USING THE SUPERCOMPACTOR TO ACHIEVE WASTE REDUCTION AT ROCKY FLATS AND THE APPROACH USED TO ESTABLISH OPERATIONAL READINESS

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ABSTRACT

The operation of the Supercompactor and Repackaging Facility (SARF) signals a major step towards reducing significant volumes of transuranic (TRU) and transuranic-mixed waste (TRU-M) at the Rocky Flats Plant (RFP). Without supercompaction, RFP will surpass its permitted storage capacity for Resource and Recovery Act (RCRA) regulated mixed waste. The original design called for the SARF to achieve a nominal compaction ratio of 5:1; however, operational tests have routinely achieved soft waste compaction ratios of 8:1 to 10:1. This paper addresses the SARF project and a readiness review conducted by EG&G Rocky Flats, Inc. (EG&G) and the U.S. Department of Energy (DOE), Rocky Flats Office (RFO).

INTRODUCTION

Maintaining compliance with state and federal restrictions on total volumes of mixed waste at the RFP has been a constant challenge over the last 4 years. Shipments of TRU and TRU-M waste to the Idaho National Engineering Laboratory (INEL), as well as shipments of low-level (LL) and LL-mixed waste (LLMW) destined for the Nevada Test Site (NTS), were terminated in 1989 and 1990 respectively. Also, starting in 1989, permitted storage limits were established for RCRA regulated mixed waste volumes. These limits would have been reached in 1992, had RFP resumed production without addressing volume reduction of these mixed wastes. Furthermore, recent and on-going work associated with fulfilling the current missions of RFP that are primarily directed towards decontaminating and decommissioning, but also include contingency options, has and will continue to generate radioactive and mixed waste. To address an anticipated need for substantial volume reduction, it had been determined in 1987 that building SARF within an existing operating building was RFP's best option.

To be responsive to the intent of Refs.(1) and (2), and to assure that the SARF facility complied with the appropriate design, environmental, waste, safety, and health requirements, a readiness review of the SARF was conducted. This readiness review consisted of two major elements: a comprehensive Operational Readiness Review (ORR), conducted by EG&G and patterned after similar activities at INEL; in conjunction with an independent Readiness Review, conducted by DOE/RFO that focused on reviewing the process and content of the EG&G ORR. The activities to support the ORR began in January 1991 and continued up to the SARF being declared ready for operation by EG&G in October 1992. The DOE/RFO readiness review was conducted from October 1991 through December 1992.

SARF PROJECT DESCRIPTION

The objective of the SARF project was to effect the safe and reliable reduction of TRU, TRU-M, LL and LLMW volumes at RFP, within the existing Building 776. The SARF is a supercompaction facility which utilizes innovative remote operation and ventilation designs to optimize health and safety of the public, workers and environment, while achieving volume reductions of up to 16:1.

The Supercompactor press is a 2200-ton vertical unit, using a single concentric mold capable of handling 35-gallon drums (See Fig. 1). A 1010 cubic foot glovebox encloses the press, and this confinement exhausts to an existing building ventilation system, equipped with four stage HEPA filtration as well as continuous and removable air head radiological monitoring. A dedicated set of fire suppression sprinklers is supplied by the building's main system, and glovebox overheat detectors (GBOs), located throughout the glovebox, provide local and remote alarm capability.

As shown in Fig. 2, waste enters SARF through either the "Hard Waste" or "Soft Waste" airlocks. Soft waste is hand sorted, precompacted into a 35-gallon drum (using a 30-ton low-force press), pierced and then loaded into the Supercompactor. Hard waste is conveyed directly to the piercers, and then loaded into the Supercompactor. After super-

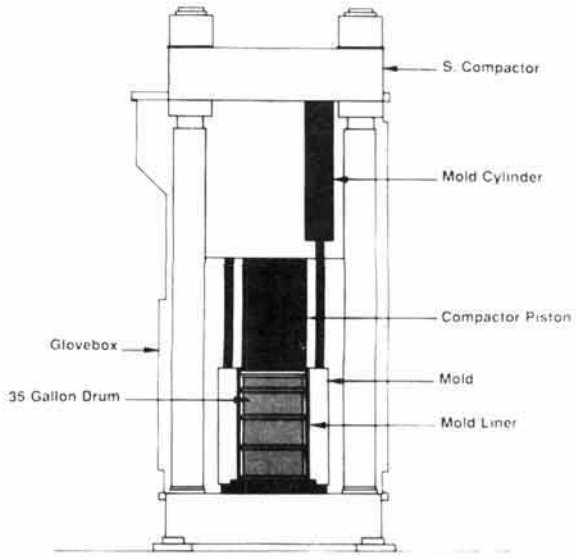

Fig. 1. Supercompaction and repackaging facility supercompactor elevation.

