BACKFIT MODIFICATIONS TO OPERATING RADWASTE SYSTEMS

[1]D. M. Giorgione, [1]C. D. Dresser, [2]J. T. LaMarca and [2]T. J. Irving

[1]Catalytic, Inc., Philadelphia, PA

[2]Niagara Mohawk Power Corp., Syracuse, NY

ABSTRACT

A comprehensive radwaste modification project to replace corroded tanks and piping and increase liquid radwaste storage capacity is described. The major factor potentially affecting both schedule and cost is the low labor productivity associated with work in radiation areas. Engineering design and construction planning activities were formulated to minimize the impact on system operation and control exposure during construction. A detailed Health Physics Plan was developed which provides for decontamination of work areas consistent with ALARA/cost benefit considerations.

INTRODUCTION

Many recent articles related to radwaste modifications are concerned with replacement or installation of processing equipment based on new or improved technology. Typical examples of this type of modification include the installation of advanced solidification systems, evaporator/crystallizers, super-compactors and incinerators. Unless existing equipment is being demolished, this type of modification can usually be completed with minimal impact on the operation of the existing radwaste systems during installation.

Less interest has been focused on modifications which may be required to maintain operability of existing equipment, satisfy changing regulatory requirements and reduce occupational radiation exposure.

Older plants can experience severe corrosion problems with storage tanks and piping systems, resulting in high maintenance costs and increased radiation exposure to workers. Eventually, large scale failure of tanks and piping could be expected. Additional problems are encountered if radwaste liquid storage capacity is inadequate. Federal and State environmental governing bodies have required sharp reductions or elimination of discharges from nuclear plants.

This paper describes a major modification project which is currently being implemented by Niagara Mohawk Power Corporation (NMPC) at the Nine Mile Point, Unit No. 1 Nuclear Station. The project provides for replacement of corroded tanks and piping and increased liquid storage capacity, with resulting improvements in operational flexibility and reliability, and reductions in radiation exposure to operating and maintenance personnel.

PROJECT APPROACH

Major modifications at Nuclear Power plants are usually performed during scheduled outages when the system(s) to be modified is out of service. Unfortunately, the Liquid Radwaste Collection System cannot be taken out of service for any extended period of time. In fact, the radwaste system volume throughput is usually higher during an outage than during normal operation, when maintenance and decontamination activities generate large volumes of water to be processed and/or stored. Consequently, major modifications to the radwaste systems are usually performed while the system is operating. A carefully conceived engineering and construction plan is required to minimize the impact of the modifications on radwaste system operation and to control radiation exposure during construction. With this objective in mind the present project was divided into four phases as follows:

PHASE I - PRELIMINARY ENGINEERING

PHASE II - HEALTH PHYSICS PLAN

PHASE III - DETAILED ENGINEERING

PHASE IV - CONSTRUCTION AND START-UP

PHASES I, II AND III have essentially been completed with construction scheduled to begin during July, 1984.

The Work Breakdown Structure concept has been utilized to manage discrete tasks. Each work package is of uniform format and completely describes each task from planning through start-up. Work package integration focused on the maximum use of Radwaste System Components during *construction* to minimize operational interruptions. The Work Packages summarily provided the basis for the overall schedule, labor requirements, cost estimates and occupational exposures.

PRELIMINARY ENGINEERING

NMPC had experienced corrosion problems with radwaste tanks and piping which required frequent maintenance. Although pipe and tank leaks had been identified, the total extent of the corrosion damage had not been quantified. NMPC therefore requested Catalytic to perform a preliminary engineering evaluation to meet the following objectives:

1. Determine the extent of corrosion damage to radwaste tanks and piping and define the modifications required to correct the deficiencies.
2. Evaluate the installed radwaste liquid storage capacity and develop a plan for increasing storage capacity.
3. Prepare a preliminary budget estimate and schedule for the proposed modifications.
4. Prepare a preliminary construction plan.

Numerous field trips were made to the Nine Mile Point site to obtain specific information and meet with radwaste operating personnel. A review was made of NMPC Work Request Forms to determine the repair history of the suspect equipment. Alternate schemes for increasing or adding storage capacity at various stages of the liquid radwaste system were evaluated based on the following considerations:

- Available Space
- Condition of Existing Tanks
- System Operating Requirements
- Installed Cost

Increases in storage capacity were obtained by adding an additional tank and increasing the capacity of tanks to be replaced. The capacities of all tanks were selected to provide the maximum storage volume without necessitating costly changes to surrounding equipment, structural members and piping. In general, the new tanks were located in the same location as the existing tanks. Due to existing tank cubicle and access restrictions, all tanks except one will be field fabricated following demolition and removal of existing tanks.

The scope of work for piping replacement was also defined during this phase. Piping which had exhibited corrosion problems or presented a reasonable potential for failure was replaced. Additional piping and instrument modifications were made to provide increased flexibility and reliability.

