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Report on Discussion of Pinex Experiment with J-12 Group at Los Alamos

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Lawrence Livermore National Laboratory

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REPORT ON DISCUSSION OF PINEX EXPERIMENT WITH J-12 GROUP AT LOS ALAMOS

by

E. Boyrie, A. Chesterman and A. Clark

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Current plans for UCRL participation in Operation Hardtack include performance of a Pinex experiment on three barge-based events: Nutmeg, Hickory, and Juniper. The J-12 group at Los Alamos has been planning since last June for a group of similar experiments. Inclusion of Pinex in the UCRL Hardtack diagnostic program occurred considerably later; also, J-12 has successfully carried out two Pinex experiments during Operation Plumbbob. This visit was made to take the fullest possible advantage of their experience to date.

We talked with Lee Aamodt, Wendell Biggers, and Leon Brown of J-12, and Avery Bond of J-7. Discussion of the experiment at these meetings is summarized under five convenient headings:

1. Detector
2. Pinhole and Collimator Assembly
3. Alignment
4. Data Analysis
5. Recovery

1. Detector

The basic detector design evolved by the J-12 group for the barge shots is a heavy steel "pig" twelve inches in diameter, within which the stack of samples forming the "film" in this pinhole "camera" is enclosed.

The assembly is diagrammed on the following page.

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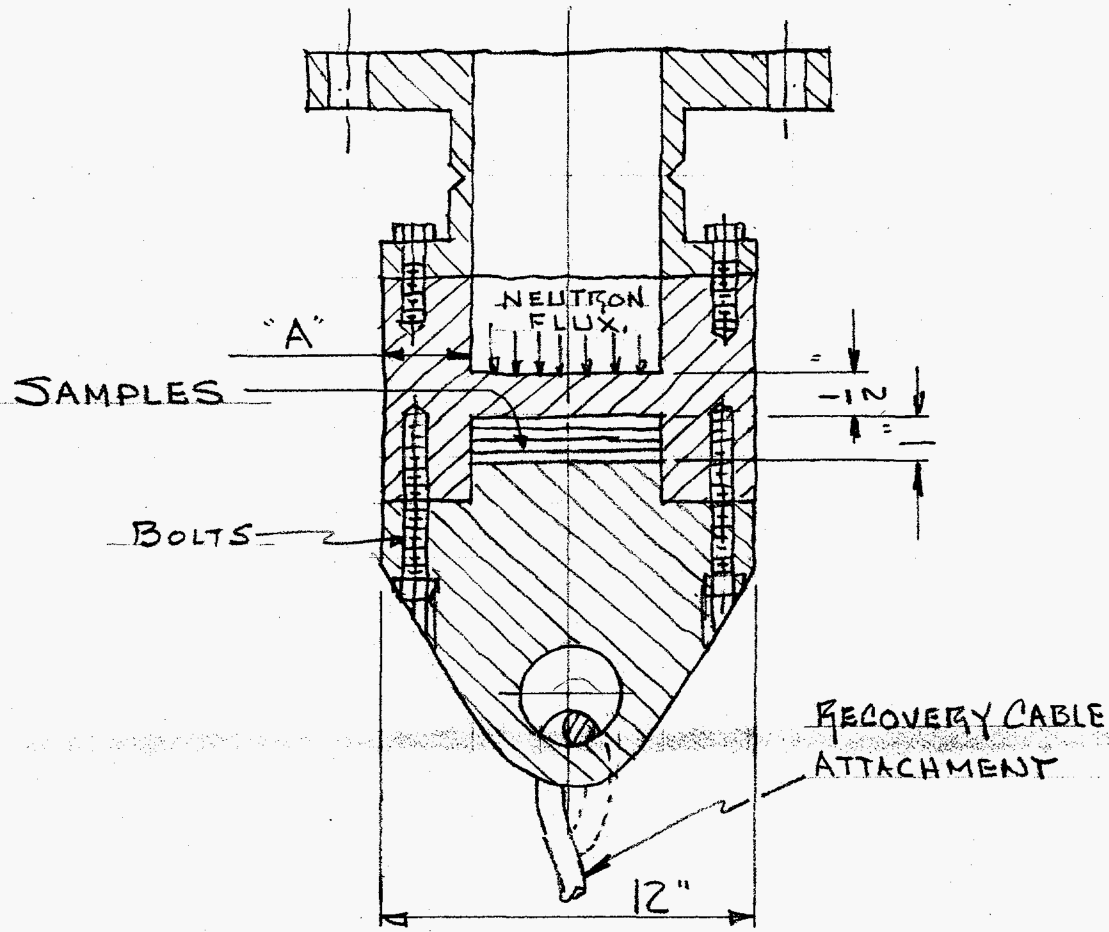

There are two variations of this design of interest to us. In one case, the sample area is a six-inch diameter circle; this is suitable for use in Nutmeg and Hickory, where a comparatively small source is being observed. The other has an approximately rectangular 4 x 10-inch area, more suitable to the 1 x 8-inch detector field called for in the Juniper event. The sample stack is secured into the detector assembly as indicated in the diagram. The half-inch layer of steel in front of the samples is designed to protect them from shock; it is believed that this thickness is a reasonable compromise between the need for such protection and the resulting interference with the neutron flux.