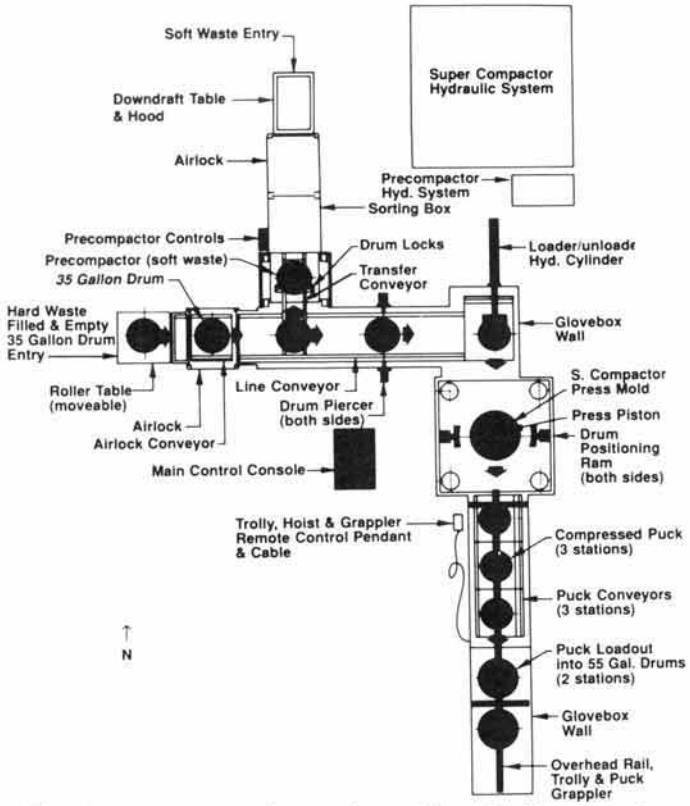

Fig. 2. Supercompaction and repackage facility plan view.

compaction, the resulting 4" to 12" puck is grappled into a 55-gallon loadout drum, for subsequent storage. Material moves through the system via a remotely-operated, programmable logic controller (PLC) supervised set of conveyors, movers, hoist and grappler. All waste is "batched" prior to processing according to loadout drums' total weight and fissile gram content limits, and also to ensure compatibility of hazardous contents. Up to 4 "feed" drums of incoming "soft" waste may become the contents of one puck, and up to four pucks may fill one loadout drum, resulting in a maximum 16:1 reduction. Trial operations to date with soft waste indicate nominal overall volume reductions of between 8:1 and 10:1.

READINESS REVIEW SCOPE

The SARF readiness review primary elements were: a comprehensive ORR, conducted by EG&G, and an independent assessment of EG&G's ORR, conducted by DOE/RFO. Figure 3 depicts an overview of the key areas included within these reviews.

The EG&G ORR approach was based upon a concept that an assessment of the project's readiness could be determined by demonstrating compliance (or non-compliance) with all known applicable requirement documents. The ORR's primary objective was to assure that the SARF was designed, fabricated, constructed, tested and would be operated in accordance with applicable codes, standards, orders, policies and procedures. As originally envisioned, the ORR was to review the readiness of the SARF hardware, programs and personnel and would only include the existing building or Rocky Flats programs directly affected by the SARF project. This approach seemed reasonable, at the time, since a safety evaluation determined that the SARF did not constitute an unreviewed safety question and that operational limits and

