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Bibliography, with Abstracts, of Reports of Nuclear Defense Laboratory and Its Predecessors (U)

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by

Burton J. Conway

January 1962

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NUCLEAR DEFENSE LABORATORY

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BIBLIOGRAPHY, WITH ABSTRACTS, OF REPORTS OF NUCLEAR DEFENSE LABORATORY AND ITS PREDECESSORS (U)

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EA-SRD-259(?)

FOREWORD

This study was conducted under Task 4N12-01-001-06, Evaluation of AW and RW Information. The compilation was started in August 1961 and completed in October 1961.

Acknowledgements

Bibliographies were prepared in 1955 by H. J. Snell and D. S. McClelland and in 1958 by R. J. Smith. Abstracts of reports which were published prior to May 1958 are presented here as they appeared in the previous bibliographies.

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DIGEST

This bibliography presents abstracts of all research reports published prior to October 1961 by the U. S. Army Chemical Corps Nuclear Defense Laboratory and its predecessors, reports prepared by NDL personnel and published by other agencies, and reports resulting from research conducted under contract to this Laboratory. It supersedes CRLR 413, Bibliography, with Abstracts, of Reports of Radiological Division, Chemical and Radiological Laboratories (U), and CWL SP 3-5, Bibliography with Abstracts of Radiological Division reports from May 1954 to May 1958 (U).

Included in this report are abstracts of Technical Command reports (TCR) prior to 1951; Chemical and Radiological Laboratories reports (CRLR) from 1951 to 1956; Chemical Warfare Laboratories reports (CWLR) from 1956 to September 1960; U. S. Army Chemical Corps Nuclear Defense Laboratory reports (NDL) from September 1960 to October 1961; Technical Memoranda (TM) from November 1957 to October 1961, Interim Test Reports (ITR) and Weapons Test Reports (WT) to October 1961. A subject index and an author index are also included.

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BIBLIOGRAPHY, WITH ABSTRACTS, OF
REPORTS OF NUCLEAR DEFENSE LABORATORY AND ITS PREDECESSORS (U)

I. (U) INTRODUCTION.

This bibliography presents abstracts of all research reports published prior to October 1961 by the U. S. Army Chemical Corps Nuclear Defense Laboratory and its predecessors, reports prepared by NDL personnel and published by other agencies, and reports resulting from research conducted under contract to this Laboratory. It supersedes CRLR 413, Bibliography with Abstracts of Reports of Radiological Division, Chemical and Radiological Laboratories (U), and CWL SP 3-5, Bibliography with Abstracts of Radiological Division Reports from May 1954 to May 1958 (U).

The name of the sponsoring organization has had several changes over the years which is reflected in the report numbering system. Prior to 1951, reports were sponsored by the Radiological Division of Technical Command and are numbered in the TCR (Technical Command Report) or TCIR (Technical Command Interim Report) series. In 1951 the name of the parent organization was changed from Technical Command to Chemical and Radiological Laboratories, and until 1956 all reports were of the CRLIR (Interim) and CRLR series. In December of 1952 the designation of CRLIR reports was abandoned and a subdesignation was used thereafter to indicate the type of report, whether formal, interim, final, engineering, foreign material or special. These subdesignations are used on all CRLR reports after December 1952. In 1956 the name of the sponsoring organization was changed from Chemical and Radiological Laboratories to Chemical Warfare Laboratories. Reports of the Radiological Division during the period from 1956 to September 1960 are numbered in the CWLR series. In September 1960 the Radiological Division of the U. S. Army Chemical Warfare Laboratories became a separate organization and changed its name to U. S. Army Chemical Corps Nuclear Defense Laboratory. Reports published after September 1960 have numbers designating technical reports of the NDL-TR series and technical memoranda of the NDL-TM series.

Formal reports are written to form permanent records of technical investigations, their data, and conclusions, and serve as a basis for executive action. These reports have a relatively wide distribution outside the Chemical Corps. Special reports are useful for the prompt transmission of urgently needed information. Their conclusions are tentative and subject to revision, and the projects under which the work was done are continuing. Technical reports are intended primarily for scientific use. These reports provide a permanent record of research and development investigations and a source of information for management of the research and development program. Technical memoranda are intended primarily as operational aids and are designed for limited dissemination of technical information for temporary use.

The weapons test (WT) reports prepared by the Laboratory for the Defense Atomic Support Agency (DASA) and its predecessor the Armed Forces Special Weapons Project (AFSWP) are originally issued as interim test reports (ITR), which are preliminary reports. The final test reports are issued with a WT number. In some cases the ITR and the WT reports are both listed. Sometimes final drafts of the WT reports have also been issued as CRLR's or CWLR's.

II. ~~(S-RD)~~ TECHNICAL COMMAND INTERIM REPORTS.
(TCIR)

TCIR - 507 - SYNTHESIS OF RADIOACTIVE METHYL IODIDE, I^{131} LABELED.
Jess W. Thomas, Phyllis Beamer, and E. Harry Bouton,
1 March 1950. UNCLASSIFIED

(U) A method is presented for the synthesis of radioactive methyl iodide, to be used later in tests of Standard Canisters V, VII, and VIII. The synthesis was conducted using inert sodium iodide dissolved in a radioactive sodium iodide solution, and inert dimethyl sulfate. The radioactive methyl iodide product of two runs was diluted with inert methyl iodide to provide concentrations of radioactive material suitable for further investigation. These end products were essentially chemically pure, and the radiometric efficiency, or ratio of radioactive product to radioactive input, was determined as 92% and 84%, respectively, for the two runs.

TCIR - 508 - DETERMINATION OF RADIOACTIVE METHYL IODIDE (I^{131}) IN AIR.
Jess W. Thomas, E. Harry Bouton, Phyllis Beamer,
Eugene E. Grassel, and Elmer H. Engquist, 1 March 1950.
CONFIDENTIAL

[redacted] The purpose of this study was to develop quantitative methods for the determination of radioactive methyl iodide in air, the ultimate objective being the standardization of test methods for gas mask sorbents. It was first established that an acetate-bromine absorber satisfactorily removes inert methyl iodide from a gas-air stream. It was then determined iodometrically, that the efficiency of the absorber, is not a function of the gas concentration, at least within the 0.02% to 12.5% limits of these tests. Complementary studies were made using radioactive methyl iodide prepared as described in TCIR 507. Aqueous sodium acetate was added to the absorbed methyl iodide, and the radioiodine precipitated as silver iodide, a nonvolatile material suitable for counting.

It was concluded that additional study of the preparation of radioactive samples is necessary to obtain satisfactory, reproducible results.

TCIR - 514 - ACCURACY OF COUNTING RADIOACTIVE BETA EMITTERS USING END-WINDOW GEIGER TUBES.
Jesse W. Thomas, 6 March 1950.
UNCLASSIFIED

(U) To permit the confident use of statistical laws applicable to a counting assay of radioactive material, it is necessary to establish the fact that the statistical laws apply under actual operating conditions.

The work here reported resulted in tables showing the accuracy of determinations to be a function of the number of counts taken and of the difference between counting rate and background. On the basis of 239 trials, consistent experimental results obtained with the Geiger tube and Berkely scaler proved closer to the average value than the theoretical dispersion would predict. Theory also requires that 215.1 values out of 239 be within the reliable error limits, whereas 213 experimental results actually fell within such limits.

Elaboration on the findings of this investigation resulted in the following definition: "A detectable amount of radiation is that amount which shows an activity which has a statistical 9 chances out of 10 of being at least an infinitesimal amount above background."

TCIR - 535 - DECONTAMINATION OF AIRCRAFT CONTAMINATED IN FLIGHT BY AN AIR BURST OF AN ATOMIC WEAPON. (Operation SANDSTONE).
Harry Levin and Homer F. Priest, 23 February 1950.
CONFIDENTIAL-RESTRICTED DATA

[redacted]) A B-17 aircraft was flown through the cloud resulting from an air atomic burst, and was brought to Army Chemical Center one year later for decontamination. Exterior surfaces of the plane had been degreased in the interim, but no attempt had been made to decontaminate the parts subjected to the tests reported here.

The power plants were found to be the most highly contaminated sections of the plane, with recorded activity up to 26 mr/hr. Satisfactory decontamination of the engines was achieved only by complete disassembly and degreasing, chemical and mechanical decontamination of nonbearing surfaces, and replacement of parts that presented special problems (e.g., braided ignition cables, etc.). Most of the contamination on supercharger air-compressor castings adhered strongly and persisted after degreasing and other solvation processes. Mechanical action, ranging in degree from mild brushing to steel wool scouring was of definite value in removing contaminant. While mild decontaminants were moderately effective, best results were obtained from the use of harsher agents. Of the latter, phophoric-chromic acid and nitric-chromic acid gave best results, neither showing appreciable corrosive effect on the metal. Citric acid, previously recommended, had low decontamination efficiency.

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TCIR - 562 - A SURVEY ON RW CLOTHING DECONTAMINATION.
John A. Pierce, Jr., 18 May 1950.
SECRET

[redacted] Radiological centers at Oak Ridge, Los Alamos, San Francisco, Hanford, and Mound Laboratory utilize prelaundering segregations and laundering techniques appropriate to the clothing decontamination problems peculiar to each installation. Because the type of contamination varies among these installations, none of their laundering formulas or cycles is recommended as optimum. This report summarizes the techniques employed at these laboratories, and describes 9 formulas employed by Quartermaster Corps laundries for nonradioactive washing.

Three specific recommendations are made: (1) If radioactivity persists after 3 decontamination cycles, the garment should either be stored to permit natural decay to reduce contamination, or it should be buried. (2) Quartermaster Corps should use impregnated clothing for its 1950 field test at ORNL. (3) Six QMC washing formulas have merit and should be considered for use by field-decontamination stations. Specifically not recommended is a study of the decontamination of various fabric types, both because of the difficulty of standard procurement and because the possible additional salvage value of contaminated clothing would not warrant the expense.