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Making a suitable allowance (see section 3) for possible misalignment of pinhole and detector, it appears that the ten-inch sample dimension is sufficient for the desired Juniper experiment coverage, so no alteration of the ten-inch LASL design is contemplated. Reduction of the thickness of the peripheral steel ring (dimension A in the diagram) so as to enlarge the sample is considered undesirable.

The recovery cable is attached to the rear of the detector assembly with a clevis and pin arrangement in the current design. It was agreed that a more direct means of cable attachment may be preferable-- the arrangement should be such as to minimize shearing action due to different accelerations imparted by the arriving shock. (See section 5)

Drawings of the two detector assembly types as presently conceived are being made available to expedite design work in Livermore. The detector assemblies are a user-furnished item which we must provide for our experiments.

An inch of thickness is available in this detector for the stacking of samples. J-12 expects that their stack will include, but probably not be limited to, a quarter-inch layer of zirconium for analysis by counting, and two 1/32" layers each of zirconium and aluminum, for analysis with film (radiography). Thirty-mil thicknesses of cadmium will be placed at the top and bottom of the stack to absorb thermal neutrons. Also being considered for use are sulfur (in some plastic carrier) and gold; gold would probably require an extra layer to absorb thermal neutrons and avoid obscuring the activity due to the threshhold reaction. The 1/4" zirconium sheets should be slit at four-millimeter intervals in both directions, leaving about 1/32" thickness; the individual pieces can then be readily separated for counting.

Activiation of sample materials is to be calibrated experimentally by exposure to a known 14-Mev neutron flux in a Cockcroft-Walton machine, so as to verify effective activation cross-sections and corresponding initial counting rates, and determine what photographic emulsions and processing procedures are appropriate (see section 4 on data analysis). Use of sources such as sodium 22 as secondary calibration standards in the field was suggested; a step-wedge absorber might be of additional assistance in calibrating beta-radiation effects.

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It was suggested that the sample stack be enclosed in a plastic envelope for pre-shot protection. Binding the sheets together with a material such as epon was discouraged because of the difficulty in separating them.

2. Pinhole and Collimator Assembly

These are also user-furnished and must be constructed at Livermore. A 55-mil diameter pinhole, around which LASL has already designed a complete assembly, will give the two-millimeter resolution desired by B-Division, with a field of view large enough for use in the Nutmeg and Hickory experiments. For Juniper, modification to provide slightly larger collimator divergence angle will be necessary to provide the field of view now called for. Drawings of the LASL assembly are being obtained; their design includes an unsymmetrical rear end at the collimator to divert possible jetting action caused by blowin to one side of the detector.

Holmes & Narver is providing the stands upon which J-12's pinhole assemblies will rest; we plan to make the same request. Sandbag shielding of the assembly in position for a distance of five feet axially and three feet radially was suggested.

Gold is being used as the pinhole insert material because it is easily machined; other possible materials do not appear to offer enough additional opacity to justify a change. The 2 3/4" pinhole length is at least one 14-Mev neutron mean free path. The stepped design of the collimator is felt to have an edge over a tapered hole both as to ease in fabrication and perhaps in minimizing surface blow-off. Non-circular pinhole shapes have been considered by J-12 but have been dropped from Hardtack plans.

3. Alignment

The collinearity of the desired point on the device case with the collimator and detector center will be verified by observing from the device a light placed at the detector. A high-intensity lamp manufactured by OSRAM has been found useful for this job. The pinhole assembly can be moved as necessary until it is in position. Next, the angular alignment of the pinhole assembly is checked by observing on a ground glass or by eye the diffraction patterns due to each end of the collimator as seen at the upstream end. When these patterns are concentric, the collimator axis coincides with the previously established line from the device through the pinhole to the detector. Some minor design work may be needed to provide suitable mounting arrangements for the alignment gear. J-12 now speaks of angular alignment accuracy of one part in eighteen hundred as being attainable with reasonable effort. Provision for moving the device a few inches in the plane normal to the pipe will be needed for Sandpiper.