Materials of construction for new tanks and piping were selected to increase the expected operating life over the original materials. All piping was upgraded to type 316L stainless steel. New tanks will be type 316L stainless steel or Carpenter 20 Cb 3 alloy. The possibility of repairing existing tanks using corrosion resistant linings was investigated but was rejected due to uncertainties in the amount of rehabilitation required before lining, potential degradation of linings due to radiation, inadequate lining life, potentially high maintenance requirements and the consequences of premature lining failure. In addition, since existing tanks will be replaced with larger tanks, rehabilitation and lining of an existing tank would not increase storage capacity.

In most cases the high radiation levels associated with radwaste storage tanks can be attributed to build-up of sludge on the tank bottom and lower tank walls. In order to facilitate the removal of radioactive solids during draw-off, provisions have been made to maintain particles in suspension. Hydraulic or mechanical agitation will be used dependent on tank size and/or service conditions. In addition, all tank bottoms will be sloped to permit the tanks to be drained entirely.

A preliminary cost estimate and construction schedule were prepared during Phase I. The primary factor potentially affecting both cost and schedule is the low productivity associated with work in radiation areas. Since extensive demolition is involved, respirators will be required, which further reduces labor productivity. These considerations formed the basis for the development of a detailed Health Physics Plan to control manrem exposure during construction.

HEALTH PHYSICS PLAN

From the start of the project it was recognized that comprehensive Health Physics planning would be required. A detailed project analysis was initiated to define the scope of work involved in effectively reducing radiation and contamination to levels which will render worker exposures as low as reasonably achievable (ALARA) and maximize worker productivity consistent with cost/benefit considerations.

The first priority was to establish a base line of existing radiological conditions. Each area requiring access to perform work received a thorough radiological survey. The radiation and contamination levels existing in the work areas, as well as the levels associated with structures to be demolished, were well defined. Using this information and the estimated labor hours, the potential manrem exposures for each work area were calculated as shown in Table I. Based on existing radiation levels the potential total exposure during construction was calculated to be 11,365 manrem, which is an order of magnitude larger than the average yearly exposure in an operating nuclear plant. This level of exposure is totally unacceptable from an ALARA standpoint, not to mention its impact on construction costs and schedule.

TABLE I

Potential Radiation Exposure

Work Area	Existing Radiation Level, mR/Hr.	Estimated Labor Hours In Radiation Areas Demolition	Installation	Potential Exposure Manrem
1	100-200	1600	5,700	1,095
2	20	200	300	10
3	200	500	3,600	820
4	800	1150	6,000	5,720
5	200	1550	13,800	3,070
6	100-200	250	4,100	650
TOTAL		5250	33,500	11,365

The next step was to define the scope of work involved in effectively reducing the present radiation and contamination conditions to levels which would maximize productivity and to establish the range of expected radiation levels following decontamination, both before and after demolition. The analysis investigated the feasibility of decontaminating the components to be demolished in terms of cost, manrem and manhour savings and established the most beneficial decontamination methods for the components and work areas.

Since most components will be demolished for disposal and considering the impact on waste processing requirements, chemical decontamination processes were eliminated. A matrix format evaluation was performed for the non-chemical decontamination processes which were considered suitable for this project. Radwaste System Components were separated into four groups as follows:

- PIPING (1 -12" diameter)
- TANKS AND FILTER HOUSINGS
- TANKS WITH INTERNAL COMPONENTS
- VALVES AND PUMPS

The applicable decontamination processes for each equipment group were then evaluated based on the proposed scope of work, practicality of shielding, contamination control, schedule limitations, impact on plant operations and availability of decontamination equipment. The evaluation process identified the most effective methods of decontamination for each equipment group with final selection dependent upon the conditions encountered at the actual time of decontamination. Based on cost, manrem and manhour savings estimates, the following decontamination guidelines were selected for use in this project:

- Use of existing in-plant hydrolasing equipment and procurement of special support equipment for the desludging of tanks and hydrolasing of piping and general plant areas to control contamination.
- Use of mechanical methods (pigs, scrapers, etc.) where hydrolasing is impractical.
- Use of strippable coatings for fixing in-place contamination and removal of contamination from various structural and spacial areas.
- Use of mobile decontamination services as required to supplement capabilities available at NMPC.
- Use of off-site decontamination facilities to reduce the amount of demolished equipment disposed of as low level waste.
- Use of enclosures, glove boxes, etc. to reduce contamination spread.
- Use of demolition techniques which minimize formation and spread of aerosols.

Estimated source reduction factors were established for both the post decontamination and post demolition conditions to be used as guidelines for solicitation of bids and preparation of schedules and cost estimates. During demolition, contamination levels will be controlled so that respirators will be required only for cutting activities and post-cutting decontamination. Post demolition contamination levels will be controlled so that respirators are required only for limited welding activities and possible post-welding decontamination.

Based on the application of the predicted source reduction factors to the existing radiological conditions, the calculated total exposure for the modifications is 2750 manrem which represents a reduction of 8615 manrem (75.8% reduction). It is anticipated that even further reductions will be possible since the source reduction factors are necessarily conservative for bidding purposes.