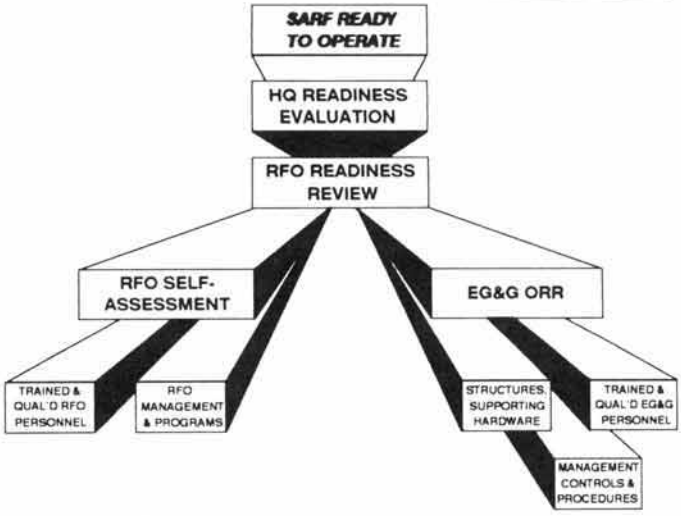

Fig. 3. SARF readiness review scope.

surveillances for the existing facility would be applicable to the SARF.

The DOE/RFO conducted an independent assessment of EG&G's approach to confirm that it provided a sufficiently rigorous basis for a readiness recommendation.

The DOE/RFO readiness review also provided DOE/RFO management a documented, independent review of the SARF's state of readiness. The RFO readiness review consisted of two separate, but interrelated activities. The first activity was a scoping assessment that evaluated the appropriateness of the ORR scope and approach. The second activity included an assessment of the ORR's bounding documents, a detailed review of a random sample of the ORR criteria/checklists, and walkdowns/interviews conducted by the RFO readiness review team members. The RFO approach was based upon a concept that an "audit type" sample review coupled with a "top-down" review of the readiness of the people, systems and procedures would provide a diverse means of assessing SARF's readiness to begin operation.

KEY ISSUES AND CHALLENGES

Summarized below are some of the key issues that had to be resolved in order to prepare the SARF to operate in an era of evolving requirements. More specifically, the RFP was challenged to adapt existing supercompaction technology to its unique problem of reducing RCRA regulated, plutonium-contaminated wastes stored on-site during a period of changing "safety culture", increased oversight interest and changing plant mission.

ADAPTING A PRODUCT

Adapting an off-the-shelf product to a unique glovebox application posed a daunting challenge in several ways. First, the evolving "safety culture" at RFP served to focus attention on reduction of maintenance and operations worker exposures to contamination from the SARF. Therefore, systems were designed to maximize remote, shielded operations while maintaining positive process control. In addition, modifications were installed both to prolong replacement intervals and also to decrease maintenance task durations.

Second, the need to interface with an existing building, and its systems vital to health and safety, resulted in limited headspace. This forced additional design changes and modifications to the original Supercompactor press, thus making it

a "one-of-a-kind" machine. Addition of an internal bearing sleeve enhanced wear performance of the ram and mold and provided an easily-removable sacrificial wear surface. PLC sequencing changes reduced ram-to-mold relative motion, providing additional wear performance.

A third major adaptation was the interface with the RFP Waste and Environmental Management System (WEMS). Communication of waste package content data and interlocking functions with SARF added significant positive controls to SARF waste processing.

CHANGING REQUIREMENTS

Attempts to meet the challenges of an evolving "safety culture" at RFP translated into specific changes in the applicability of requirements to the design and startup of the SARF. The standards-based methodology long accepted by the Nuclear Navy and commercial nuclear world entered the SARF project forcefully. Two areas of significance to the startup of the SARF were: 1) The review of the compliance status of the SARF and the building support systems with respect to selected design, operations and safety standards, and, 2) The applicability of DOE Order 6430.1 (5) and 6430.1A (6) to both SARF and the interfacing support systems. The basis for the review of compliance with standards for both the SARF and the building support systems is found in Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 90-2.

