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INTER - OFFICE MEMORANDUM

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April 19, 1945

To: Mr. K. T. Bainbridge

From: H. L. Anderson

Subject: The 100 Ton Shot Preparations - Addition No. 7 to Project TR Circular

Preliminary to the final test of the gadget it is planned to shoot 100 tons of H.E. This shot is intended to provide some experience in measuring large explosions and will serve as a practice episode. The radioactivity which will be encountered in the final shot will be simulated here by distributing among the boxes of H.E. a solution of a 100 day Hanford slug having about 300 curies of activity. While the geometry and the general nature of the explosion of this 100 ton shot differ in several remarkable respects from that of the final shot, it is expected to afford a much better basis for anticipating the conditions of the gadget shot than is now had. In particular, we hope to learn:

(1) What is the general utility of a lead shielded army tank (M4) as a means to enter the radioactive area to obtain samples. What is the extent and depth of the debris from the crater and how does it affect the maneuverability of the tank.

(2) What is the level of radiation over active region and how effective is the shielding of the tank.

(3) What happens to the radioactivity; what fraction deposits superficially over the ground nearby, what fraction is mixed with the earth thrown up from the crater, and what fraction is essentially lost through having been thrown up in the air and dispersed over a much wider area.

(4) What amount of segregation takes place among the several fission products and the plutonium after these are isolated by chemical extraction from samples taken from a number of positions in the active area.

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Per memo dated 6/29/77
By Les Redman

In addition, practice will be afforded in the manipulation of the tank and the sampling devices, in the measuring of the samples of earth, and in the chemical analysis procedure for extracting fission products from Trinity earth.

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FINAL DETERMINATION
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L. M. Redman
OCT 24, 1980
7/1/86

Plans and Status

(A) Dissolution of Hanford Slug

A suitable lead shield was available and this has been fitted on a truck which has taken it to Hanford. The slug will be inserted in the shield there and should be returned to Trinity on April 25.

A stainless steel dissolver has been designed and the shop is completing this. A concrete sarcophagus (3 1/2' thick) to contain the dissolver will be stationed SSE of the wooden tower at a distance of 75 ft. The design for the concrete structure has been submitted to Capt. Davalos and should be completed by April 15. The concrete structure will be partially lined with lead bricks (8" x 4" x 2") and will be capped

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with an 8" lead top made of these brick. This shielding should be sufficient to allow a working time of the order of 4 hours above the apparatus.

The dissolver is to be provided with a 2" tube through which the slug is introduced. A bed of dry ice will protect the walls of the dissolver from the impact of the slug when it falls into the dissolver. A suction device has been designed which transfers the slug from its shield on the truck to the entrance tube of the dissolver. The shop is fabricating a funnel which guides this transfer. The transfer device will be operated from behind a wall made of concrete bricks and observation will be by telescope using mirrors mounted above the carrier.

The dissolving will be effected by periodic addition of conc. HNO_3. During the dissolving a stream of N_2 will be passed through the solution by way of the lead-out tube to sweep the active gases out of the system and to prevent plugging of the lead-out. The dissolver and lead-out will be wound with heating elements dissipating about 1-2KW to accelerate dissolution. Around 2400 liters of NO_2 will be liberated over the period of solution estimated to take from 15-25 hours. This gas will be diluted around 2-3 fold with N_2, thus giving around 6000 liters in all. The active gases present in the slug (mostly 5.3 day Xe^{133} and the 8 day I^{131}) known to distil during dissolution will be present in the gas stream. The activity of these constituents will be 1×10^{-6} curies/cc and 3×10^{-5} curies/cc, respectively. The γ radiations of 5.3 Xe consist of a 35 kv X-ray and an 85 kv γ-ray, whereas that of 8dI is an 0.4 Mev γ-ray. The tolerance dosage is of the order of 10^{-11} curies/cm^3. This would entail a dilution of 100,000. Since the gases will be vented at a distance of 1000 ft. from the dissolver, it appears that no arrangements need be made for gas removal other than dilution at the end with a blower. The gases will also carry some spray which may deposit near the vent. An area around the vent (2200' diameter) should be roped off to prevent contamination of shoes, clothing, etc., and also direct hazard to personnel.

After solution of the slug, the volume will be made up to about 15 liters by adding water and testing for the level by a bubbling technique (to be worked on). The gas lead into the dissolver and the acid and gas vent leads will then be disconnected, and a gas lead connected to the inlet side for pumping up the solution. It is estimated that 30 lbs. pressure will be needed to pump the solution up into the pile. The tubing to be used in the pile will be saran tubing, 3/4" O.D., 1/2" I.D. arranged in 4 layers, 4 strings per layer. Under the present design, around 1/3 of the tubing will be outside of the pile, or roughly 1/12 of the total activity will be distributed at each face of the pile. At the foot of the tower it is estimated that the working time for a tolerance dose (.1R/day) will be the order of one hour, but will be considerably more dangerous in close proximity to the saran tubing, once the solution is pumped over. Some control will have to be exercised over personnel working near the pile once the solution is in place.