TCIR - 572 - APPARENT THERMAL CONDUCTIVITY OF GRANULAR RADIOLOGICAL AGENTS.
G. L. Priest, H. F. Priest, and R. Alvarez, 12 July 1950.
SECRET-RESTRICTED DATA

[redacted] This report describes a satisfactory method for measuring the apparent thermal conductivity of granular tantalum and other granular, candidate, radioactive materials. Results, estimated as accurate to within 5%, indicate that the thermal conductivity of a granular material is approximately 1% of that of the corresponding solid.

The apparatus consists of a steam-jacketed, cylindrical, brass shell having a length at least four times its diameter and a wall thickness of 0.015 in. A carefully constructed, butt-jointed thermocouple is exactly centered under tension in the tube. Measurement is made of the flow of heat through the granular mass by periodic galvanometer readings until the indicated temperature at the middle of the cylinder equals that of the steam. These readings are plotted against time, and values are obtained from the resulting time-temperature relationship which permit the calculation of thermal diffusivity by the use of Waddam's equation. Thermal conductivity is then determined from the average value of thermal diffusivity by appropriate calculation.

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TCIR - 591 - TOTAL LINEAR ABSORPTION COEFFICIENTS OF VARIOUS MEDIA FOR GAMMA RADIATION.
John A. Pierce, Jr. and Paul M. James, 8 November 1951.
UNCLASSIFIED

(U) Total absorption coefficients for gamma radiation were determined for four materials on which no pertinent data had previously been available: methylacrylate, 100-octane gasoline, TNT, and tritional; determined to be 0.0696, 0.0343, 0.0924, and 0.1055 per cm, respectively. The method employed in these determinations involved the use of Ta^{182} (1.1 Mev) in a gamma gun for collimation of the rays, and the subsequent application of the exponential attenuation law, $I = I_0e^{-\mu x}$. To check the accuracy of the determinations, absorption coefficients were also calculated for seven other materials on which data were already available in the literature. The presently determined results checked closely with published data on these seven materials, thus indicating the accuracy of the method employed.

TCIR - 606 - RADIOLOGICAL CLOTHING MONITOR.
H. B. Martin, 27 November 1950.
UNCLASSIFIED

(U) The device described here is a clothing monitor which permits measurement of the total radioactivity on a single garment in a single operation. It consists of a table having a copper screen top, 27 by 29 inches. Immediately below the top are mounted five 12-inch, thin-wall G-M tubes arranged in such a manner as to monitor the area completely. A hinged lid contains five additional G-M tubes behind a similar protective screen, so arranged that when the lid is closed the tubes in the two sections are perpendicular to each other at their approximate midsections. A scaler, a register (recorder), and an automatic timer, together with a suitable source of high-voltage current, constitute the remaining equipment for the apparatus. Due to the simultaneous operation of ten tubes, the background for the device is relatively high, this background being reducible only at the expense of sensitivity. For this reason, a total count of twice background has been set as the tolerance level above which a garment is considered unwearable.

[redacted]

TCIR - 627 - THE PROPER ROLE OF DETERGENTS IN RELATION TO RADIOLOGICAL DECONTAMINATION.
Harry Levin, 5 February 1951.
CONFIDENTIAL

This report discusses the nature of six chemical compounds cited as being effective decontaminating agents. The mechanics of their decontaminating properties are investigated to determine whether the effectiveness is attributable to base-exchange combinations, adsorption, chelate reactions, polar attraction, detergency, or other characteristic of the agent.

It was determined, with respect to the six decontaminants, that:

1. Removal of fission products is probably due to the decontaminants' affinity for colloidal soils on which the fission products have lodged.

2. Decontaminating efficiency may be due to scavenger action rather than selective attack on certain chemical species.

3. Because of adsorption and masking, the mass-action laws for combination of decontaminants and fission products in aqueous solution cannot predict effective limits of decontamination.

4. Certain of the decontaminants may be effective in certain instances and ineffective in others, even with the same species of contaminant.

5. It is impractical to attempt, by sensitive reactions, to identify fission products as they are deposited after an atomic-bomb burst.

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III. [redacted] TECHNICAL COMMAND REPORTS.
(TCR)

TCR - 60 - INTERIM REPORT OF THE DEVELOPMENT OF THE RADIOACTIVE SODIUM IODIDE TEST FOR FILTER MATERIAL. - Elmer H. Engquist and Jerry J. Mahoney, 18 April 1950. SECRET

[redacted] The development of a test method for the determination of type 6 filter material efficiency is described, the method employing particulate sodium iodide labeled with I^{131}.

An aerosol having a mean particle size of 0.48μ was used to test the efficiency of Chemical Corps type 6 filter material at levels of radioactivity between 0.1 and 20.0 μc/l (0.6 Mev beta energy and 0.37 Mev gamma energy). The filter material exhibited normal filtration efficiency (approximately 0.03% to 0.04% penetration) up to the highest of these levels. The accuracy of these measurements by radiometric methods, checked by nonradioactive chemical tests was found to be within ± 10%.

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IV. [redacted] CHEMICAL AND RADIOLOGICAL LABORATORIES INTERIM REPORTS. (CRLIR)

CRLIR - 24 - GROSS DECONTAMINATION STUDY OF A MACADAM ROADWAY CONTAMINATED BY FALLOUT OF RA.
Joseph C. Maloney, William H. Carr, Jr., Ralph E. Rexroad, and Frank S. Badger, 31 August 1951.
SECRET-RESTRICTED DATA

[redacted] Purpose of this study was the determination under field conditions of the feasibility of decontaminating macadam roadway contaminated by fallout of RA, a candidate radiological warfare agent. To conduct these tests, an area of macadam surface 10 ft by 10 ft, was marked off into 100 one-foot squares. An agent of 0.96 Mev gamma energy, having a half life of 2.7 days, was dispersed over this area within a tent inclosure. Air-suspended contaminant was precipitated onto the test surface by water sprays, the water also hastening hydrolysis of agent on the roadway. Decontamination procedures were conducted, and activity readings made from a movable bridge straddling the contaminated area and one foot above it.

It was concluded that scrubbing with detergent solution is an effective method of decontamination, with efficiencies approaching 95%. Hosing, effective to a certain extent against all degrees of contamination, is especially effective in areas of high concentration. Existing Engineer Corps and Chemical Corps equipment may be used to achieve decontamination sufficient to prevent spread of radioactivity by the passage of troops through the area.

CRLIR - 25 - REPORT OF THE PROTECTION AFFORDED BY FIELD FORTIFICATIONS AGAINST GAMMA RADIATION FROM AN AIR-BURST ATOMIC BOMB. (Operation RANGER)
Paul R. Cerar, 14 June 1951.
SECRET-RESTRICTED DATA

[redacted] Study was made of the degree of protection afforded by one-man, two-man, and prone foxholes against gamma radiation emitted at the time of detonation of an air-burst atomic bomb. The foxholes were oriented perpendicular, parallel, and at a 45° angle to the foxhole-burst line, and at distances up to 2,000 yd from ground zero. In addition to determination of gamma ray dosages; determinations were made of gamma exposure as a function of slant distance from the bomb burst, gamma attenuation by dirt, half-thickness for dirt, and gamma radiation at the foxhole positions due to atmospheric scattering.

Film packs at specified locations in the foxholes produced exposure readings such that the following conclusions could be drawn: (1) a two-man foxhole located 1,000 yd or more from ground zero affords good protection against gamma radiation emitted during the detonation 2,000 ft above ground of an approximate 20 KT atomic bomb, the exposure being less than 224r at a 32-inch depth. (2) A one-man foxhole affords better protection against gamma radiation than does a prone shelter or a two-man foxhole, maximum protection being found at the side of the foxhole nearest the burst.

CRLIR - 38 - CLOTHING DECONTAMINATION STUDIES AT DUGWAY PROVING GROUND.
John A. Pierce, Jr., Robert P. Beckelheimer, and
Frank S. Badger, 20 February 1952.
CONFIDENTIAL

[redacted] Tests were undertaken to determine contaminability and decontaminability characteristics of military fabrics with respect to various RW contaminants. Eight different RW munitions were set up at 100-yd intervals, with the fabrics and clothing to be tested located in regular patterns downwind from the line of munitions. Test pieces were exposed horizontally at a distance of 25 yd from each munition, and perpendicularly at a distance of 45 yd.

These tests revealed that the working of the material (folds, seams, etc.) is a significant contamination factor, while the nature of the fabric appears to be the critical decontamination factor. HBT and wool uniforms have better contaminability and decontaminability characteristics than sateen uniforms. When made up into bags of like size, rayon, nylon, and wool exhibit characteristics superior to sateen and HBT. Formula 77 satisfactorily decontaminated all samples.

CRLIR - 49 - FEASIBILITY STUDY OF SOLUBLE FILMS IN DECONTAMINATION OF STRUCTURES.
Ralph E. Rexroad, June 1951.
CONFIDENTIAL-RESTRICTED DATA

[redacted] Typical building-material surfaces were coated with certain protective films and then contaminated with a solution of mixed fission products. These films, though soluble in alkaline solutions, are insoluble in water, a property which makes them suitable for use on surfaces exposed to rain. The contaminated, coated surfaces were subjected to low-pressure (5 lb/sq in) hosing with an alkaline solution, this treatment washing both film and contaminant from the various materials.