DETAILED ENGINEERING

During this period all drawings and specifications required to issue bid packages for procurement of equipment and construction contracts were prepared. Approximately 100 drawings and 20 specifications were completed. Based on the information generated during the preliminary engineering phase, the design philosophy was specifically formulated to address the restraints identified as being critical to the installation of the modifications:

1. The low labor productivity associated with work in radiation/contamination areas.

2. Control of radiation exposure.

3. Maintain radwaste system operability during construction.

4. Minimize temporary reductions in storage capacity.

Items 1 and 2 above were addressed as part of the overall Project ALARA Program which involves elements of both the Health Physics Plan and Engineering Design. Items 3 and 4 were addressed as part of both the Engineering Design and Construction Planning Activities.

Occupational radiation exposure dose is a function of both the strength of the radiation field to which an individual is exposed and the length of time he is exposed. ALARA (As Low As Reasonably Achievable) as applied to nuclear power plants means that every reasonable effort must be taken to minimize occupational radiation exposure consistent with the state of technology and cost/benefit considerations. The installation of modifications to operating plants must consider not only the radiation exposure to operators and maintenance personnel after the modifications become operational but also the radiation exposure associated with the installation of the modifications.

The Project ALARA Program as applied to the Detailed Engineering is based on USNRC Regulatory Guide 8.8 and the Catalytic ALARA Design Review Manual. A written ALARA procedure was developed specifically for this project. This procedure defines the ALARA responsibilities of key project personnel. A comprehensive ALARA checklist was developed for use by Design Engineers to assure that ALARA considerations were included at each point of the design. A final ALARA review of all bid packages was performed by the Lead Licensing/Nuclear Engineer. A complete discussion of all ALARA provisions included in the detailed design is beyond the scope of this paper. A brief description of some specific design features aimed at reducing exposure and construction labor hours follows.

As previously indicated, all tanks except one will be field fabricated. Individual sections must be small enough to fit through access doors and hatches. In addition, the weight of the sections is limited by handling and lifting capabilities in the work areas. In order to reduce the construction labor hours, the largest tank sections consistent with access and handling restrictions were selected. Wherever practical, all connections, nozzles, supports, internals, etc. will be shop welded onto plate sections. The intent is to achieve maximum possible shop fabrication and still meet clearance requirements. The entire tank will be assembled in the shop and match-marked to eliminate any fit-up problems in the field. Plate sections will be welded together from inside the tank. This provides additional protection against radiation and contamination from existing equipment and eliminates welding in the confined space between tank and cubicle walls.

During the design phase the access routes for transporting plate sections to the tank cubicles were identified. In one situation where access problems were anticipated, a scale model of the access route, including the tank and tank cubicle, was constructed. The model simulated all restrictions due to hatches, doors, stairs, piping, ductwork and existing equipment using simple shapes to provide the minimum clearances. Using this model the route for transporting the plate sections and the tank erection sequencing were verified before completion of design drawings.

Provisions were also incorporated into the design of the piping replacements to reduce exposure and/or labor requirements consistent with ALARA/cost benefit considerations. Piping specifications included requirements for maximum assembly of piping outside radiation areas. Evaluations were performed to identify the cost/benefits of rerouting piping through less radioactive areas and minimizing replacements or additions in high exposure areas. In general, only piping which had exhibited leakage problems or presented a reasonable potential for failure was replaced.

The restrictions related to operability and storage capacity have been previously identified. In order to minimize the impact of the modifications on plant operations, a Construction Sequence Schedule was prepared. The construction work was divided (by systems or sub-systems) into ten major tasks. A separate sequence diagram was prepared for each task. All demolition and installation work associated with each task (structural, piping, electrical, etc.) was identified in line form. Each Sequence Diagram also provides the following information:

- List of Reference Drawings.
- Required Prerequisites.
- Temporary Provisions and tie-ins to maintain system operation.
- Maximum duration for completion of critical activities affecting plant operation.
- Effects on receiving, processing and storage of liquid waste.

Each task was then incorporated into the overall project schedule and formed the basis for the construction work packages which are described below.

CONSTRUCTION

Construction is scheduled to begin in July, 1984. All construction work (demolition and installation) was combined into a single procurement package so that the responsibility for coordinating the various work disciplines (structural, piping, mechanical, electrical and instrumentation) will be handled by a single organization. This approach was selected for this project because the nature of the work requires intermittent performance by the various disciplines. Each task is essentially a separate project which must be completed before starting the next task.

The construction work will be controlled using field construction packages to be prepared by the contractor. Each package will clearly define the work to be accomplished and shall include, as a minimum, provisions for:

- Bills of Material
- Prerequisites
- Sequential Work Instructions
- Quality Control
- Health Physics
- Approval Signatures

Each construction package must be approved by NMPC before any work related to that package begins.

SUMMARY

This paper has presented a brief description of the planning and engineering activities associated with a major radwaste modification project. While some of the details are specific to the present project the general approach, particularly in the areas of Health Physics planning and construction sequencing, is applicable to most radwaste modifications.