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HEADQUARTERS
TASK GROUP 7.1
JOINT ASKD FORCE 7
Los Alamos, New Mexico

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APPENDIX I
to
CLOUD SAMPLING REQUIREMENTS FOR CASTLE (u)

1. Introduction

The collection of samples of airborne radioactive debris from the cloud resulting from the explosion of a test weapon or nuclear device is of the greatest value to the weapons development program. These samples support critical radiochemical measurements which provide an absolute determination of the yield or energy release of the weapons is one of its most important characteristics.

In order to permit timely action for their support, the following requirements for manned aircraft to accomplish cloud sampling on CASTLE are submitted. These requirements are based largely upon IVY cloud sampling experience and results. They are supported by the fact that the amount of radioactive material collected by a sampling aircraft is quantitatively and directly proportional to the performance of the filter device used, to the speed performance of the aircraft, to the radiation exposure of the sampling personnel, and to the extent of radioactive decay which has occurred after burst by the time sampling is performed. The largest possible sample for a fixed biologically acceptable radiation exposure will be obtained by use of the highest possible performance filter device, and a high performance aircraft which samples as long as possible after burst as is consistent with cloud dispersal phenonmena. As a result of IVY and Nevada test experience, it is possible to state the sample sizes required for the CASTLE devices in terms of the radiation exposures and equipment performance used in the past. Further reduction of IVY data and development of operational concepts may modify, to some extent, the requirements submitted herein.

2. Sample Requirements

a. Number

Six primary samples are desired of each of the six devices tested. One special sample at highest possible altitude is desired, in addition to the primary six, for at least four of the six devices.

b. Size

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The size of each primary sample will be satisfactory when each represents the amount of material collected on seven to eight square feet of special filter paper by filter devices which have a performance equivalent to the Fletcher wing tip type used on IVY, when the sampling pilot exposure on landing is 3.5

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roentgens, when an aircraft with a speed of at least 0.8 mach is used, and when sampling is performed later than two hours after shot time.

c. Collection Times

As mentioned in paragraph 1, the amount of radioactive material collected for a fixed pilot exposure (3.5R total) increases with how much radioactive decay has taken place by the time sampling is performed. Opposing delay in sampling is the risk of failure which increases as cloud dispersal takes place according to the effects of the vertical velocity gradient and angular shear of the wind structure in the region of the desired altitudes. For Mike Shot on IVY a slow rate of cloud dispersal due to a favorable wind structure permitted successful sampling as late as six hours at about 47,000 feet true altitude, while for King Shot that portion of the main body of the cloud which lay between 38,000 and 48,000 feet dispersed so rapidly that sampling at these altitudes was ineffective three hours after shot time. Later samples had to be collected at lower altitudes where the wind structure did not disperse the cloud so rapidly. Although dispersal effects can be estimated from the wind structure predicted for shot time, a wind structure which is predicted to be unfavorable may not offer a very powerful argument for a change in shot schedule. In order to achieve maximum sample sizes, operational planning for CASTLE cloud sampling should be based on actual cloud penetrations conducted in three phases over the following appropriate time intervals:

1st phase: H≠ 2:00 to H≠ 3:00 Hours
2nd phase: H≠ 3:00 to H≠ 4:00 Hours
3rd phase: H≠ 4:00 to H≠ 5:30 Hours

These times are chosen on the basis of favorable cloud dispersal and radiation intensities as the minimum times to reach an in-cloud radiation exposure equivalent to a total exposure of 3.5R on landing. In the event of unfavorable wind structure, the first flight will certainly collect the desired samples, the second will probably do so, and if necessary the third can be flown at other, possibly lower, altitudes where the cloud persists longer. On the basis that the above minimum time for the third flight may frequently be insufficient under operational conditions, a longer flight time would be desirable. Since cloud dispersal appears to be less rapid at 50,000 feet or above, a higher altitude would also be desirable for this flight, if this were possible. An alternative to the above schedule, in the event of an extremely unfavorable wind condition, would be to start to obtain all samples at not later than two hours after shot time and to sacrifice a possible increase in sample size.

d. Collection Altitudes

The degree to which a sample is representative of the total bomb debris is normally found to depend on how far below the main cloud mass it is collected. For this reason, it is desirable to collect samples either in the main cloud mass or as close to it as possible. For bombs with yields up to 500 kilotons, and perhaps to 1000 kilotons, satisfactory sampling of the main cloud mass can be achieved at altitudes up to about 45,000 feet true (usually not lower than 35,000 feet except for very small yields) on tests conducted at the Eniwetok Proving Ground where the mean tropopause height is about 55,000 feet. For the higher yields of the really "super" devices the desirable sampling altitude should be at least 55,000 feet to permit collection of material more representative of the main cloud mass.