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Activity readings before and after decontamination showed that surfaces protected with a wood-resin film were 95% to 98% decontaminated, as compared with a 34% to 57% decontamination of nontreated surfaces. Surfaces protected with films of Monsanto Resin SR4 were 35% to 99% decontaminated, as compared with a 9% to 66% decontamination of nontreated surfaces. Comparison of the efficiency of the film-removal method of decontamination with that of standard methods was made by contaminating nontreated surfaces in the same manner and to the same extent, and subjecting the surfaces to hosing at 250 lb/sq in. for 15 seconds. Decontamination effected by this method ranged from 64% to 88%.

CRLIR - 64 - MAXIMUM ALLOWABLE CONCENTRATIONS OF FISSION PRODUCTS IN THE AIR AS A FUNCTION OF EXPOSURE TIME AND TIME AFTER DETONATION.
Robert L. Harvey, 9 November 1951.
UNCLASSIFIED

(U) Previously published tables of tolerable concentrations of radioactivity, such as the standards set by the Subcommittee on Internal Dose of the National Committee on Radiation Protection, are based on continued exposure over long periods. In military operations such data are frequently inapplicable, the need usually being for information on the concentrations permissible for brief exposures. The purpose of this work is therefore the determination of those higher concentrations of airborne activity which may safely be breathed over specific, relatively short periods of time.

To estimate the internal hazard resulting from short-term inhalation of airborne fission products, the author has calculated the volume of inhaled contaminated air that he estimated would cause the body to retain one microcurie of Sr^{90} or its equivalent. By assuming a person's rate of breathing, he was able to estimate the permissible length of time that the person could breathe air having a specified radioactive content. These calculated data have been embodied in a family of curves from which may be read directly the permissible concentrations of fission products in air (μc/l) which may safely be breathed for periods of 8 hr, 24 hr, and 7 days, starting at 1 hr to 1 yr after detonations.

This report has been superseded by CRLIR 81.

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CRLIR - 81 - MAXIMUM ALLOWABLE CONCENTRATIONS OF FISSION PRODUCTS IN THE AIR AS A FUNCTION OF EXPOSURE TIME AND TIME AFTER DETONATION.
Robert L. Harvey, 16 January 1952.
UNCLASSIFIED

(U) This report supersedes CRLIR 64, in which were described the calculation and determination of fission-product concentrations, higher than those published by the Subcommittee on Internal Dose of the National Committee on Radiation Protection, which are permissible for relatively short-time exposure.

In this report, some of the previous assumptions have been modified, calculations have been refined, and the presence of plutonium has been considered. The calculations of this paper result in a lower estimate of the per cent of Sr^{90} which is absorbed and retained in the human body for a given concentration in air. The outcome of this work was the setting of permissible airborne concentrations up to 50 times those established in CRLIR 64. The author points out that his calculations are based on an assumption that all ingested radioactivity will be deposited in the bones; no computation has been made of the dose resulting from material accumulated in the lungs.

CRLIR - 94 - EXPERIMENTAL TESTS OF SHIELDING AND ATTENUATION OF GAMMA RADIATION FROM RADIOACTIVE TANTULUM VERSUS INFINITE PLANE THEORY.
Jerry J. Mahoney and Robert B. Price, 4 January 1952.
SECRET-RESTRICTED DATA

([redacted]) This report deals with the shielding afforded by walls, roofs, and floors of structures against radioactive contaminant, and with the attenuation of radioactivity by structural materials, air, and earth at varying heights above a contaminated plane.

Attenuation factors were determined for a concrete roof and for concrete-block and tile-block buildings at varying heights above floor level. No difference was found in dose rates at positions having the same geometric relation to vertical and horizontal planes of the same size and shape uniformly contaminated with the same amount of radioactive material.

The effects of air scattering and ground reflection were observed at various heights above contaminated ground. Roughness of terrain was found to increase total attenuation, particularly at lower altitudes. Dose rate was found to increase with height above contaminated land of "infinite" area, where the contaminant was buried in a uniform pattern and at a uniform depth below the surface, due to decreasing earth attenuation as the metering height increased.

CRLIR - 115 - DECAY OF RADIOACTIVE MIXTURES.
Hugh R. Lehman and Robert H. Lynch, 8 April 1952.
UNCLASSIFIED

(U) The fission of U^{235} by slow neutrons results in a fission-product mixture that exhibits a distinctive radioactive decay curve, which, as derived by Way and Wigner, approximates a straight line when plotted on log-log graph paper. From curves derived by Hunter and Ballou, it appears that during the decay of such a mixture, the fractional activity of every participant nuclide passes through a maximum value of percentage activity. The purpose of this report was to derive a function predicting the time at which the various fission products "peak", and to explain the deviations from the Way-Wigner theoretical curve.

It was demonstrated that a nuclide exhibits a "peak" at a time dependent only on its half-life and on the slope of the log-log relationship for a particular fission-product mixture. For the cited fission-product mixture, the slope constant is approximately -1.2. Thus, most nuclides will exhibit their fractional activity "peaks" at approximately 1.7 half-lives from the time of formation of the mixture. Whether or not a particular nuclide or fission chain will become so prominent during its "peak" that the mixture will temporarily appear to be a single species depends on several factors (1) possible reinforcement of the "peaking" nuclide by competitors of similar half-lives, (2) the original fission yield of that nuclide, and (3) parent-daughter doubling of the activity when the daughter's half-life is shorter than that of the parent.

CRLIR - 126 - STUDIES ON ARMORED VEHICLES AT OPERATION JANGLE.
(WT-402)
Elmer H. Engquist, 21 April 1952.
SECRET-RESTRICTED DATA

([redacted]) The studies reported here pertain to the protection provided by various types of armored vehicles against airborne, radioactive, particulate material; to the shielding afforded by such vehicles in traversing contaminated areas; to the effectiveness of field decontamination of these vehicles; and to the protective efficiency of the E26 tank collective protector. Test vehicles were located 2,000 ft from ground zero of the surface and underground shots, variously positioned with respect to the blasts. To provide comparative data, hatches were closed or open, and the engines were operating or stopped.

Shielding factors against gamma radiation were found to range from 16 to 20 for M24 tanks, from 45 to 55 for M26 tanks, and from 10 to 12 for T18E1 personnel carriers. The concentration of airborne activity in vehicles, extrapolated to H + 1 hour, averaged 0.25 mc/l and was not significantly affected by the hatches being open or closed. With soil conditions similar to those of the Nevada Test Site, satisfactory decontamina-tion of vehicles was achieved by hosing the exteriors and vacuum cleaning the interiors. The efficiency of filter material in the tank collective-protectors was found to approach 99.98%. The running of vehicle engines while exposed to a base surge was found to result in nonhazardous contaminati of air-cleaner and crankcase oil.

CRLIR - 137 - SOME TECHNIQUES APPLICABLE TO THE STUDY OF ABD FALLOUT.
(Operation BUSTER-JANGLE)
Malcolm G. Gordon and Benjamin J. Intorre, October 1952.
SECRET-RESTRICTED DATA

[redacted] Three methods are outlined for distinguishing, by autoradiographic methods, between radioactive and nonradioactive particles from atomic blast fallout. Because these methods depend on particle size, reference is made to the processes employed in separating fallout into various size ranges. Microscopic examination of the autoradiographs permits the counting of radioactive particles when a light background is used to accentuate the darkened area surrounding every radioactive particle. When a dark background is used, count may be made of nonradioactive particles. It was determined that a higher proportion of the larger sized particles is radioactive than of the smaller particles. Of the particles in the 150μ to 850μ range, 17% are radioactive, while in the 8μ to 38μ range only 1% are radioactive.

CRLIR - 158 - THE DEVELOPMENT OF A RADIOACTIVE SOURCE FOR A TRAINING AID.
James C. Kerrigan, 14 August 1952.
UNCLASSIFIED

(U) Commercially available radioactive source capsules do not possess field symmetry, with the result that instrument readings taken at points equidistant from the source are not uniform. Because an important use of a standard radioactive source is the calibration and checking of survey instruments in the field, the Radiological Division, C&RL, found it necessar to develop a training-aid source having field symmetry.

This report describes the Co^{60} source (1.1 to 1.3 Mev, half-life 5.3 yr) developed to meet this need. The design of the capsule was such that readings taken at points equidistant from the capsule, whether from any side or the bottom, are uniform. The radioactive cobalt slug is enclosed in a sealed stainless steel capsule, the lead shield for which is contained in a plywood carrying case. An approved remote-handling device is supplied with this shielded source. Also supplied is an accurate calibration of the source, complete with date of calibration, the strength (in mr/hr) at calibration, and suitable equations, tables, and graphs for computing its strength at later dates.

CRLIR - 170 - RADIOCHEMICAL STUDIES ON SIZE-GRADED FALLOUT AND FILTER SAMPLES.
(Operation JANGLE)
Robert C. Tompkins and Phillip W. Krey, 7 August 1952.
SECRET-RESTRICTED DATA

([redacted] Fission product activity was shown to vary with particle size. A study of the data obtained in these tests leads to a plausible hypothesis from which have been derived equations that fit the data within experimental error. It may reasonably be assumed that an atomic cloud initially comprises a complete spectrum of particle sizes. Particles grown by agglomeration and/or condensation of other matter on the particle surfaces. During this growth process, fission-product atoms are adsorbed on the surfaces of these particles, with simultaneous reduction of concentration of free sorbable fission-product atoms in the cloud. Consequently the distribution of fission-product activity in the radioactive fallout particles is nonhomogeneous.

A formula was derived for the calculation of activity per unit mass of particle, and graphs have been plotted of the activities of Zr^{95}, Ba^{140}, and Ce^{144} vs particle size. On the basis of the gaseous precursors of the nuclides analyzed, equations were derived indicating the distribution of these nuclides in the particles. The Sr^{89} activity was found on the surface of the particles, whereas the Zr^{95}, Ba^{140}, and Ce^{144} were distributed throughout the agglomerate shell of the particle.

