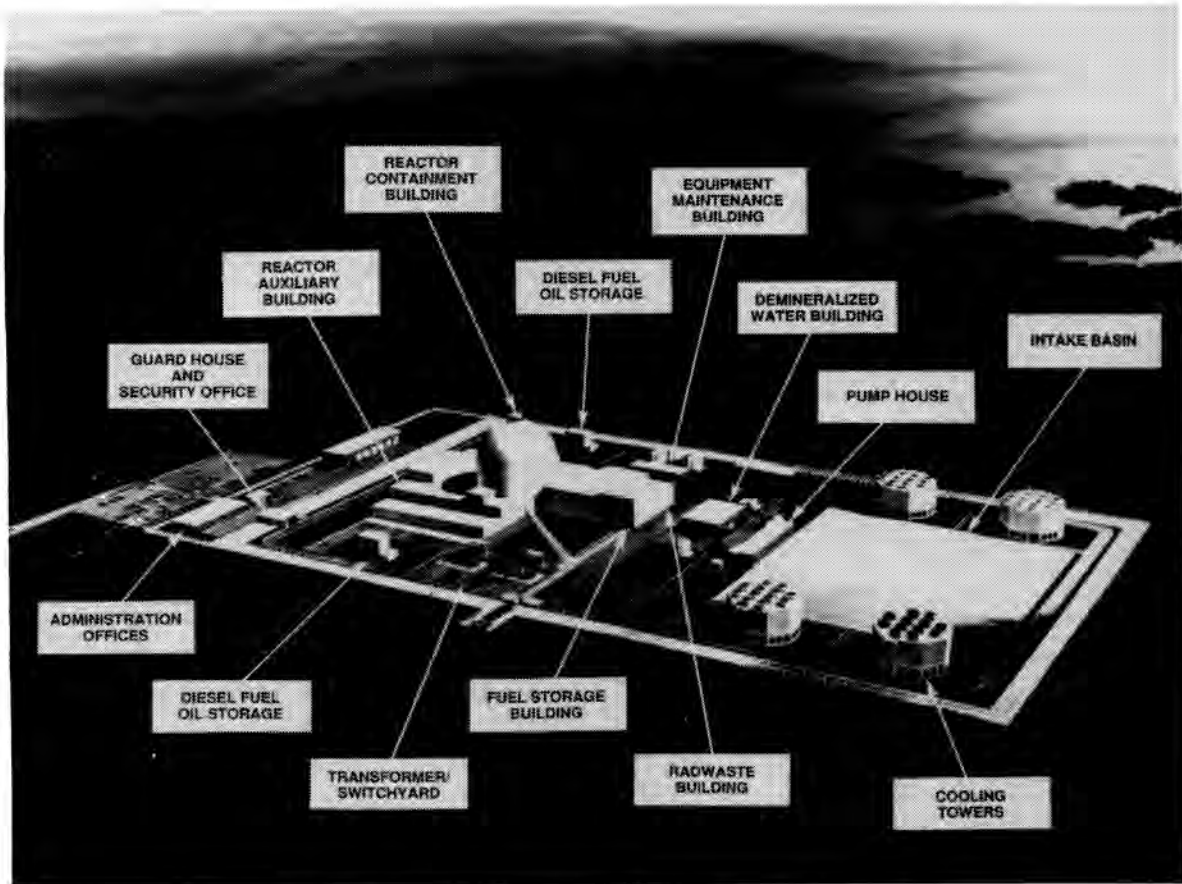


Fig. 1. New Production Reactor/Heavy Water Reactor Facility.

reduced at the source, whenever feasible. Pollution that cannot be prevented should be recycled in an environmentally safe manner. Disposal or release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner. The law does not mandate pollution prevention programs; however, it does require that firms which submit toxic release information pursuant to Section 313 of the Emergency Planning and Community Right to Know Act (SARA Title III), report pollution prevention information with their toxic chemical release report at the beginning of 1991. The EPA Pollution Prevention Strategy was published as 56 FR 7849.

Nuclear facilities must consider the additional guidance from 10 CFR Parts 50 and 61, U.S. NRC Regulatory Guides, ANSI/ANS standards, and the EPRI Advanced Light Water Reactor Requirements Document.

POLLUTION PREVENTION/WASTE MINIMIZATION PROGRAM DEVELOPMENT

Development of the NPR/HWRF Pollution Prevention/Waste Minimization Program was divided into four (4) phases; planning, assessment, feasibility, and implementation; using the U.S. EPA Waste Minimization Opportunity Assessment Manual and U.S. DOE Model Process Waste Assessment Plan as guides. Figure 2 illustrates the flow of activities for the overall NPR/HWRF Pollution Prevention/Waste Minimization Program. The four (4) phases, key activities and program results are described below.

The Planning Phase included establishing the waste assessment goals, waste assessment organization, and management commitment. A Waste Assessment Team was established from the NPR/HWRF design staff to lead program development. The goal of the Planning Phase was producing and issuing, with NPR program approval the Pollution Prevention/Waste Minimization Plan (3) specifically for the NPR/HWRF. Approval of the plan established management commitment for the program.