The plan for transferring the solution to the H.E. pile is to evacuate the saran tubing and force the solution out of the lead by applying pressure above the liquid in the dissolver until it fills the saran tubing and enters a glass sighting tube under observation through a telescope. A valve will be provided in the lead-out which will then be closed from behind some concrete protection. In case of need, this valve can be opened and the liquid returned to the dissolver.

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The 100 Ton Shot Preparations(Continued)

Following is a list of the major equipment which will be required to carry out the operations mentioned:

1. Two motor generators to supply 5 kw each for heating equipment and other electrical apparatus.

2. A steam generator for bending the saran tubing.

3. Eight large cylinders of N_2.

4. A 4-ton crane for lifting heavy shielding, etc.

5. Possibly a centrifugal air blower for diluting the radioactive gases.

6. Saran tubing (3/4" O.D., 1/2" I.D.) for leading away active gases and for holding the solution. 3000 ft. of tubing and connectors will be ordered.

7. Lead bricks for shielding the dissolver. 3-1/2 tons of 8" x 4" x 4" and 1-1/2 tons of 8" x 2" x 2" (bricks will be ordered).

8. Forty tons of concrete blocks, 1' x ½' x ½' (density 3) for shielding.

9. Two megavac pumps.

10. 200 lbs. conc. HNO_3.

11. 100 lbs. dry ice.

12. Three large variacs.

13. 50 gallons distilled water.

14. 1000 ft. lead pipe.

There are many other small items not included which will be sent to the site in the course of the experiment.

The following schedule of operations is contemplated at Trinity. Dummy runs will be made in the period April 23 - May 1, in which the dissolving and the subsequent pumping operations will be tested. The dissolving of the irradiated W slug and filling of the tubes in the H.E. should take place in the period May 1 - May 3.

(B) Modification of M4 Tank for Sampling

Lead Protection - It is anticipated that the radiation in the active area after the gadget shot may be of the order of 100 R/hr. In order to remove samples from areas where the radiation level is of this order, an M4 tank is being fitted with lead protection so that the observer and driver will receive about 1/50 of the radiation outside the tank. A total of 11,000 pounds of lead will be installed by the plumbing shop; they have completed about half of the job at this writing.

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The 100 Ton Shot Preparations (Continued)

Air Supply - Clean air will be supplied to the observer and the driver by means of compressed air tanks mounted externally above the engine hatch. Four tanks will provide 660 cu. ft. of air, enough for 2-1/2 hours for the two men. This air will be supplied to the men through lucite window pressure masks and will provide positive pressure protection against inhaling of radioactive dust, especially dust containing plutonium.

Sampling - Sampling will be done by hand through a 2-3/4" hole in the floor of the tank. A variety of hand sampling devices will be tried at the 100 ton trial. These include a post auger, a barrel auger, and a core drill.

In the final shot it is anticipated that difficulty will be encountered in maneuvering the tank in the crater where the depth of loose earth exceeds about two feet. It is also likely that the radiation near the crater may exceed the safe level.

An effort is being made to have ready for trial the rocket sampling device suggested by Roger Warner. This device is being prepared at CIT and consists of a sampling tube and core catcher attached to the nose of a rocket. A steel cable remains attached to the rocket to facilitate recovery. Before launching, the cable is wound on a special beg board reel which minimizes drag on the cable while the rocket is in flight. The rockets will be launched from a skid towed by the tank. Their range will be about 200 meters.

Tank Failure - Provision must be made to rescue the men in the tank in the event of failure in a very intense radiation field. Two tanks are available and these will be coupled to each other with a 100 foot steel cable. In the event of failure of one of the tanks, the other will be able to drag it to safety.

Radiation Meters - Samples will be removed only from areas where the level of radiation is sufficiently high so that easily measurable amounts of radioactive substances can be expected to be present. In general this means that the level of radiation should be of the order of 1 R/hr. or more. Two radiation meters will be placed under the tank for a continuous reading of the local intensity. A third radiation meter will be arranged so that it can be inserted in the hole made by the core drill to explore possible stratification of the radioactivity. A radiation meter will be installed on the side of the tank to give the general radiation level outside the tank. Finally, radiation meters will be provided in the observer and in the driver compartments to give the radiation level to which the men are being subjected. Extension leads to the external meters will be provided so that all readings and adjustments may be made from a panel in the observer's compartment. For the final shot the range of the external meters must be from .1 R/hr. to 100 R/hr.; the internal meters from 0.01 R/hr. to 10 R/hr. Dick Watts is modifying his standard direct reading ionization meters for external mounting; the chamber which is to fit in the core hole is yet to be designed and will probably not be ready for the 100 ton shot. The other meters will be the conventional health models.