CRLIR - 196 - EFFECTS OF IMPACT UPON CANDIDATE PELLETS, ROOFING SURFACES, AND SOILS.
Manfred Morgenthau, Albert H. Ferguson, and Harold Avrouchenko, October 1952.
SECRET-RESTRICTED DATA

[redacted] Because the value of the disintegrating type of RW pellet depends in part on the difficulty of decontaminating a target area, it is

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essential to know the break-up characteristics of candidate pellets. In this investigation test pellets were hurled mechanically against common roofing materials and soils, at speeds approximating the terminal velocities of air-dropped pellets. Study was then made of the effects of pellet composition and type of target on pellet break-up and scattering characteristics.

It was found, in general, that the size of particles, and the area of scattering decreased as the hardness of the pellet decreased. Hardness, in turn, varied with the pressure used to manufacture the pellet. Of the pellets tested, those which best withstood normal handling and also showed superior impact characteristics were of barium-lead and litharge composition, formed respectively under 20-tons/sq in. and 30- to 40-tons/sq in. pressure. Pellets striking wet soil or dry sand penetrated without break-up, but they fractured without penetration on impact against other dry soils.

V. [redacted] CHEMICAL AND RADIOLOGICAL LABORATORIES REPORTS. (CRLR)

CRLR - 14 - FILTER MATERIAL EFFICIENCY AGAINST HIGH LEVELS OF AIRBORNE RADIOACTIVE CONTAMINATION.
Elmer H. Engquist, Jerry J. Mahoney, and Robert B. Price, 13 August 1954.
SECRET

[redacted] The penetration of Chemical Corps type 6 filter material by I^{131}-labeled aerosols having a mean particle size of 0.48μ has previously been shown (TCR 60) to be between 0.02% and 0.04% when activity levels were as high as 20μc/l. This work was undertaken to determine the penetration of this type filter material by similar aerosols at considerably higher activity levels.

Using sodium iodide aerosols labeled with I^{131}, and maintaining the mean particle size at 0.48μ, as in the earlier work, it was found that there is a significant increase in the efficiency of type 6 filter material at higher activity concentrations. Specifically, penetration between 60 μc/l and 400 μc/l activity was found to range from about 0.005% to 0.007%. It appears, therefore, that Chemical Corps type 6 filter material may be used effectively against airborne particulate material having radioactivity of the order of magnitude of that anticipated in the vicinity of an atomic bomb explosion.

CRLR - 71 - PRELIMINARY REPORT ON THE FEASIBILITY OF BODY ARMOR FOR USE BY SPECIAL TROOPS AGAINST IONIZING RADIATION.
Alfred W. Klement, Jr., January 1953.
SECRET

[redacted] This report is based on an extensive literature search through data relating to point-source radiation, whereas conclusions based on radiation from uniform field areas would have been of greater value.

Where, for tactical reasons, special troops must be disposed in areas heavily contaminated by radioactive material, protective body armor appears feasible. Because absorption effects are almost entirely dependent on the mass of the absorbent, lead appears to be the best available material. For adequate protection, armor must consist of lead at least 2 mm thick, or of other material equivalent to such lead thickness. The weight of such armor makes impractical more than partial body protection. It is more important to protect vital organs (chest and abdomen) by 30% than to protect the entire body by 30%. For example, 600 r may be lethal when

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the body is totally unshielded, while it may take 900 r to be lethal with 30% protection. But, with 30% protection of the abdomen alone, the lethal dose may be raised to about 800 r. The conclusion was reached that 40% reduction of effective radiation intensity is attainable by the use of 62 lb of lead in trunk armor, or 31 lb in abdomen armor. This protection should be supplemented by combat boots, steel helmet, two layers of standard clothing, and leather gloves.

The final report of this work appeared as CRLR 211.

CRLR - 104 - CONTAMINATION-DECONTAMINATION STUDIES ALOFT (WT-27).
(Operation GREENHOUSE)
Simon R. Sinnreich, Malcolm G. Gordon, and Glenn E. Fulmer,
2 January 1953.
SECRET

[redacted] This study was designed to provide information concerning the differences in radioactive contamination of materials having various surface characteristics, and in the decontamination of their surfaces by various agents. Test panels incorporating 54 possible surface variations were attached to aircraft flown through atomic clouds and thus exposed to contamination. The variations included three degrees (low, medium, and high) each of roughness, porosity, and contact angle, and two conditions of dye retentivity (fast and nonretentive). Twelve decontaminating agents, fundamental components of commercial detergents, were tested on each contaminated panel surface.

The data resulting from this work indicate that roughness, and to a lesser extent, dye retentivity, are characteristics requiring careful consideration in the selection of surfaces for military use. Contact angles and porosity may be regarded as unimportant factors in the selection of such surfaces. Sequestrants and anionic detergents are the most efficient agents for the radiological decontamination of all types of surfaces.

CRLR - 105 - CLOUD SAMPLING TECHNIQUES USING SNAP SAMPLERS.
(Operation IVY)
Michael J. Schumchyk, 16 February 1953.
SECRET-RESTRICTED DATA

[redacted] Snap samplers were installed in several jet aircraft flown through nuclear clouds at Operation IVY (November 1952). This aerosol-sampling device consisted of a probe with an orifice designed to give approximately isokinetic sampling, projecting from the nose of the aircraft, and connected via a quick-opening valve to a collapsed, plastic bag. The pilot opened the gate valve electrically when cockpit instruments indicated that the plane had entered an area of at least 1 r/hr activity. Air filled

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the bag to capacity (15 cu ft at sampling altitude) in about 12 seconds at which time the expanded sides of the bag pressed against an electric switch closing the bag valve. On landing, the air in the bag was pumped through a particulate filter into a cylinder, leaving the radioactive contaminant adhering to the inside of the bag or to the filter material.

It was determined that the R factors obtained were normal, and that the two decay slopes measured (-2.08 and -2.35) were relatively higher than decay slopes determined for samples obtained from other operations and by other sampling methods. Activity levels of samples obtained in these tests were too low to provide more than limited data. The low readings were attributed both to the fact that aircraft speed was such that the plane flew well beyond the sampling zone by the time the bag was filled and to the considerable decay occurring during the 45 hr required to ship the samples to the counting laboratory.

The final report of this work appeared as CRLR-197, and WT-617.

CRLR - 109 - RESULTS OF CHEMICAL CORPS CHEMICAL AND RADIOLOGICAL LABORATORIES PARTICIPATION IN OPERATION THUNDERCLOUD.
(Part of JANGLE, WT-401)
John R. Hendrickson and Robert L. Hanzel, 24 November 1952.
SECRET-RESTRICTED DATA

[redacted] Three investigations are described in this report: (1) the shielding afforded by a medium tank and a personnel carrier against the radioactivity resulting from an aerial atomic blast, (2) the evaluation of filter efficiency of a tank collective protector, and (3) a determination of the extent to which clothing is contaminated when worn by men marching within 500 yd of ground zero shortly after the blast.

Film badges indicated 94% to 99% lower dosage inside the tank than outside, and similar readings inside the personnel carrier showed 95% shielding by this vehicle. Filter efficiency of the tank collective protector was found to be very high, with negligible radioactivity penetrating the type 6 filter material. No problem was presented by contamination of either impregnated or unimpregnated clothing worn near ground zero at H + 4 hr. Shoes showed the highest contamination, approximately 2 to 3 times background.

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CRLR - 112 - FALLOUT STUDIES ON ENIWETOK ATOLL.
(Operation IVY)
Edwin H. Bouton and Edward F. Wilsey, 2 March 1953.
SECRET-RESTRICTED DATA

[redacted] Studies were made of fallout patterns, activity characteristics, particle size, and radiochemical content of airborne particulate matter generated by the surface detonation of a thermonuclear device (Mike Shot) and the air burst of an atomic bomb (King Shot). These studies were made by sampling fallout with intermittent fallout collectors, trays, and Tracerlab Continuous Air Monitors. The studies revealed that:

1. Radioactive fallout continued for at least 6 hr after each shot, most of it occurring during the first 30 min. Fallout from Mike Shot was collected as far as 15 mi upwind from ground zero, while that of King Shot was collected up to 10 mi downwind from ground zero. Fallout activity did not vary in any regular fashion with distance from ground zero in either case. Some of the Mike-shot fallout was liquid.

2. The Mike-shot decay slope, as determined at all collecting stations, averaged -2.10 for the period between H + 190 hr and H + 500 hr. Decay slopes for King Shot averaged -0.67 for the period between H + 150 hr and H + 450 hr.

3. Preliminary results indicate that Mike-shot activities (10^8 to 10^{11} disintegrations/min) were about 10^3 times the King-shot activities. Over 90% of the Mike-shot fallout consisted of particles one micron or less in size, but most of the fallout radioactivity was found in particles larger than 20 μ.

The final report of this work appeared as CRLR-215 and WT-617.

CRLR - 116 - OPERATING INSTRUCTIONS FOR RADIOLOGICAL SECTION OF MOBILE CHEMICAL LABORATORY, E4.
M. A. Schmoke and F. A. Hedman, 5 March 1953.
CONFIDENTIAL

[redacted] Functions of the Radiological Section of the Mobile Chemical Laboratory, E4, include: (1) the detection and measurement of gamma radiation and beta radiation in various media; (2) the collection of actual and suspect radioactive material; (3) the confirmation of location and intensity of reported gamma radiation; and (4) the preliminary examination and evaluation of enemy RW protective material, protective equipment, RW weapons, and munitions. The overall purpose of this laboratory section and its specially trained personnel is to help minimize the effects of enemy use of atomic bombs and RW agents.