Deck motion due to daily temperature cycling has been estimated at half an inch; presumably relative displacement of the Pinex components would be a comparable amount. Similar displacement due to flexure of the barge is expected to be mainly in the vertical direction and limited to about one inch. Both these effects are thus expected to be of roughly the same magnitude as the nominal alignment error associated with this method of measurement. Thus the detector sizes appear to be adequate to keep the device image on the detector surface.

Horizontal orientation of the device for the Juniper event should minimize the risk of image loss due to barge motion; no shielding is required at the device on account of the Pinex experiment. Substantial design elaborations, such as a proposed addition of hinge-and-knife-edge mounting of the pinhole assembly to decouple from barge motion, are felt to be infeasible at this late date.

It is planned to pressurize the Pinex pipe with two atmospheres of helium as a precaution against underwater leakage.

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4. Data Analysis

The stack of samples in the detector will be such as to provide for analysis by both counting and radiographic techniques. UCRL will do its own radiographic work; at LASL, Frank Berry of the Graphic Arts group is responsible for developing this method. Suitable emulsions and film processing techniques will be selected as calibration procedures are developed at both laboratories.

A suggestion was previously made that LASL might handle the counting of our samples in addition to their own. However, they are undertaking a very extensive program of Pinex experiments, concentrated in the month of May (not considering schedule alterations), such that availability of their counting equipment for our use cannot be guaranteed, particularly after Hickory. The question as to whether or not it is advisable to provide counting equipment of our own is under consideration. If LASL's counting facilities are utilized, J-12 is to be contacted in the field and the samples put aboard a flyaway immediately after recovery. Our counting sample should conform to LASL plans; hence the specification of four-millimeter squares in the quarter-inch zirconium sheet as mentioned in section 1.

Accuracy of the two methods of data analysis was estimated at three percent for counting and five to ten percent for film.

It appears that analysis by counting is most likely to be needed in the case of a very late recovery, such that activities have dropped too low to blacken film emulsions satisfactorily. Lee believes it likely, with our zero point located in a shot crater, that if recovery is not accomplished "on schedule" it will not be made at all -- that there is not much chance of recovery by diving or dragging.

5. Recovery

J-12 plans to lay out several hundred yards of cable to a marker buoy, and take this aboard a T-boat equipped with a winch; divers from Scripps Institute are expected to be available in case the detector assembly becomes parted from the cable or the cable is fouled. There

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may be a similar winch, with a capacity of fifteen hundred yards of one-inch cable, available for loan to UCRL for recovery operations. Lee anticipates that the location of our events in a shot crater will give rise to persistent poor visibility and high radiation levels after each shot, and prevent the divers from giving us effective recovery assistance.

As mentioned in section one, the cable connection to the detector may be modified. Several possibilities were discussed: lead two or three cables away from the pig in different directions, run the cable in a spiral, use nylon instead of steel for cable, eliminate the proposed anchor block on the bottom, etc. At present (December 27) we are proposing simply to thread a single loop of the one-inch steel cable through a two-inch hole straight through the pig, and run this loop directly to the buoy; this will be reviewed with Lee by telephone, and compared with any changes in their detector pig design.

Comment was made on the fact that we have only a few (about eight) feet of water between the detector assembly and crater bottom, because of some uncertainty as to where the detector will go after the shot. It might conceivably be driven into loose sand with considerable force, or, on the other hand, move with the water surrounding it and be thrown a considerable distance. The LASL Pinex barges will be moored almost half a mile from shore, in water about five fathoms deeper than the Tare anchorage, so they are less concerned about the possibility of having their detector buried. We can investigate the feasibility of moving the barge to deeper water (limitations imposed by other diagnostic programs may prevent this), or seek reassurance concerning the shallow anchorage from theoretical considerations. Gene Pelsor believes that the pig is not likely to be thrown farther than something like twenty feet, and that it will tend to settle to the bottom rather than be propelled there. LASL Pinex design involving shock effects is being based largely on data obtained from Sandia's Peacepipe experiment conducted during Operation Plumbbob.

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Separation of the detector assembly from the main pipe is expected at a point just above the detector , where a deep V-groove is cut in the pipe. Shock traveling through the air above the barge, and reaching the detector ahead of the shock coming down the pipe, is expected to provide a downward force that will snap the pig off and send it toward the bottom.

"Gimmicks" might be added to the detector assembly to aid the recovery crew in locating it; for instance, a supply of yellow marker dye released slowly into the water has been suggested. We also can run a cable ashore (six hundred feet) for recovery from that point if it appears that this could increase the probability of detector recovery.

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