ROLE OF INDEPENDENT OUTSIDE EXPERTS

The SARF Project made effective use of independent, outside expertise. The use of these highly experienced personnel, in conjunction with the project knowledgeable personnel, proved to be extremely effective in determining alternative and creative solutions to problems, as well as identifying/preventing potential problems. The individuals performed several different functions. The initial involvement, in June, 1991, was by a team of three individuals with significant experience in the use of heavy machinery in a radiological environment. They helped the project focus on fundamental machine design issues that needed to be addressed. Additional personnel were utilized, from August 1991 through October 1992, by DOE Construction & Engineering Division (CED), to augment the DOE/RFO/CED staff's oversight role in specialty areas of mechanical engineering, instrumentation and project management. DOE Waste Programs Branch utilized a senior operations individual to supplement the assessment of the SARF operating procedures. The overall result was a high level of synergy in the program's ability to respond to changing requirements.

CONCURRENT ACTIVITIES

The need for the SARF to become operational, as soon as possible, dictated that many activities be performed in parallel, rather than the more preferred series sequence. Examples of these parallel activities included preparation of operational procedures and training of operation/maintenance personnel prior to the finalization of the SARF design. Performing these activities in parallel with design finalization placed an increased emphasis and priority on the need for integrated system and pre-operational testing. While each of the major SARF subsystems could be checked-out and operated in accordance with its original design, the numerous changes in hardware and other requirements prevented development of a detailed operational philosophy until very late in the project. To minimize the potential adverse impact of this situation, unique approaches were developed that included: significant involvement of the operations and maintenance personnel in engineering checkout of the components; development of a personal computer (PC) based stimulation type system model; and combining plant functional groups with operations personnel in "round-table" reviews of procedure changes, as they were developed.

MISSION CHANGES

In January, 1992, the Secretary announced that RFP would change its mission to decontamination / decommissioning (D&D), while maintaining a production contingency. The production contingency role is viewed as a short-term impact on SARF throughput, whereas the D&D mission is considered long term and potentially substantial. The role of the SARF in supporting production contingency will consist of compacting wastes associated with maintaining vital safety system support and ongoing consolidation of special nuclear material. Long-term, the SARF is viewed as playing a vital role in an integrated approach to reducing waste volumes generated by the D&D mission at RFP. SARF will provide significant cost benefits for both transportation and disposal.

ESTABLISHING SCOPE OF THE READINESS REVIEW

The main challenge facing the readiness review was to establish appropriate scope for the effort. This was especially difficult, since the SARF was located inside a building that was not designed or built in accordance with new standards, and the interfaces were not easily defined. Additionally, standards applied to the RFP Resumption ORR, coupled with involvement of a variety of oversight groups, necessitated addressing the ORR criteria against evolving and/or changing requirements. EG&G had developed bounding analyses, which consisted of a Requirements Document identifying applicable and non-applicable documents for the SARF ORR; and a Critical Systems Analysis, which limited the physical hardware to be reviewed during the ORR. It was not clear, though, that these analyses would adequately address evolving and/or changing requirements. In addition, during the scoping assessment, RFO challenged the narrow scope established by EG&G's ORR, especially in the area of interfaces between the SARF and building support systems and programs. As a result, EG&G modified their ORR approach to combine the compliance-based readiness tree elements into a more traditional readiness tree approach. EG&G expanded the scope of the ORR to include additional building support interfaces, such as the differential pressure monitoring in the Utilities Control Room and the addition of SARF vital safety system equipment to the building limiting condition of operations (LCO) surveillance program.

UNIQUE FEATURES

The SARF project incorporated several unique features. This section of the paper provides a brief overview of each of the more significant of these features.

SARF is the only operational supercompactor in the U.S. which processes transuranic wastes within a totally confined glovebox. To do this, it makes maximum use of remotely operated moving and handling equipment, whose functions are supervised and interlocked through the use of a PLC. The

SARF PLC also interfaces with the RFP WEMS to ensure positive control and waste certifiability of all processed material. A highly innovative "action/reaction" software analytical tool was used to independently verify and validate operation of the PLC code. In addition, a PC-based stimulator was developed, so that operators could "walk-through" detailed system operation on a PC screen, prior to actually operating hardware on the floor. This stimulator also allowed observation of system response to proposed PLC logic changes, again prior to any actual system entry.