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In addition to general information on the nature of radioactivity, and on the means for its detection and measurement, this manual contains operating instructions to aid laboratory personnel in carrying out their duties. Considerable information giving a general background in the field of radiological effects has been included to assist personnel in the performance of duties for which no adequate instructions can be prepared.

CRLR - 117 - THE CONTAMINATION OF A VEHICLE ENGINE (WC 54) WITH RADIOACTIVE SAND, AND ITS DECONTAMINATION.
M. G. Gordon, H. A. Chambers, and L. A. Ford, 9 February 1953.
CONFIDENTIAL

[redacted] To determine the location and extent of radiological contamination of a running vehicle engine, fine sand tagged with aged (1-$\frac{1}{2}$ yr) fission-product solution was introduced into the engine intake-air through an air filter. Fifty grams of such contaminated dust was introduced into a special chamber surrounding the air filter, over an 8-hr period, at a rate corresponding to 0.025 g/cu ft of combustion air. This arrangement was effected by operating the engine at 1,300 rpm, equivalent to a speed of 30 mi/hr.

External monitoring gave no indication of the hazard involved in servicing contaminated vehicle engines. The metal and air shielding afforded by the engine and its location in the vehicle was such that contamination within the engine could not be traced externally. Radioactivity varied from (relatively) very high in the air filter, carburetor, and engine head to low in the exhaust system, valves, and pistons. Contamination in the crankcase and the oil filter was found to depend on engine condition, with little contamination in these locations if piston rings were close-fitting. Decontamination was easily effected in most cases by simple techniques, such as wiping or brushing. These techniques reduced original contamination readings ranging between 4,000 and 43,000 counts/min to residual readings of from 1,300 to 1,500 counts/min.

CRLR - 120 - PRELIMINARY CALCULATIONS ON THE EFFECTIVENESS OF SMOKE AT OPERATION KNOTHOLE.
Charles S. Brice, Jr., 24 March 1953.
SECRET-RESTRICTED DATA

[redacted] On the basis of experimental data obtained by using a collimated beam of light, prediction is made of the degree of attenuation of thermal radiation by a white, oil-fog smoke, and of the temperature rise within a carbon smoke. Calculations were based on smoke concentrations up to 70 mmg/l.

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Thermal attenuation by white smoke is indicated to be 88.5%, 95.8%, and 98.6% respectively at distances from ground zero 2,500, 4,500 and 6,500 ft. These figures were based on an assumed wind velocity of 2 to 3 mi/hr at the time of test.

The calculated temperature rise in an assumed 100-ft layer of fairly dense, carbon smoke at ground zero is shown to be from about 3,800°C at the top of the cloud layer to about 170°C at ground surface. For a thin smoke, the expected temperature increase would be between 400°C at the top of the cloud and 200°C at the ground. The temperature rise in similar cloud layers at 2,000 ft from ground zero would be expected to range from 300°C at the tope of a fairly dense cloud to 0.1°C at the ground, and from 35°C to 13°C for a thin smoke.

CRLR - 159 - LABORATORY EVALUATION OF THE PORTABLE PARTICULATE SAMPLER, E31. Luther M. Hardin and Michael J. Schumchyk, 20 April 1953. CONFIDENTIAL

[redacted] The Portable Air Sampler, E31, was set up inside a cubical test chamber 1 m on a side, into which and from which a radioactive sodium iodide (I^{131}) aerosol was introduced and exhausted at constant rates, so that the air within the chamber was maintained at about atmospheric pressure and was completely changed every 10 min. The aerosol radioactivity levels varied between 1 x 10^{-8} and 500 x 10^{-8} μc/cc, and the aerosol particulate matter had a median diameter of 0.6 μ. Tests were made in both static air and fan-induced air turbulence. Twenty-minute samples were collected by individual sampling tubes of the instrument, at rates of 1 liter/min and 0.5 liter/min, in quiet air and in turbulent air. At the conclusion of the test, the perpendicularly mounted sampling filters were counted for radioactivity.

The results indicated an accuracy of ± 10% in the determination of aerosol activity-concentrations when the particles were less than 5μ in diameter, and with simulated wind speeds up to 6 mi/hr. Less reliable results were obtained at flow rates of 0.5 liter/min through the filter than at 1 liter/min. Activity-concentration values at the lower rate of flow deviate from the standard filter-sample values by as much as ± 20%. Finally, it was established that the E31 sampler can be used to determine activity concentrations as low as 10^{-8} μc/cc when 20-min sampling periods are used.

CRLR - 160 - A REPORT ON RADIATION SURVEY METERS AND ON RADIATION DOSIMETRY.
Otto C. Wagner and Karl Eklund, 14 August 1953.
CONFIDENTIAL

[redacted] This report contains detailed information on radiation-survey meters and dosimeters of interest to the Armed Forces. The information includes the model number, manufacturer, description, method of operation, range, availability, cost, dimensions, and weight of each item.

The cut-off date for inclusion in this report was 1 September 1952.

This report was not for general distribution. It was compiled as a basis for a joint Signal Corps-Chemical Corps report on the subject.

CRLR - 162 - AEROSOLS FOR RADIOLOGICAL WARFARE.
Charles Robbins, Charles S. Brice, Jr., and Alfred W. Klement, 29 April 1953.
SECRET-RESTRICTED DATA

[redacted] This report explores the feasibility of utilizing RW agents as aerosols rather than as ground contaminants. The analysis is mathematical in nature and is based on some tenuous assumptions, but the calculations are believed to be accurate within $\pm$ 30%.

The conclusion is reached that though it is technically feasible to disperse fission products as aerosols, such aerosols appear to have no special advantage over RW ground contamination. In situations where the RW aerosol is effective, ground contamination appears to be more effective. This conclusion is supported by three generally accepted facts: (1) the limited availability of radioactive aerosols limits their use, (2) protection against internal hazards is relatively simple, while protection of personnel from exterior contamination can be accomplished only by physical removal of the contaminant, (3) a ground contaminant remains effective for a period of months unless physically removed, while a radioactive aerosol would disperse in a much shorter time.

CRLR - 186 - AN EVALUATION OF THE AIRBORNE HAZARD ASSOCIATED WITH RW TESTS AT DUGWAY PROVING GROUND.
Peter V. Susi and Alfred W. Klement, 27 May 1953.
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[redacted] This report describes the method employed to evaluate the airborne radiological hazard associated with RW tests in which disintegrating

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tantalum pellets were used. The work deals with the ultimate size of particles resulting from disintegration of the test pellets and with the extent to which such hazardous particles might become airborne with varying wind velocity.

The humidity at which tantalum pellets are disintegrated has no effect on the particle size, although it does affect the rate of disintegration, higher humidities producing more rapid disintegration. Particle-size distributions and quantities of airborne tantalum were determined in wind-tunnel tests. At a wind speed of 10 mi/hr, 7% of the tantalum became airborne, and 99% of this airborne material was found to be 13μ, or smaller, in size. In small-scale field tests, contamination of a desert area with the test agent resulted in no detectable airborne radioactive material at wind velocities up to 20 mi/hr. With wind velocities of 25 mi/hr and simultaneous disturbance of the area by vehicular movement, radioactivity was noted 200 ft downwind of the area to the extent of only 5×10^{-10}μc/cc.

CRLR - 188 - RADIOACTIVE PARTICLE STUDIES INSIDE AIRCRAFT (UKP-8). (Operation UPSHOT-KNOTHOLE)
John M. Roady and Nicholas S. Capasso, 11 June 1953.
CONFIDENTIAL

[redacted] Samples were taken of air entering the cockpits of F-80 drone aircraft that penetrated the atomic clouds a short time after the detonation of two of the airburst shots of Operation UPSHOT-KNOTHOLE. Particulate matter in the sampled air was collected on the slides of a five-stage cascade impactor and on a millipore filter attached to the effluent end of the impactor. This report records the test setup employed for evaluation of the potential inhalation hazard to which aircraft crews would be subject on passing through an atomic-bomb cloud.

For such evaluation it was necessary to collect a suitable sample of the cloud particulate matter of the size range in which lung retention is a maximum (0.1μ to 10μ diam). The collection was made in a manner that made possible the determination of: (1) concentration of alpha and beta activity in the air; (2) particle-size distribution and activity vs particle size, (3) specific activity of individual particles in the specific size range, (4) total activity of air in the cockpit at peak concentration, and (5) the rate of dilution of this air by clean air upon emergence from the cloud. The samples were later analyzed, and supporting measurements were made.

The final report of this work appeared as CRLR-299 and WT-717.

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CRLR - 190 - PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION (UKP-58).
(Operation UPSHOT-KNOTHOLE)
Elmer H. Engquist, June 1953.
SECRET-RESTRICTED DATA

([redacted] In clear atmosphere, thermal radiation normally reaches an object via a straight line from the bomb source. By introducing a smoke screen, the radiation is diffused around an object within the screen, and such radiation as reaches the object does so from many directions, thereby minimizing burns and reducing the ignition of fires.

This report sets forth the test conditions under which measurements of thermal flux were made at a station 2,166 ft from ground zero when an approximate 16 KT nuclear device was detonated 500 ft in the air. The smoke screen for this test was developed by smoke pots in concentric rings of 200- and 300-ft diameters around the test station. Data obtained from three different types of instruments at the station showed that between 0.5 and 0.7 cal/sq cm were received. Without the radiation-diffusing smoke, the incident thermal flux was approximately 78 cal/sq cm. Thus, there was indicated an attenuation of radiant energy approaching 99% under conditions of the test.

The final report of this work appeared as CRLR-298 and WT-768.