The Assessment Phase included 1) compilation of a Controlled Substances List and Process System Data; 2) a screening and selection process for appropriate system technologies; 3) inventory and characterization of waste generation; and 4) prioritization of waste streams.

The Waste Assessment Team prepared the "Controlled Substance List" based on RCRA, CERCLA/SARA, Clean Water Act, Clean Air Act (Amended 1990), and Savannah River Site operating experience to identify substances with the potential to adversely affect human health, the environment and plant systems operation (4). The substances on this list were further categorized as "banned substances" and "critically controlled substances." Critically controlled materials are those substances that, while not banned from the NPR/HWRF, pose an undesirable risk to human health and the environment and may involve significant regulatory concerns. The NPR/HWRF wastes were classified in the categories listed below, in order of priority. The order of priority for these classifications was based on a) maturity of the industry experience and technologies in accomplishing significant

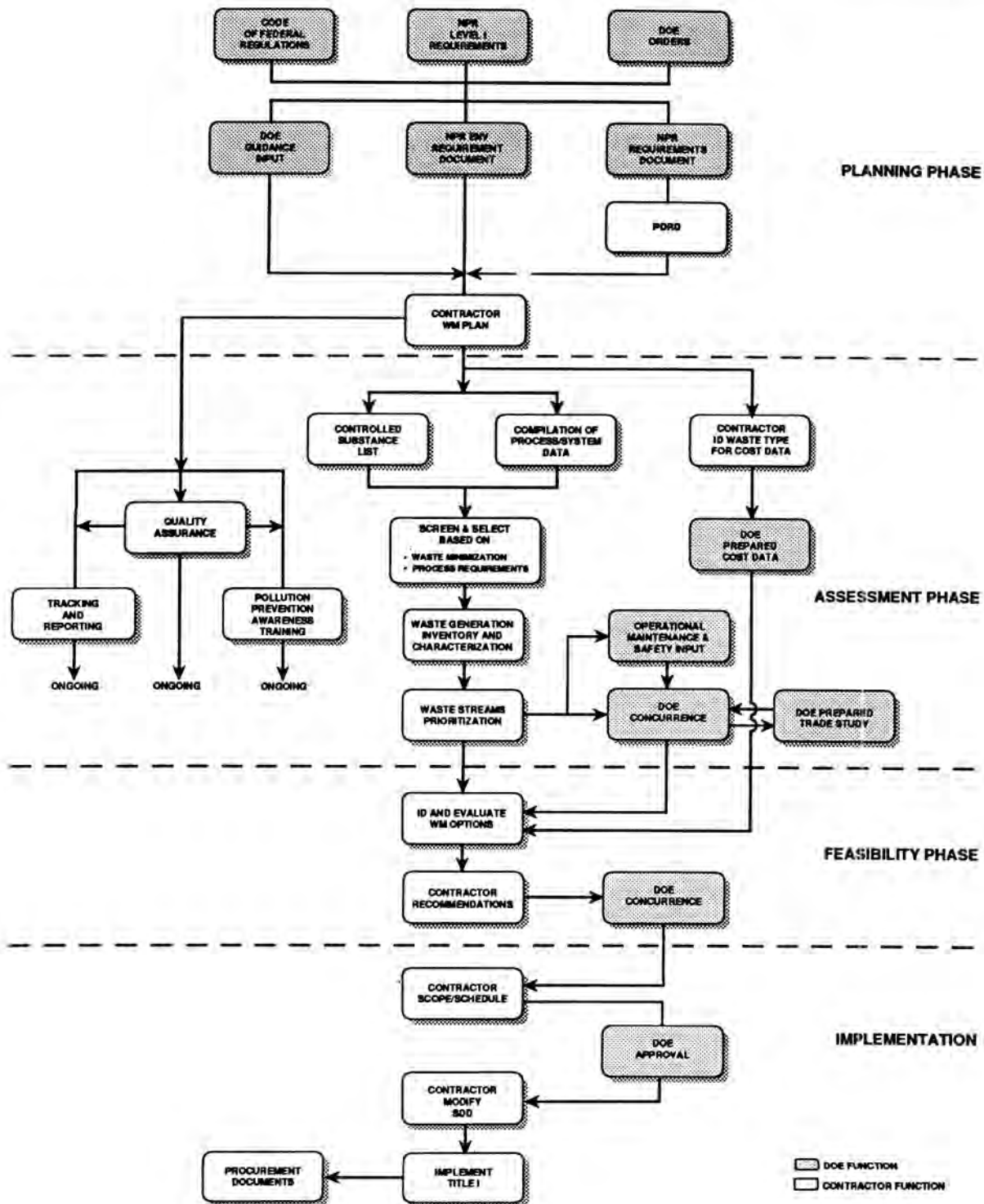


Fig. 2. NPR-HWRF Pollution Prevention/Waste Minimization Program flow chart.

pollution prevention and waste minimization, b) regulatory concerns and uncertainty, c) future potential liabilities, d) amount of waste produced, and e) potential for alternate processes or systems to produce a significant reduction in the waste stream.