For the 100 ton shot the radiation intensities will be about 500 times smaller than for the final shot so that the meter sensitivities will have to be considerably greater. Some makeshift arrangement may be required here.

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Observation - The driver will use the regular tank periscope for visual observation. The observer will be provided with a special wide angle periscope, the plans for which are still in the drafting room. This periscope is provided with 360° motor driven rotation.

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Communication - Driver to observer communication will be by telephone. The observer will be able to communicate with the base station or to mobile vehicles via Motorola radio receiver transmitter sets. Throat microphones will be required to allow the men to communicate without removing their masks.

Location of Tank Position - The position of the tank will be determined by visual observation using standard surveyors transits installed on top of the 10,000 yd. concrete shelters at points A and P. Preliminary surveys will delineate a grid over the active region so that position of the tank will be uniquely determined directly from a pair of angles measured with the two transits. At Trinity the definition at 10,000 yds. is somewhat reduced due to the heat waves which appear above the ground. It will be necessary to mark the tank in such a way that it can be clearly distinguished at this distance. No satisfactory way to determine rocket sampling positions has been worked out.

Helicopter for Sampling - Most of the difficulties and limitations of the tank method for sampling can be overcome by using a helicopter. For flight at 200 meters the men in the helicopter receive about the same radiation intensity as the men who are shielded in the tank. Since the sampling time is shorter using the helicopter, the total dosage can be much less. It is doubtful, however, whether a helicopter will be on hand for the 100 ton shot.

(C) Measurements for 100 Ton Shot

The 100 ton shot is expected to displace about 500 cubic meters from the crater. On the basis of the Ra-La experience, about one-tenth of the active material may be mixed with this debris and this may be spread over an area of about 70 meters radius. Since the crater will be clean swept, no considerable accumulation of dirt inside are anticipated and for the most part the debris will be in the form of a layer an inch or two thick.

The Hanford slug is expected to have 300 γ curies and 900 β curies of activity. With a counting efficiency of 30% the gross beta counts per minute per gram of dirt will be about 7.2×10^4. In the table below is listed expected average β counts per minute per gram of sample for the several fission products and of plutonium.

Element	Half Life	Fraction of Total Curies	Beta c/m gm. of sample
Cb	35 days	.2	14,000
*Zr	65 days	.15	11,000
Y	57 days	.12	8,600
*Sr	55 days	.11	7,900
*Ce	28 days	.11	7,900
*Ru	40 days	.054	3,900
*Ce	340 days	.056	4,000
Pr	13.5 days	.033	2,400
*Ba	12.5 days	.030	2,200
Te	32 days	.0084	600
*Ru	330 days	.0055	400
*I	8 days	.0025	180
Sr	30 years	.0025	180
Cs	36 years	.0017	120

	Alpha c/m gm. of sample
*Pu	6
Pu spiked with additional 10 gm. Pu	80

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The 100 Ton Shot Preparation (Continued)

Sugarman plans to carry out chemical extraction on the plutonium and on all the fission products asterisked. In this way fractionation effects will be studied and practice with chemistry will be afforded.

The whole active area will be surveyed with portable radiation meters. The average radiation will be about .01 R/hr. which will be easily measurable with our portable radiation meters.

About twenty dirt samples will be taken along two radii at right angles to one another. These will be used in the chemical analysis. In addition about twenty samples will be taken to explore variations of activity with depth of the debris. Gross β and γ activity measurements will be made from pressed plaques of these samples using the Geiger counting sets as well as the ionization chamber. The activities obtained will be compared with that from an aliquot of the original active solution so that a fairly reliable estimate of the fraction of activity which falls on the ground and its distribution will be obtained.

(D) Laboratory Facilities

The counting laboratory at Trinity will have two Geiger counting sets and one ionization chamber connected to a vibrating reed electrometer. These will be used to measure the gross β and γ activity of samples of dirt. A hydraulic press will be used to press these dirt samples into uniform plaques for measurement.

A fast alpha counting set will be used to study the alpha activity of the earth using a thin layer technique.

The fission product analysis of the dirt samples from Trinity will be carried out in the chemistry laboratory being readied in Y Building. The analysis for plutonium will probably be done in Segre's extention to H Building, which has been made available for this work. The counting of α and β activities will be done in M Building where a counting room has been completed and apparatus is now being installed.

H L Anderson

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TR Distribution List

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