DOE/EIS-0281-SA-02

SUPPLEMENT ANALYSIS

Site-Wide Environmental Impact Statement
for
Sandia National Laboratories/New Mexico

Isentropic Compression and Flyer Plate Experiments Involving Plutonium at the
Z and Saturn Accelerators

September 2002

INTRODUCTION – PURPOSE OF SUPPLEMENT ANALYSIS

This Supplement Analysis (SA) has been prepared to determine if the Site-Wide Environmental Impact Statement for Sandia National Laboratories/New Mexico (SWEIS), DOE/EIS-0281, adequately addresses the environmental effects of a proposal to conduct isentropic compression and flyer plate experiments involving plutonium at the Z and Saturn Accelerators, or if additional documentation under the National Environmental Policy Act (NEPA) is needed. The need for a SA to an existing environmental impact statement (EIS) is initiated by subsequent changes in the basis upon which the original EIS was prepared and the need to evaluate whether or not the EIS is adequate in light of those changes. It is submitted according to the requirement for determining the need for supplemental environmental impact statements (10 CFR 1021.314) in the Department of Energy's (DOE) regulation for implementing NEPA.

DOE has identified a need for additional research and development data on special nuclear materials (SNM) for use in the weapons program and stockpile stewardship. The unique capabilities of the Z and Saturn Accelerators would provide a more efficient way of obtaining accurate data on special nuclear materials. This data would be used to validate computer modeling of potential weapons' performance. The SWEIS analyzed the environmental effects of operating the Z and Saturn Accelerators under three alternative levels of operation – No Action, Expanded Operations, and Reduced Operation Alternative. The No Action Alternative would maintain the status quo – operating at planned levels as reflected in current DOE management plans. Operating levels under the Expanded Operations Alternative would increase to the highest reasonable levels that could be supported by current facilities and their potential expansion, as well as construction of identified facilities for future actions. Operating levels under the Reduced Operating Alternative would be reduced to the minimum levels needed to maintain facilities and equipment in an operational readiness mode. The Record of Decision for the SWEIS, issued in December 1999, documents DOE's preferred alternative as the Expanded Operations Alternative. Under this preferred alternative the Z and Saturn Accelerators would continue to subject various targets to intense bursts of X-rays. The capability of the Z Accelerator would be increased to a maximum of 350 shots per year, of which approximately 78 percent could involve nuclear materials. The output of the Saturn Accelerator would increase up to a maximum of 500 shots annually.

The DOE proposal analyzed in this SA is to conduct isentropic compression and flyer plate experiments involving plutonium at the Z and Saturn Accelerators. At the Z machine the proposal is to utilize greater amounts of Pu than were analyzed in the SWEIS. At the SATURN accelerator, the proposal is to introduce nuclear materials and explosives that were not analyzed in the SWEIS.

This SA specifically compares key impact assessment parameters evaluated in the SWEIS Expanded Operations Alternative with comparable impact assessment parameters of the proposal for conducting experiments at the Z Accelerator and the Saturn Accelerator. This includes both operational modes and activity levels. Based on this analysis, this SA will be used to make a formal NEPA determination whether (1) the existing SWEIS should be supplemented, (2) further NEPA documentation should be prepared, either in the form of an EA or a supplemental EIS or (3) no further NEPA documentation is required.

PROPOSAL DESCRIPTION

Background

Facility Characterization and Current Uses

The Z Accelerator and the Saturn Accelerator each have 36 modules arranged radially around a central experiment vacuum chamber. Each accelerator is divided into the energy storage section components (oil section), the pulse forming section components (water section), and a vacuum section (center section). The Saturn Accelerator was originally called the Particle Beam Fusion Accelerator (PBFA I). The Z Accelerator is larger and is able to accommodate larger test objects in its central chamber and was originally called the PBFA II. Both Accelerators are used to simulate X-rays produced by nuclear weapon detonation.