1. Mixed wastes
2. High level radioactive wastes
3. Intermediate level radioactive wastes
4. Transuranic wastes

5. Hazardous (RCRA) wastes
6. Toxic/hazardous air pollutants
7. Toxic pollutants
8. Low-level radioactive wastes
9. All other non-hazardous wastes

Each of the 110 systems of the HWRF preliminary design were evaluated as necessary for appropriate technologies based on process requirements and pollution

prevention/waste minimization goals. The waste generation inventory and characterization process also considered each system of the HWRP. For each system all waste streams and/or process discharges to other systems were identified, considering operational aspects (e.g., leakage and liquid, solid and gaseous discharges), maintenance activity (e.g., spare parts, lubricants, greases, and solvents), decontamination (e.g., decon. solutions and abrasive blast material), and decommissioning (e.g., equipment and associated solid components).

Waste streams were evaluated and prioritized based on the controlled substance list, classification list, volume of waste generated, difficulty of treatment and disposal, and the potential for significantly reducing the source term (4). The systems which contained the various waste streams were placed into the three categories listed below.

- Non-Radioactive, Non-Hazardous, and Low Volume of Non-Polluting Waste (51 HWRP Systems)
- Small Waste Volumes with Proven Pollution Prevention/Waste Minimization Technologies (14 HWRP Systems),
- Waste Streams with Potential to Significantly Impact Environment, Safety and Health or other Plant Systems (45 HWRP Systems).

Using current regulatory restrictions and technologies, the plant systems producing wastes which are most difficult to handle, treat and/or dispose, and those systems generating the largest quantities of waste, were selected for further analysis. Based on this additional assessment, of the 45 facility systems in the third category, six priority waste streams with a high potential for pollution prevention/waste minimization were preliminarily identified for the NPR/HWRP.

Waste Source/Process System Description	Waste Classification
1. Cleaning Solvents and Decontamination Solution	Mixed Waste
2. Lead Shielding	Mixed Waste
3. Reactor Core & Fuel Assembly	Intermediate Level/Transuranic
4. Reactor Vessel/Head/Internals	Intermediate Level/Transuranic
5. Reactor Coolant System	Low Level Radioactive
6. Spent Resin	Low Level Radioactive

The Feasibility Phase will include identification and evaluation of pollution prevention/waste minimization options. The measures used to achieve the program goals shall have the following prioritization:

1. Source Reduction - reduce or eliminate waste generation at the process source. The following are examples of source reduction options:
 - Material Substitution
 - Process Modification
 - Segregation
 - System-Based Inventory Control

- **Prioritize to Minimize Consumption**

2. Recycle - for wastes that are unavoidable reduce the quantity by recycling the waste within the same process or in other plant processes.
3. Minimize volume, toxicity, mobility of wastes - for wastes generated, treat the wastes to reduce the volume required for disposal and storage, change physical/chemical properties to reduce their toxicity, and/or contain the pollutants to reduce mobility.

The design review process will examine each system to determine if maximum utilization of traditional treatment technologies have been employed to enhance environmental compliance in those cases where wastes cannot be eliminated. Life cycle costing methodologies will be performed on each priority waste stream and cost/benefit analysis performed to determine the most appropriate option. Life cycle costing methodologies will be comprehensive, including cost of handling, storage, and disposal, as well as liability costs associated with the wastes created.

The Implementation Phase will include the requirements for implementing the selected options. Other considerations during the Implementation Phase are configuration control, operating procedures, maintenance programs and performance assessment through waste tracking and reporting.

CONCLUSION

Implementation of the program will insure pollution prevention/waste minimization will be integrated into the HWRP throughout the life of the project design, construction, operation and decommissioning. Aspects of the program concerning Quality Assurance and Training have been incorporated into the planning and assessment phases, and will be ongoing efforts for the life of the program.

The NPR/HWRP pollution prevention/waste minimization program seeks to eliminate and if not feasible, to minimize the generation of waste with particular emphasis at the source. The ultimate goal is to reduce waste generated, as a result of facility operation, to as low as reasonably achievable levels given the best available technologies.

At this time, activities have been performed through the Assessment Phase of the Pollution Prevention/Waste Minimization Program. These activities and those associated with the Feasibility and Implementation Phases will be modified and performed consistent with the evolving and improving strategies and concepts for the NPR.

REFERENCES

1. U.S. Environmental Protection Agency, Waste Minimization Opportunity Assessment Manual," EPA/625/7-8/003, July 1988.
2. U.S. Department of Energy, Model Process Waste Assessment Plan," July 1991.
3. U.S. Department of Energy, Heavy Water Reactor Facility Pollution Prevention/Waste Minimization Plan," April 1991.
4. U.S. Department of Energy, Heavy Water Reactor Facility PP/WM Program, Waste Stream Characterization and Prioritization Report," May 1991.