EG&G opted to use the SARF ORR as part of a pilot program to develop a general ORR approach at the RFP. The essential elements in this approach consisted of developing a Requirements Document (3), a Critical Systems Report (4), "compliance" and "criteria" based readiness "trees", and project specific criteria/checklists. Development of the Requirements Document included reviewing approximately 1000 documents and justifying the applicability of approximately 100 of these documents to the SARF project. The Critical Systems Report provided a systematic process to bound the scope of the components and systems to be included in the ORR.

The DOE/RFO readiness review utilized several creative elements. First of all, the use of a DOE/RFO scoping assessment, described previously, to delineate the scope and approach of DOE's readiness review was unique in itself. For example, the scoping assessment determined that a "sampling" approach to reviewing the ORR criteria would be used. The effectiveness of this approach was due, in part, to the development of a set of weighted criteria to enhance the random selection of specific checklists to be reviewed. This criteria resulted in more checklists being reviewed in those areas that had the greatest potential to impact the SARF's readiness. In addition, the DOE/RFO "top down" review approach proved to be an excellent complement to the EG&G "compliance" review approach. Also, the review included an assessment of the RFO Waste Operations organization to assure readiness to adequately oversee SARF operations. Probably one of the more truly unique aspects of the review was the participation by DOE/HQ observer teams.

Typically, a readiness review is conducted at the end of a project. Due to the time constraints on the entire SARF project, there was not enough time available to allow the readiness reviews to be completely conducted at the end of the project and then correct any discrepancies noted. In addition, due to the complexity of the engineering and other activities involved, EG&G decided that it would be prudent to conduct the ORR in parallel with the actual project activities. For similar reasons, DOE/RFO decided to conduct its readiness review in parallel with the ORR. In retrospect, due to the number of discrepancies noted, the decisions to conduct the reviews in parallel proved to be beneficial to the overall project schedule.

LESSONS LEARNED

A number of important lessons were learned that applied to both the SARF Project and the readiness review process. Key "lessons learned" are highlighted below.

Lessons Learned - SARF

- Design changes will occur during projects, and the expertise and material required to effect them, within the projects' system boundaries, may be acquired at some additional cost. However, within the DOE complex, there may be cases where modifications will be necessary outside new systems' boundaries. Specifically, if existing, old facilities must be significantly modified to provide proper interface support to a new project, costs of these changes may become extremely high, possibly prohibitive. The challenge is to find a proper pedigree of interface which links a new project with older support systems built to earlier standards.
- Careful and in-depth preparation of up-front performance specifications will obviate embarrassing delays due to rework and corrective action as the project nears closure.
- Effective software development plans and proper software configuration control are paramount in systems where hardware and software interaction is key to system performance.
- The expectations for performance in the areas of health, safety and environment (HS&E) continue to increase. Allow for this and set project HS&E standards appropriately during conceptual design.

Lessons Learned - Readiness Review

- The use of the scoping assessment in combination with the bounding analyses provided a useful tool for properly scoping the readiness review.
- Combining the compliance-based tree with the more traditional readiness tree added a new dimension to assessing readiness in this era of evolving safety culture and standards-based compliance assessments.
- Conducting the reviews in parallel provided RFO the opportunity to delve deeper into issues over time in order to reach adequate closure in a shorter time period.
- Early participation by DOE-Headquarters provided a basis for expediting the concurrence process.
- The SARF readiness review generated enhancements to EG&G's ORR criteria database that will streamline the process of screening for applicable requirements for future ORRs.

CONCLUSIONS

The adaptations of the SARF to the specialized application of reducing the volumes of TRU and TRU-mixed wastes at RFP will be beneficial in reducing worker and maintenance personnel exposures. These adaptations will also extend the durability and reliability of the press, and assure proper tracking and control of RCRA regulated wastes through the supercompaction treatment process.

A unique approach was taken in conducting the SARF readiness review. The approach proved successful, despite intense scrutiny from oversight groups. Involving DOE Headquarters oversight groups early in the process provided the RFO and EG&G the opportunity to address those issues efficiently. Lessons learned from this effort should benefit other DOE sites faced with similar situations.

While this project had several unique aspects, the general approach outlined in this paper should apply to a variety of multi-disciplined engineering projects.

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