- *The Z Accelerator*. The Z Accelerator facility is located in Building 983 in Technical Area IV. This multiple use facility provides weapons systems survivability testing for the Inertial Confinement Fusion Program and weapon science research by simulating the X-rays produced by nuclear weapon detonations. Operating on the principle of pulsed power, the Z Accelerator stores and accumulates electrical energy over a period of minutes then releases that energy in a concentrated burst. The accelerator produces a single, extremely short, extremely powerful pulse of energy that can be focused on a target. The capacitor bank stores up to 11-Megajoules of energy, under oil, plus a water line pulse forming section to create a 20-Megampere, 50-Terawatt, 3-Megajoule electoral energy pulse. Laser triggered switches are used to ensure all 36 modules fire simultaneously. It is located in an open-air tank that is 108 feet (ft) in diameter and 20 ft high and is divided into three annular regions containing 540,000 gallons of transformer oil, 600,000 gallons of deionized water, and in the center is a vacuum chamber and target area.

- *Saturn Accelerator*. The Saturn Accelerator is located in Building 981 in TA IV. It produces X-rays to simulate the radiation effects of nuclear bursts on electronic components and materials; as a pulsed-power and radiation source; and also operates as a diagnostic test bed. Areas of application include satellite systems; electronic and materials devices, components, and subsystems; and reentry vehicle and missile subsystems. The Saturn is smaller than the Z Accelerator that uses similar technology to produce a 10-Megampere, 20-Terawatt, 1-Megajoule electrical energy pulse. The Saturn is electrically triggered. It is located in an open-air tank that is 96 ft in diameter and 14 ft high. The tank is divided into energy storage, pulse compression, power flow, and power combination sections. The Saturn Accelerator contains approximately 300,000 gallons of transformer oil and 250,000 gallons of deionized water.

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- Preferred Alternative – Expanded Operations.

  Z Accelerator. Under the expanded operations alternative the Z Accelerator would continue to be used to produce extremely short, extremely powerful energy pulses. The Z Accelerator's capability would be maximized to 350 shots per year. Approximately 78 percent of accelerator operations would involve tritium, deuterium, plutonium, and depleted uranium. A recent proposal (documented in NEPA review SNA 01–0700) to modernize the Z Accelerator with a resultant increase in shot capacity from the 350 shots analyzed in the SWEIS to 400 shots per year was categorically excluded from the need to prepare an environmental assessment or an environmental impact statement (2/6/02).

  Saturn Accelerator. Under the expanded operations alternative the Saturn Accelerator would continue to be used to produce X-rays to simulate the radiation effects of nuclear bursts on electronic and material components. The Saturn Accelerator's output would remain at a maximum of 500 shots annually. No nuclear or explosive materials have been associated with activities at the Saturn Accelerator.

<u>Proposed Action</u>

Sandia National Laboratories, New Mexico (SNL/NM), in association with Los Alamos National Laboratory (LANL) or Lawrence Livermore National Laboratory (LLNL), or both, are proposing to conduct isentropic compression and flyer plate experiments involving plutonium at the Z and Saturn Accelerators. These experiments would utilize greater amounts of Pu-239 at the Z Accelerator than was addressed in the SWEIS and introduce nuclear materials, i.e., Pu-239, and explosives into the operation of the Saturn Accelerator. The purpose of these experiments is to provide information needed for the weapons program and stockpile stewardship. Because of the unique capabilities of the Z and Saturn Accelerators, the proposed testing would provide a more efficient way of obtaining accurate data on SNM that can be used to validate computer modeling of potential weapon performance.

The test packages containing Pu-239 that would be used in the proposed experiments would be produced by either LANL or LLNL. These test packages would be sealed units and would be shipped to SNL/NM by ground transportation in compliance with existing guidelines and requirements. One round-trip for each experiment would be expected. All on-site transportation would also be conducted in compliance with established requirements for the movement of radioactive material. These test units would be received at the SNL/NM 6000 igloo site for interim storage. The receipt of the test units would coincide with programmed testing and would normally be retained for a few days. An anticipated maximum of two test units would be present. The test units containing Pu-239 would then be transported to the accelerator facilities for experimentation. The period of time that these test units would normally be retained at the accelerator facility before being utilized is anticipated to be several days or, in the event of delays, one or two weeks.

A total of approximately 20 isentropic shots are projected annually – approximately 12 shots at the Z Accelerator and 8 at Saturn. A total of up to eight samples would be measured with each shot. There would be no direct contact with Pu-239 during handling and experimentation because each test package would be sealed. There would be no additional routine radiation doses to workers. The total mass of Pu-239 for any shot would not exceed 8 grams (g), which is below the category 3 nuclear facility limit of 8.4g. More typically, the mass of Pu-239 for each shot would be approximately 2.5g, plus or minus 0.5g. There would be a maximum amount of 2.5g to 8g of Pu-239 present at each facility.