CRLR - 191 - EVALUATION OF A THERMAL ABSORBING SMOKE SCREEN (UKP-59).
(Operation UPSHOT-KNOTHOLE)
Elmer H. Engquist, 10 June 1953.
SECRET-RESTRICTED DATA

[redacted] In this experiment, the method of formation and the characteristics of a precursor shock wave were studied. The precursor was emphasized over a blast line by means of a heated-air layer resulting from the absorption of thermal radiation by a carbon-smoke screen. The effect of the carbon-smoke screen on the pressure wave is not yet completely understood, pending detailed analysis of the pressure curves. However, a generalization may be made that the distance over which the precursor was apparently formed was less in the smoke screen than in the clear area. Also, the maximum pressure in the smoke screen was two to three times greater than in the clear area, although in some cases recognition of the precursor and primary shock waves was difficult, due to marked modification of the wave form.

Supplementary measurements showed that the thermal flux was significantly reduced by the carbon-smoke screen, the data indicating tentatively an attenuation of thermal radiation greater than 98%.

The final report of this work appeared as CRLR-283 and WT-769.

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CRLR - 196 - AERIAL SURVEY OF GROUND CONTAMINATION AT OPERATION IVY (WT-617).
Charles S. Brice, Jr., 29 May 1953.
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[redacted] A procedure is described whereby air-ground correlation factors are determined, permitting evaluation of radioactive contamination on the ground from instrument readings in an airplane flying over the contaminated area. Ground intensities were obtained by multiplying the aerial readings by the air-ground correlation factor obtained during the survey.

The reliability of the procedure depends upon the flight of the observing helicopter along a previously charted course at a constant speed (30 mi/hr), and at a constant height (25 ft) above the ground. Readings were taken by the helicopter crew at definite time intervals (5 sec) and compared with readings taken by ground personnel 3 ft above the ground, at locations corresponding to those of the aerial readings. During the first week after the surface detonation of a thermonuclear device, the average daily correlation factor (the ratio of the intensity at a point on the ground to the intensity in the helicopter at an altitude of 25 ft) remained about 2.8. By the end of the second week it had dropped to about 2.2.

CRLR - 197 - FINAL REPORT ON CLOUD SAMPLING TECHNIQUES USING SNAP SAMPLERS (WT-617).
(Operation IVY)
Michael J. Schumchyk, 3 June 1953.
SECRET-RESTRICTED DATA

[redacted] The data presented here were derived from studies of the gas and particulate-matter samples collected from clouds produced by nuclear detonations in Project 5.4b of Operation IVY. Collection of these samples was made by snap samplers installed in F-84G aircraft, and by the methods described in CRLR-105.

Analysis of the particulate samples collected after Mike shot (the detonation of a thermonuclear device) indicated that the total number of fissions that produced the sample was of the order of 10^{10} to 10^{11}. The following R factors (R factor: the counting-rate ratio in a sample divided by the same ratio for thermal fission of U^{235}) were obtained from bag particulate samples: Ce^{144}/Mo^{99}, 0.14; Ba^{140}/Mo^{99}, 1.37; Sr^{89}/Mo^{99}, 0.57; and from a filter particulate-sample: Ce^{144}/Mo^{99}, 0.97.

Activity readings obtained on the snap-sampler evacuation filters (used when transferring the gas sample from the collecting bags to the

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shipping containers) and corrected to H + 1 hour, ranged from 1.4×10^8 to 46.8×10^8 disintegrations/min. The decay slopes for samples from an evacuation filter and from a plastic sampler bag were determined to be -2.08 and -2.35, respectively.

A preliminary report of this work appeared as CRLR-105.

CRLR - 211 - FINAL REPORT ON THE FEASIBILITY OF BODY ARMOR FOR USE BY SPECIAL TROOPS AGAINST IONIZING RADIATIONS.
Alfred W. Klement, Jr., 22 June 1953.
CONFIDENTIAL

[redacted] On the basis of an extensive literature search, deduction was made in CRLR 71 that body armor against radiation was feasible for use by special troops. This report describes tests in which the degree of radiation attenuation by such armor was determined and corroborates the deduction made in the earlier report.

While exposure in the field would normally be to area-source radioactivity, both area- and point-sources were employed in studies of attenuation by standard types of combat armor and the proposed lead type. Actual attenuation of area-type radioactivity by lead body armor was found to be close to that calculated from theoretical data. Reduction factors were slightly higher than those obtained in point-source experiments. These tests, which confirmed the feasibility of using lead armor for partial body-protection against gamma radiation, also revealed that present combat-type armors provide little or no protection against ionizing radiations.

A conclusion is also drawn in this report that reduction of beta-particle intensity by ordinary clothing is slight. Several layers of clothing are required to reduce intensities by significant amounts.

A preliminary report of this work appeared as CRLR-71.

CRLR - 215 - FALLOUT STUDIES ON ENIWETOK ATOLL (WT-617).
(Operation IVY)
E. H. Bouton, Phyllis B. Gordon, R. C. Tompkins,
W. R. VanAntwerp, and E. F. Wilsey, 26 June 1953.
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[redacted] Fallout arising from the surface detonation of a thermonuclear device (Mike Shot) and from the air burst of an atomic bomb (King Shot) was collected by several different methods, and studied to determine the

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fallout pattern, activity characteristics, particle size, and radiochemical content of each. Study was also made of the rate of fallout during the first 6-$\frac{1}{4}$ hr following each shot.

Mike-shot samples of 0.54 sq in ranged from 10^9 to 10^{13} disintegrations/min, equivalent to as high as 2,750 c/sq ft. The fallout from Mike Shot continued for at least 6 hr within 15 mi of ground zero, but was heaviest during the first 30 min after detonation. The average Mike-shot decay slope was -2.1 for the period from H_m + 190 hr to H_m + 500 hr. More than 90% of all the Mike-shot fallout studies consisted of particles less than 1μ in diameter, but about 94% of the radioactive particles studied were larger than 10μ. Less than 1% of all the solid particles counted by light-microscope methods were radioactive, indicating that little respiratory hazard existed.

Activities of the King-shot samples were lower by a factor of 10^3 to 10^5. These activities ranged up to 9.2×10^{-4} c/sq ft. The average King-shot decay slope was -0.65 for the period H_k + 150 hr to 150 hr to H_k + 450 hr.

A preliminary report of this work appeared as CRLR-112.

CRLR - 218 - A SIMPLIFIED PROCEDURE FOR REFILLING GEIGER-MUELLER TUBES.
Henry A. Garon, 11 June 1953.
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(U) A relatively simple method has been devised for refilling discarded Geiger-Mueller tubes and preparing them for re-use. New tubes have average lives of 10^9 counts and are relatively expensive as compared with the refilled tubes which have life expectancies of between 1×10^8 and 5×10^8 counts.

The processes of mica-window replacement, tube evaucation and refilling, and tube sealing and testing are described in detail. The mixture found to be optimum for tube refilling is a 24 to 1 ratio of helium gas to absolute ethyl alcohol vapor (total pressure within the tube: 25 cm of Hg). Refilled tubes with replaced mica windows were found to operate satisfactorily at an altitude of 8,000 ft. Theoretically, such tubes should perform satisfactorily up to 30,000 ft.

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CRLR - 241 - THE ELUVIATION OF RW AGENTS INTO SOIL.
Manfred Morgenthau and Albert H. Ferguson, 17 August 1953.
SECRET-RESTRICTED DATA

[redacted] Information was needed on the depth of penetration into soils of radioactive contaminants deposited on the ground surface under the application of definite quantities of water. Two RW agents were tested on three types of soil: beach sand, loamy sand, and silt loam. A tubular container was filled with compacted test soil and the surface of the soil contaminated by placing activated pellets on it and allowing them to disintegrate. Two liters of water were then allowed to filter through the column at a constant head of 6 mm. Samples were then taken at various depths in the test column, dried, and counted for radioactivity. The activity of the seepage water was also measured. The volume of water used in the tests was calculated to equal 39 inches of rain in one and 73 inches of rain in another.

Test results indicate that the water-induced penetration of most soils by the RW agents used is negligible. In a few porous soils, like sand or gravel, an agent such as zinc bromide may penetrate to a depth of more than 4 inches. But because penetration by common RW agents is only 2 inches or less, the usual methods of land decontamination will remove practically all the agent.

CRLR - 242 - ATTENUATION OF RADIANT ENERGY BY FOG-OIL AEROSOLS.
Charles W. Forsthoff and John S. Desjardins, 26 October 1953.
CONFIDENTIAL

[redacted] The purpose of this study was to determine the effectiveness of fog-oil aerosols in scattering and absorbing radiant energy so that, to a first approximation, the capabilities of operational fog-oil aerosols in attenuating radiant energy can be predicted.

The object of this investigation was to determine the attenuation by fog-oil aerosols, of the radiant energy emanating from a point source. Of particular bearing is the locating of the radiation source with respect to the aerosol cloud, as indicated below: (1) At the center of an aerosol cloud, (2) At the edge of an aerosol cloud, or (3) At a certain distance outside the surface of an aerosol cloud.

Subject to laboratory limitations, this experiment indicated that, for the first approximation, a 100-ft-thick fog-oil aerosol cloud having an average concentration of 40 mmg/l will attenuate approximately 9.1% of the radiant energy passing a point 4,500 ft from the ground zero of a 20 KT atomic bomb detonated at a height of 2,400 ft. Increasing the distance from ground zero gives a corresponding increase in the attenuation of the radiant energy.

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CRLR - 243 - A REVIEW OF THE EFFECTS OF THERMAL RADIATION FROM ATOMIC WEAPONS.
Carl Crisco, Jr., and Luther M. Hardin, 11 August 1953.
SECRET-RESTRICTED DATA

[redacted] (Prepared for Joint Issue by the CmlC and QMC).

Different agencies within the Department of Defense have investigated the effects of thermal radiation from atomic weapons and have published the results of their studies in reports of diverse origin. This report presents a summary of the findings of the various investigating agencies and correlates them in useful form. The report includes a discussion of: (1) the characteristics of thermal radiation from an atomic bomb detonation, (2) the apparatus and techniques used in thermal radiation studies, (3) the effects of thermal radiation on military equipment and structures, (4) the effects on clothing materials, and (5) the protection afforded by various clothing materials.