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On CASTLE it is desired that the six primary samples be collected at an initial altitude of 42,000 feet true and a final altitude of at least 47,000 feet true over the time intervals mentioned in paragraph 2c.

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It is, therefore, desired to obtain a single special sample on each of the four high yield CASTLE shots from as high into the main body of the cloud as possible and to check the representativeness of the lower altitude samples by comparison with it. This special sample should be collected at least 55,000 feet true at about H+4 hours and should require a flight time at 55,000 feet of approximately one-half hour in the sampling area in order to make one or two cloud penetrations. Unless samples from lower altitudes prove by this comparison generally to be as representative as the high altitude sample, it would be desirable on "super" shots after CASTLE to collect as many of the primary samples as possible at altitudes of 55,000 feet or higher. As mentioned in paragraph 2c, the apparently lower rate of cloud dispersal above 50,000 feet would make such a capability serve the additional purpose of making it possible to plan to sample between 4 to 6 hours after shot time with a greater probability of success when unfavorable wind conditions exist at lower altitudes.

3. Operational Requirements

a. Aircraft

1. Sampling aircraft are required to provide the six primary samples and the special sample described in paragraph 2a. The aircraft for the six primary samples should have the flight time capabilities in the vicinity of the cloud stated in paragraph 2c and corresponding altitude capability stated in paragraph 2d. In order to minimize exposure during return to base, these aircraft should use axial flow engines with turbine and air intake located not less than ten feet from crew compartment. They should have a speed performance of approximately 0.8 mach and be capable of carrying high performance filter devices. These devices should be equipped with rainproof valves and with a sample radiation measuring instrument to be read in the cockpit. Their location on the aircraft and the design of the filter element should minimize crew radiation and permit safe removal of the intensely radioactive materials collected and the transportation of these materials. The design of the filter element should also be integrated with requirements based on laboratory handling operations. All air entering the crew compartment for heating, ventilating and pressurization purposes should be filtered to prevent the entrance of radioactive cloud particles. Los Alamos Scientific Laboratory also has a general requirement that the sampling aircraft be capable of carrying gas sampling equipment. As a result of a cooperative arrangement it is expected that details regarding this requirement will come from another agency. It retains, however, the greatest importance to this laboratory.

The special sample aircraft should have the altitude and flight time characteristics in the cloud vicinity stated in paragraph 2d. Its speed and engine type may be whatever is required. For a medium speed aircraft, it is suggested that the "shoe-box" type filter device developed by Tracerlab, Inc., for AFOAT-1 be adapted for use. If a higher speed jet-type aircraft is used (0.8 mach), it is suggested that a filter device similar to the type used on IVY be developed within the shape of the wing tank used on the aircraft. The air entering

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the crew compartment on the special aircraft should likewise be filtered.

2. Scientific Control Aircraft

The presence of scientific program personnel in the cloud vicinity during the operation is essential to provide technical guidance and evaluation of the radiation hazard in terms of cloud structure for the sampling aircraft. On the basis of the observed development of cloud structure, they locate and follow the position of sections of the cloud most likely to contain significant samples, and assist the performance of the sampling mission by vectoring the sampling aircraft to these locations. They also operationally control the total radiation exposures of the sampling pilots according to the relative readings of the radiation instruments relayed to them on the completion of a cloud penetration. Although one of these personnel will be a rated aircraft director, they are not directly responsible for the safety of flight operations or the direction of aircraft to and from the general sampling area, although they may assist in the latter activity. In order to permit these personnel to function effectively, an aircraft is desired with the following general requirements:

(a) Position: In the immediate vicinity of the cloud from zero time to the conclusion of sampling operations.