A one hundred percent containment for the Pu-239 during the experiments would be achieved through the use of an explosive closure device. At the Z Accelerator this closure device would use approximately 250g of high explosive (HE) to hermetically seal the Pu-239 in the primary containment chamber. Smaller amounts of HE would be needed at the Saturn Accelerator because of a difference in hardware size at this facility. Currently, both systems are designed to have the vacuum chamber function as the secondary containment. Neither machine has lost vacuum during shooting, which essentially eliminates any release to the environment through firing.

The HE would be obtained from the inventory of the SNL/NM Explosives Components Facility (ECF). The ECF is located in TA II. Assembly of the explosive closure device would likely be performed at the ECF. Preliminary to the accelerator experiments would be a series of technology demonstration experiments to prove the viability of the design for containment. Explosive and nuclear test materials would be separately located until just prior to experimentation when the nuclear material test unit and the explosive closure device would be installed into one of the two accelerators.

The sealed test packages would be shipped back to their source, LANL or LLNL, following experimentation where test products would be recovered, disposed of as waste, or both.

The introduction of SNM and explosive materials at Saturn will require the implementation of radiation protection measures and use of trained personnel. Radiation protection measures would be included in Standard Operating Procedures. Anticipated safety documentation would include a preliminary hazard screening and a hazard assessment. Additionally, a qualitative risk assessment would be done to better quantify the risks associated with performing Pu-239 experiments at Saturn, as well as at the Z Accelerator.

DISCUSSION

The purpose of this section is to determine if the impacts resulting from the proposed action are within the scope of impacts discussed and evaluated for the Expanded Operations Alternative as presented in the SWEIS and subsequent NEPA determinations. Important to these determinations are the temporary presence of the experimental packages, the containment of experimental products, and the return of these sealed experimental packages to their point of origin.

This section (1) identifies key assessment parameters that would be affected by the proposed action, (2) identifies the extent to which these parameters would be affected as a consequence of implementing the proposed action, (3) identifies effects to those parameters that would result from implementation of the Expanded Operations Alternative as presented in the SWEIS, (4) compares differences in the extent of effects to identified key assessment parameters that would result from implementation of the proposed action and the Expanded Operations Alternative, and (5) states whether the magnitude of impacts from the proposed action are encompassed by the analysis presented in the SWEIS.

The key assessment parameters that would or could be affected by the proposed action were identified from the impact assessment parameters evaluated in the SWEIS. Those that would not be affected, e.g., hazardous and solid waste, are not discussed. A matrix is provided to enable a rapid, comprehensive comparison of coverage provided. The last column of the matrix provides comments regarding coverage of the impact assessment parameter for the proposed action within the scope of the SWEIS.

The key assessment parameters evaluated and compared are the following:

- Accelerator Operations
- Material Consumption
- Nuclear Material Inventory/Accidents
- Explosives Inventory
- Waste Generation
- Air Emissions
- Transportation

Accelerator Operations

The potential capacity of annual shots analyzed under the Expanded Operations Alternative for the Z Accelerator, as increased by facililty refurbishment, is 400. Of these 400 shots, 50 would involve Pu-239. Approximately 40mg of Pu-239 per shot was contemplated. As stated, a total of approximately 20 isentropic compression shots or firings are projected annually – 12 shots at the Z Accelerator and 8 at Saturn. The number of shots contemplated for the proposed action would be encompassed within both the total number of shots and the number of shots involving Pu-239 at the Z Accelerator. Existing operational processes would easily accommodate the increase in experimental amounts of Pu-239 used.

The number of potential shots analyzed for the Saturn Accelerator is 500. The number of shots proposed is approximately 8, well within the number of shots addressed in the SWEIS. While the use of nuclear materials in test objects at Saturn was not addressed in the SWEIS, the hazards and risk of the proposed use of explosives and nuclear materials is addressed by the bounding impact and accident analysis performed for the nearby Z Accelerator. Safety concerns of operating the Saturn Accelerator with these materials can be assimilated into the operations of Saturn with the implementation of appropriate radiation safety controls, as assessed in the Hazard Analysis and controlled with Standard Operating Procedures.

Consequently, the above comparison of operational processes and levels that would be associated with the proposed action with those addressed in the SWEIS demonstrates that the consequences of the proposed action are within those described and analyzed the SWEIS.