CRLR - 268 - RADIOLOGICAL COUNTERMEASURES.
Manfred Morgenthau and Morris L. Schoss, 28 August 1953.
SECRET-RESTRICTED DATA

[redacted] On the basis of protection and decontamination studies conducted in barren areas under simulated attack conditions, and on small-scale laboratory tests, an assay is made in this report of the probable efficacy of countermeasures which might be taken in an urban area under RW attack.

The conclusion was reached that an intelligently instructed population of an industrial-urban housing complex can so adjust its behaviour, by following simple directions, that the average radiation exposure will be substantially lower than under routine behaviour conditions. But individual measures alone will not prevent harmful exposure. The radiation intensity of a contaminated target-complex can be reduced by applying basic shielding and decontamination procedures to an extent that individual dosage would be reduced by 35% to 90%. In this connection it is felt that removal or burial of the contaminant would be less laborious and more effective than the erection of shielding barriers. Finally, the time of recovery from RW attack will depend on the facilities available, the manpower reserve, the extent and quality of official planning prior to the attack, and on the indoctrination and training of the populace. One imponderable factor exists: the effect of prevailing weather during and following the attack.

CRLR - 283 - EVALUATION OF A THERMAL ABSORBING SMOKE SCREEN (WT-769). Elmer H. Engquist and Charles W. Forsthoff, February 1954. SECRET-RESTRICTED DATA

[redacted] The purpose of this experiment was to obtain a better understanding of the method of formation and the characteristics of the precursor shock wave obtained in some prior atomic weapons tests. The modification of the shock wave at Shot 10 was emphasized through the presence of a heated-air layer provided by the absorption of thermal energy in a carbon-smoke screen. Supplementary measurements were made to determine the attenuation of thermal radiation by a thermal-absorbing smoke screen.

Detailed analysis of the pressure curves by Projects 1.1a and 1.2 indicates that the blast wave was greatly modified by the presence of the carbon-smoke screen. The maximum pressure in the smoke screen was higher than in the clear area from approximately 900 to about 3,000 ft. The wave form was markedly modified from that of a normal shock wave in the precursor region, both in the smoke screen and in the clear area, though the distance over which this modification occurred varied between the smoke and clear areas. In the clear area, the normal shock front appeared at about 1,500 ft. The time of arrival of the initial shock disturbance at any position in precursor region was later, by as much as 20%, in the smoke-screen area than in the clear area.

The net effect of the smoke screen on the blast wave was to modify the precursor wave and reduce the range over which the precursor effect occurs. In general, the smoke screen reduced the thermal effect; and blast data such as the peak positive-pressure and shock arrival-time were more nearly like what would be obtained from a nonthermally-heated blast-reflecting surface. In the clear area, the blast data, because of the more pronounced precursor effect, differed considerably from the data under the smoke screen.

The thermal flux was significantly reduced by the carbon-smoke screen. The measured attenuation of thermal radiation at a ground station 2,640 ft from air zero was 97.4 ± 0.3%. The normal thermal flux of 47.0 ± 4.0 cal/sq cm was reduced to 1.2 ± 0.1 cal/sq cm.

A preliminary report of this work appeared as CRLR 191 and UKP-59.

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CRLR - 297 - ATTENUATION OF 1.2 MEV GAMMA RADIATION BY SOVIET AND U. S. MILITARY VEHICLES AND U. S. RAIL EQUIPMENT.
Robert P. Beckelheimer and Ralph E. Rexroad, 1 August 1953.
CONFIDENTIAL

[redacted] The object of the work described in this report was to determine the amount of shielding from gamma radiation afforded by certain Soviet and U. S. military vehicles and U. S. rail equipment, when operated in areas contaminated with Co^{60} (gamma energies of 1.17 and 1.33 Mev).

Under the conditions of the test, practical attenuation factors (the dose rate inside the vehicle divided by the dose rate 3 ft above the center of the road outside) for gamma radiation from a 20-ft roadway when the vehicles were located at the center of the road ranged from 0.02 to 0.44. The attenuation factors for vehicles traveling along the shoulder of the road ranged from 0.005 to 0.29. Sandbags over the floor boards and mutual shielding by personnel riding in the bed of the truck have negligible effect on the dose rate. The load of a cargo truck offers little shielding to personnel in the cab.

Practical attenuation factors for gamma radiation from a level field with the vehicles located at the center varied from 0.025 to 0.75.

Decontamination of a 16-ft wide strip through the field reduced the dosage rate by 30% when the contaminant was merely swept aside, and by 50% when the contaminant was removed for personnel walking through the field. These factors are increased as the mode of conveyance changed from walking or riding in a jeep to riding in larger vehicles.

Practical attenuation factors for gamma radiation from a level field with rail equipment located at the center ranged from 0.15 to 0.55.

CRLR - 298 - PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION (WT-768).
(Operation KNOTHOLE)
Elmer H. Engquist and Charles W. Forsthoff, 7 December 1953.
CONFIDENTIAL

[redacted] The original objective of Project 8.4-1 was to evaluate the attenuation, by an operational fog-oil smoke screen, of thermal radiation resulting from the detonation of a nuclear device, and to secure data to verify theoretical calculations on the above currently being developed under contract to the Chemical Corps.

It was originally planned to conduct this evaluation on shot 9 with an operational smoke-screen setup using smoke generators, and/or smoke pots. Thermal flux data were to be obtained under the smoke screen at distances varying from 2,500 to 6,500 ft from ground zero of the nuclear device detonated 2,420 ft in the air. However, adverse wind conditions and possible interference with the overall test program under these conditions resulted in a last-minute cancellation of the smoke-screen test.

With instruments recovered from shot 9, and new instruments fabricated in the interim, a preliminary study was rapidly planned for shot 10. The objective of this setup was to obtain partial data for a preliminary analysis of the Thermal Radiation Attenuating Clouds (TRAC) program and to obtain data applicable to future planning for a full-scale evaluation of an operational smoke screen. A single instrument station was located at a slant range of 2,261 ft from the detonation of a nuclear device approximately 500 ft in the air. The smoke screen for this test was created with 175 smoke pots surrounding the station in 200-ft and 300-ft diameter rings.

Analysis of photographic records of the test has shown that the carbon-smoke screen, also set up on shot 10, intercepted the thermal radiation impinging upon the fog-oil smoke screen being tested by this project. The carbon-smoke screen, therefore, contributed to the measured reduction of thermal radiation at the instrument station.

The thermal flux in the direction of air zero, measured with 180° field-of-view calorimeters, was 0.8 ± 0.1 cal/sq cm. The flux measured with instruments of two other types was less than 0.7 cal/sq cm. The incident thermal flux, without smoke, at this distance was 57.5 ± 5.0 cal/sq cm. The attenuation of radiant energy by the carbon and fog-oil smoke was therefore 98.6 ± 0.3%. Based upon measurements of radiant-energy attenuation made solely within the carbon smoke, it has been estimated that the carbon smoke reduced the incident radiation from 57.5 to 6.8 cal/sq cm. The actual attenuation of thermal radiation by the fog-oil smoke screen was, therefore, from approximately 6.8 to 0.8 cal/sq cm, or 85% to 90%.

A preliminary report of this work appeared as CRLR-190 and UKP-58.

CRLR - 299 - RADIOACTIVE PARTICLE STUDIES INSIDE AN AIRCRAFT (WT-717).
Nicholas S. Capasso, William M. Home, and John M. Roady,
4 December 1953.
(Operation KNOTHOLE)
CONFIDENTIAL

[redacted] The object of Project 2.1 was to determine the physical nature and concentration of atomic-bomb-cloud particulate matter entering aircraft through the cabin-pressurization system.

The purpose of this study was to evaluate the inhalation hazard to which aircraft crews would be exposed on passing through an atomic-bomb cloud and to determine the degree of the inhalation hazard relative to the external radiation hazard.

The sample for the cascade impactor was obtained from the cabin-pressurizing system in the drone F-80 aircraft through the standpipe on the right of the pilot's seat in the cockpit.

Three cascade-impactor samples were collected in the cloud resulting from two air-burst detonations. Samples were collected from 2 to 7 min after the detonations. The particles collected ranged in average diameter from less than 0.1 μ up to 4.2 μ; and over 95% of the activity present was associated with particles less than 0.2 μ in diameter.

The total individual internal-radiation dose resulting from the inhalation of fission products during the cloud passage was calculated, using certain basic assumptions, and found to be 1.9 mr. This internal dose is negligible compared with the integrated, external gamma dose of 30 r.

A preliminary report of this work appeared as CRLR 188.

CRLR - 300 - AN EVALUATION OF SOME LIQUID ADHESIVE RW AGENTS CONTAINING VARIED PERCENTAGES OF ZIRCONIUM-NIOBIUM OXIDE.
Robert J. Smith, Seymour Tarras, and Malcolm G. Gordon, 4 February 1954.
SECRET-RESTRICTED DATA

[redacted] The objectives of this investigation were: (1) to determine the adhesive properties toward asphalt and concrete of mixtures of silicate in water, polystyrene in ethylene dichloride, and polymethyl methacrylate (lucite) in ethylene dichloride, each containing from 3% to 40% of radioactive zirconium-niobium oxide agent; (2) to study the effects of various drop-sizes on retention (resistance to decontamination) of the three mixtures; and (3) to determine the drying time of the adhesive agents at various temperatures.