(b) Altitude: An initial true altitude of 35,000 to 40,000 feet with capability of climbing to 45,000 feet as required by the cloud structure.

(c) Speed: To minimize navigation and vectoring problems a medium speed is desired.

(d) Endurance: Capable of remaining aloft for ten (10) hours.

(e) Personnel: Maximum of three (3) scientific personnel aboard, one of whom will be a rated aircraft director.

(f) Communications:

(1) Two installed 8 channel VHF systems with suitable spares.

(2) One HF liason set.

(3) One low frequency homer designed for continuous operation with sufficient power to permit approximately a 200 mile ranging capability under operational conditions.

(g) Navigation: Capability of continuous absolute aircraft positioning to within five miles.

(h) Special Personnel Equipment: Space in the aircraft for scientific personnel should be located to permit direct contact with pilot and should be provided with interphone and oxygen outlets to permit movement necessary to observe the cloud as required by the aspect of the aircraft relative to cloud. If not otherwise provided, means should be made available to keep window areas used for observation clear of frost.

(i) Back-up: A suitable back-up is required. An aircraft which participates in other test operations may be used as a back-up, provided that it has similar capabilities and can be made available throughout the sampling operation.

b. Radiation Instruments:

Airborne radiation instruments are required to permit operational control of radiation exposure within biologically acceptable limits and to warn

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pilot personnel of hazardous radiation intensities which might exist. The performance of these instruments is critical to the success of the mis- the radiation safety of the pilot and the operational guidance of the a determined by their relative readings. It is desired that the Air Task vide the necessary personnel and dehumidified field facilities for the st calibration, pre-flight test and maintenance for these instruments and the ated electronic circuitry in the aircraft.

1. Radiation Exposure Dosimeter (Integron)

With thorough pre-flight tests and calibrations the "integron," developed for IVY by LASL proved to be satisfactory for the operational control of exposure. This unit is electrically self-contained. If F84G aircraft are used, its position should be changed to a location nearer the pilot than was used on IVY.

2. Sample Radiation Intensity Meter (Wing Tank or Chamber)

The radiation rate from the sample which is measured instantaneously by an ionchamber in the right wing tank was found in IVY to provide very valuable immediate information on the effectiveness of a sampling aircraft during its sampling mission. This instrument requires 28 volt DC and 115 volt, 400 cycle AC power from the aircraft as well as suitable wiring between the cockpit and wing tank. Experience with the electrical leads and connectors supplied in IVY F84G aircraft indicates that the circuitry for this instrument must employ water and moisture proof cables and connectors in order to avoid serious functional difficulties arising from the salt-moisture conditions typical of tropical marine climates. If the IVY F84G's are used in CASTLE it is desired that all wiring and connectors be replaced as required to assure reliable performance at Eniwetok.

3. Cockpit Radiation Intensity Meter

This rate meter measures the cloud radiation intensity and guides the pilot in the performance of the penetrations. It also controls the total radiation exposure and duration of sampling by measuring the background radiation intensity acquired by the aircraft as a result of surface and engine contamination. As a result of lack of tropicalization and ruggedness the IRM-72 (Jasper) supplied for use on IVY proved to generally unsatisfactory. It is suggested, therefore, that the Jasper be replaced by a more suitable instrument which is more rugged, is tropicalized, and otherwise meets the specifications established for the Jasper before IVY.

c. Pilot Radiation Protection

Experience in IVY indicated that personnel shielding of nominal lead equivalence provides a significant radiation protection even for gamma radiations from a pure fission device. Although the personnel shielding equipment provided by the Air Task Group for IVY was effective, its cumbersome nature appeared to give rise to psychological difficulties incident to emergency exit or bailout from the aircraft. It is suggested, therefore, that this equipment be redesigned for CASTLE to achieve simplicity and safety and that it be used particularly on tests of devices in which tuballoy is a major constituent and from which a high flux of soft gamma radiation can be expected. It should be

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mentioned that even the 30% reduction found for fission bombs is valuable in case of a high accidental overexposure which might occur if a pilot made an early penetration and chose a poor escape path from the cloud. It is desired that the LASL be consulted regarding the redesign of this shielding.

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