Material Consumption

The proposed experimentation would not result in the consumption of Pu-239.
As stated, approximately 250g of HE would be used for each of the approximately 12 test shots that would be performed annually at the Z Accelerator. The Expanded Operations Alternative analysis provides for 375g of explosive for each shot (assuming five valve setups per shot) and up to 100 shots per year using the explosive closure device. An annual consumption of 37,500g of Bare UNO 1.1 explosive was addressed for the Expanded Operations Alternative. Consequently, the amount of HE consumed annually under the proposed action is encompassed by the SWEIS.

Smaller amounts of HE, i.e., less than 250g per shot, would be utilized and consumed at the Saturn Accelerator. While the SWEIS did not address the presence and use of HE at this facility, the SWEIS did analyze the effects of the annual site consumption of 37,500g of Bare UNO 1.1 explosive. Consequently, the consumption of HE in conducting the proposed experimentation at the Saturn Accelerator was encompassed by the analysis contained in the SWEIS. Also, safety concerns would be addressed by a Hazard Analysis and Standard Operating Procedures and would preclude any alteration of the site-wide consequences resulting from the consumption of the relatively small amounts of HE at Saturn.

Nuclear Material Inventory/Accidents

Material inventory would be the amount of Pu-239 on hand and is of concern from a potential accident scenario. As stated, the test units would be received at the SNL/NM 6000 igloo site for interim retention. From the igloo site the test units would be transported to the accelerators for experimentation. The Pu-239 would then be part of the material inventory of the accelerator facility for the period of time that it is present. With one or two test units present awaiting or in use, there would be a maximum amount of 2.5g to 8g of Pu-239 present periodically. For the Z Accelerator this amount would be an increase from the 200mg Pu-239 inventory presented and analyzed in the SWEIS. For the Saturn Accelerator the use of Pu-239 would periodically add nuclear material to its inventory.

The accident scenario that was postulated in the SWEIS for TA-IV was a catastrophic unspecified event that causes all the tritium (1,000 curies in the form of tritiated water) and/or all the plutonium (200mg) present in the facility to be released at ground level. The accident analysis found that the Z Accelerator was the only facility in TA-IV with amounts of radioactive material that presented a potential consequence to the public, environment, or workers outside the facility. The frequencies for all the accident scenarios established for the Z Accelerator was estimated to be extremely unlikely ($1x10^{-4}$ to $1x10^{-6}$ per year – an incredible event). The accident analysis found that based on the amounts and form of radioactive material involved, the consequences from the greatest possible release would be small. The effective dose equivalent to the maximally exposed individual for this accident was calculated to be $8.85x10^{-4}$ rem with an associated increased probability for latent cancer fatalities of $4.4x10^{-7}$.

The periodic increased quantities of Pu-239 at the Z Accelerator and its periodic use at Saturn would not alter the frequencies for all the accident scenarios established for the Z-Machine. In addition, the infrequent presence of elevated quantities of Pu-239 and, importantly, the mitigating effects of the form in which the Pu-239 would be present and the high degree of physical protection afforded by the packaging of the test unit (explosive containment device) make the catastrophic release of the inventory extremely unlikely.

An analysis of an aircraft accident with fire scenario at the Z and Saturn Accelerators with up to 16 g of Pu-239 in the facilities was prepared. The impacts of a unspecified catastrophic event with the release of all 16 g of Pu-239 in addition to the existing 200 mg of Pu-239 and the 1,000 Ci of tritiated water were greater than that presented for TA-IV and all other accident initiated radiological releases analyzed in the SWEIS. Therefore, a refined assessment was conducted and resulted in a much lower dose to the MEI of 4.2E-4 rem and increase LCF of 2.1E-7. This refined assessment used the same input assumptions as those used for similar accidents in the SWEIS (i.e., Airborne Release Fraction/Respirable Fraction values taken from the *Airborne Release Fractions/Rates and Respirable Fraction for Non-reactor Nuclear Facilities*, DOE-HDBK-3010-94, and plume rise resulting from the fire). Making use of more realistic release ARFs and RFs compensates for the increase material at risk resulting in the lower consequence values. From this analysis, the occasional increase in plutonium inventory at the Z Accelerator and the addition of nuclear materials to the Saturn inventory is within the scope of effects analyzed in the SWEIS.

	SWEIS Unspecified TA-IV release	Fire at Z and Saturn Accelerators	Fire in Hot Cell Facility[1]
Dose (MEI) rem	8.8E-4 rem	4.2E-4 rem	1.3E-2 rem
LCF	4.4E-7	2.1E-7	6.6E-6

1. The Fire in the Hot Cell Facility resulted in the largest dose to the MEI and LCF from accident analyzed in the SWEIS

Explosives Inventory

The quantity of explosive in inventory at the ECF that was addressed under the Expanded Operations Alternative was 150,000g. Considering that explosives for fabrication of only one or two closure devices (250g each) would be required at any one time, this amount is fully bounded by the 150,000g addressed in the SWEIS.

The quantity of explosive that would be in periodic inventory at the Z Accelerator would be 250g to 500g. The quantity of explosives in inventory at the Z Accelerator that was addressed under the Expanded Operations Alternative was 1,500g. Consequently, the periodic and short-term presence of up to 500g as a consequence of the proposed action would be bounded by the SWEIS.

The Saturn Accelerator did not report an explosives inventory in the SWEIS. Nevertheless, the implementation of safety measures such as those used at the Z Accelerator, e.g., Standard Operating Procedures, would preclude the development of health and safety issues and would be bounded by the SWEIS analysis.

Waste Generation

As stated, the test units containing Pu-239 are sealed and all products resulting from testing would be confined and the test unit returned to the originating laboratory. Consequently, waste generation, other than that described in the SWEIS, would not change.

Waste products generated from the detonation of HE contained by the explosive closure device would be negligible, consisting mainly of combustion products that would be released into the atmosphere (see subsequent discussion on air emissions). Also, since the SWEIS assessed the potential for 100 tests with as much as 375g of HE, the amount of waste generated by proposed tests would fall well within this estimated usage.

Air Emissions

The use of an explosive closure device would provide complete containment of radioactive materials. Backup containment would be provided by the vacuum chamber and, if necessary, installation of a secondary shield.

There is essentially no air activation and, consequently, no production of radiological air emissions, occurring as a consequence of operating the Z or Saturn Accelerators. The proposed action would not change this.

Combustion products from the detonation of HE would be released into the atmosphere, e.g., carbon dioxide, carbon monoxide, water, oxides of nitrogen, etc. These short-term emissions would be too small to alter the criteria pollutant concentrations presented for the Expanded Operations/No Action Alternatives in the SWEIS. Consequently, air emissions are bounded by the SWEIS.

Transportation

As stated, the number of round-trips required by the proposed action for the transport of nuclear materials would be a maximum of 20. This would translate to 40 one-way trips. Transportation impacts analyzed in the SWEIS addressed three regions of influence: Kirtland Air Force Base; major Albuquerque roadways; and major roadways between Albuquerque and specific waste disposal facilities, vendors, and other DOE facilities. The number of annual shipments (one-way) of radioactive materials addressed for the Expanded Operations Alternative was 1,782. The analysis of this number of trips for the Expanded Operations Alternative as well as bounding travel distances fully encompasses those that would occur with the proposed action.

Transportation of explosives related to receipt and on-site transportation would largely be proportional to the number of test events. Considering the additional receipt of explosives related to the proposed action there could be a maximum increase of about 10 shipments. This small number would be encompassed within the 1,771 addressed in the SWEIS. The number of on-site transfers would be proportion to the number of test events and would likely be about 20 round trips from the ECF to and from the accelerators. While no on-site transportation figures (excluding commuter traffic) were addressed in the SWEIS, this additional number of trips related to the proposed action is insignificant when compared to the collective on-site traffic.

CONCLUSION

DOE has not identified any other differences in parameters relevant to the analysis of environmental impacts between the proposed experiments at the Z and Saturn Accelerators and the actions analyzed in the SWEIS for the Expanded Operations Alternative. The scope of the proposed federal action has not changed (in ways that would significantly affect human health or the environment) from the scope of proposed accelerator operations described in previously cited NEPA documentation.

Impacts of the proposed activities have been bounded by the impacts analyzed in the SWEIS, and no further NEPA review is considered necessary for proposed experimentation at the Z and Saturn Accelerators as described. Reliance on the information presented for operation of the two accelerators described in the SWEIS is reasonable, and this information was publicly disclosed. The information used in the SWEIS is also up to date. Any changes in approaches in the proposed action have been identified in this SA.