The asphalt and concrete test-pieces were contaminated with drops released from glass dropping-tubes of different orifice size and at various heights. The samples were counted, decontaminated by a wet-brushing technique and counted again. Of the silicate-agent mixtures, only those containing less than 10% of agent were retained satisfactorily on concrete; the retention of all such was unsatisfactory on asphalt. The lucite-agent and polystyrene-agent mixtures were retained on asphalt when as much as 40% solid agent was used, and on concrete with up to 30% solid agent. The silicate solutions dried slowly at room temperature and froze without drying below 32°F. The lucite and polystyrene solutions dried quickly at room temperature and only slightly slower at 30°F. They both froze at 0°F and shriveled after a 6-hr exposure.

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CRLR - 307 - RADIOLOGICAL WARFARE AGENT DECONTAMINATING STUDIES OF REPRESENTATIVE ROOFING MATERIALS.
Manfred Morgenthau, Joseph C. Maloney, and John U. Estes, 14 October 1953.
CONFIDENTIAL

[redacted] The objectives of the experiments described in this report were to test the decontaminability of various roofing materials, such as: rolled asphalt, strip shingle, corrugated metal, and builtup roofing (contaminated with a radioactive tantalum powder) and to evaluate the feasibility of the following decontamination techniques: low-pressure (8 lb/sq in) hosing, low-pressure hosing combined with scrubbing, hosing at 24 lb/sq in, fire-pressure (40 lb/sq in) hosing, high-pressure (50 lb/sq in) hosing, hot-water (Sellers Jet) hosing at 90 lb/sq in nozzle pressure, vacuum cleaning, and dry sweeping.

The decontamination effectiveness ranged from 0.9% for dry sweeping on the strip shingle to 100% for high-pressure hosing on the corrugated metal roofing.

CRLR - 308 - DECONTAMINATION OF RADIOACTIVE TANTALUM DUST FROM VARIOUS ROOFING MATERIALS BY WEATHERING.
Manfred Morgenthau and Murray A. Schmoke, 2 December 1953.
CONFIDENTIAL

[redacted] The object of this experiment was to determine the decontaminating effects of weather on various roofing materials contaminated with radioactive tantalum powder.

Weathering of the listed roofings for 47 days resulted in the following amounts of decontamination:

Rolled asphalt	92%
Asphalt strip-shingle	40%
Builtup (tar and gravel)	33%
Corrugated steel	89%

CRLR - 319 - NONATOMIC TEST OF ATTENUATION OF THERMAL RADIATION BY FOG-OIL AEROSOLS.
Jerry J. Mahoney and Robert B. Price, 23 February 1954.
CONFIDENTIAL

[redacted] The purpose of this study was to measure in field tests the attenuation of solar radiation by fog-oil smoke screens. The data obtained may be of value in predicting the attenuation by such screens of the thermal radiation from nuclear explosions.

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Seventeen Chemical Corps smoke generators (modified M3's produced smoke screens of 300-yd maximum width 100-ft maximum thickness, and of concentrations ranging from 0.6 to 7.5 g/sq m. The results show that an oil fog consisting of particles approximately 0.1 μ in diameter and at a concentration of 1 g/sq m over flat terrain attenuates by approximately 75% the solar radiation incident at an inclination of 30°.

CRLR - 320 - PRELIMINARY CALCULATIONS ON THE CONCENTRATION OF FOG-OIL SMOKE REQUIRED FOR THERMAL ATTENUATION.
Elmer H. Engquist, 5 April 1954.
SECRET-RESTRICTED DATA

[redacted] The object of the work described in this report was to make an analysis of the range of blast, nuclear, and thermal effects of air-burst atomic weapons in order to determine the quantity of fog-oil smoke needed, uniformly dispersed over an area, to reduce the ground range of thermal effects to that of moderate blast effect.

Data obtained from TM 23-200, Capabilities of Atomic Weapons, were used for analysis of the ground range of blast, nuclear, and thermal effects. The criterion established for calculating and predicting the required quantity of smoke was the amount necessary to reduce the thermal flux to 3 cal/sq cm at the range where blast overpressures were 8 lb/sq in. To make the preliminary estimates, data on attenuation of thermal radiation as a function of path length and concentration were necessary. Data obtained in laboratory experiments using a carbon arc as a thermal source and data obtained in a field test using the sun as a thermal source, were employed in this study.

CRLR - 326 - EXPERIMENTAL-THEORETICAL ATTENUATION OF 1.2 MEV GAMMA RADIATION BY SIMPLE STRUCTURES.
Ralph E. Rexroad, David L. Dunbar, and John C. ~~Peale,~~
15 September 1953.
CONFIDENTIAL

[redacted] The object of the work described in this report involved determination of the following:

1. The minimum area to produce the effect of an infinite field, or total plane, of contamination.

2. The dose rate at various heights above a relatively flat, uniformly contaminated plane as a function of contamination density.

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residual activity of about 2 r/hr, which probably could not be tolerated by a populace already considerably exposed in achieving this reduction in level.

(U) Using very optimistic assumptions, it is estimated that the cleaning up of the typical 20-sq mi urban area would take about 200 working hours or thirteen 16-hr days (limited by the number of trucks, shovels, and water available), and perhaps would require the recruitment of personnel from surrounding areas to maintain minimum radiation exposures.

CRLR - 369 - EXPERIMENTAL STUDIES OF GAMMA-RAY STRUCTURAL SCATTERING IN THE B-47 AIRCRAFT (U).
Carl E. Heidt and Cecil R. Ward, 14 October 1955.
SECRET-RESTRICTED DATA, Special Report

[redacted] One of the major problems associated with the RW program is the design of a mobile shield which will protect the flight crew of the delivery aircraft from the harmful effects of a 15-megacurie gamma (Zr^{95}-Nb^{95}) munition. It is of utmost importance that the photon behavior within the aircraft be understood as thoroughly as possible due to the obvious weight limitations inherent in such a design. The objectives are (1) to determine if structural scattering significantly increases the crew dose rate as observed in a simple air geometry and (2), if so, to determine an order of magnitude of this scattering.

[redacted] The conclusions drawn from this study are: (1) structural scattering does not significantly increase the crew dose rate observed in an air geometry. On the contrary, the inherent shielding provided by the aircraft, primarily in the form of fuel, results in a net decrease in dose rate, i.e., structural attenuation is far more significant than structural scattering; (2) allowing for the effects of replacing the test point source with the RW munition, there is every indication that this structural attenuation will decrease the expected dose rate by a factor of at least 2, or even 3; and (3) results clearly indicate that the aircraft structure can be safely ignored (i.e., air can be conservatively used as the sole scattering medium) in the programming of the in-flight shielding problem associated with the design of an RW aerial munition system.

CRLR - 402 - A GUIDE TO RADIOLOGICAL WARFARE COUNTERMEASURES, Stanford Research Institute.
June 1954.
SECRET-RESTRICTED DATA, Special Report.

[redacted] This report is a compilation of existing information on radiological warfare countermeasures. Lacking data on enemy RW capabilities and plans, estimates are made of the most probable agents and types of

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attack that might be made against this country. Comparisons are made between atomic warfare contamination and radiological warfare contamination. Primary application is made of the assembled data through estimates of the logistics for the decontamination of a 20-sq mi area in Oakland, California. The area contains Army and Navy supply depots, a naval air station, light and heavy industry, a large business and financial district, and several types of residential districts. In addition, an operations analysis is made of the problem of decontaminating the 20-sq mi area leading to a plan for rapid recovery of essential areas.

(U) This report also appears under Contract DA-18-108-CML-5068, 3 June 1953, ETF 760-9-3/1 (revision).

CRLR - 413 - BIBLIOGRAPHY, WITH ABSTRACTS, OF REPORTS OF RADIOLOGICAL DIVISION, CHEMICAL AND RADIOLOGICAL LABORATORIES (U).
Harry J. Schnell and Don S. McClelland, 7 September 1955.
SECRET-RESTRICTED DATA, Special Report

(U) This report consists of abstracts of all research reports published prior to 1 May 1954 by the Radiological Division.

CRLR - 420 - DECONTAMINATION AND PROTECTION (U).
WT-928, Operation CASTLE, Project 6.5.
Joseph C. Maloney, Ernest H. Dhein, and Manfred Morgenthau, 18 September 1954.
CONFIDENTIAL-RESTRICTED DATA, Special Report

(U) The preliminary report of this work was published as ITR-928, and the final report as WT-928.

CRLR - 430 - QUANTITY, DISTRIBUTION AND RADIOACTIVITY OF FALLOUT RESULTING FROM NUCLEAR EXPLOSIONS.
Luther M. Hardin, Bruce N. Whitlock, and Carl Crisco, Jr., 8 December 1954.
SECRET-RESTRICTED DATA, Special Report

(U) Data obtained from experimental tests of both fission and thermonuclear devices are presented to show dimensions of craters, total weight of fallout, weight concentration of fallout along iso-fallout contours, activity associated with fallout, decay of activity, and residual contamination patterns.

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(U) In addition, a detailed discussion of current methods for scaling contamination patterns to other yields and conditions of detonation is included.

[redacted] Generalized contamination patterns for surface and underground detonation of fission weapons and surface detonation of thermonuclear weapons are shown with illustrative examples for scaling downwind and crosswind distances to other yields and other wind speeds. The JANGLE data are used as a basis for the extrapolation to 23- and 83-KT fission weapons; the CASTLE BRAVO data, for the extrapolation to other yields are in the megaton range.

CRLR - 435 - RADIOCHEMICAL ANALYSIS OF FALLOUT, WT-918. (Operation CASTLE). Robert C. Tompkins and Philip W. Krey, 29 September 1954. SECRET-RESTRICTED DATA, Special Report

(U) The preliminary report of this work was published as ITR-918; the final report as WT-918.

CRLR - 436 - FALLOUT STUDIES, WT-916. (Operation CASTLE) Edward Wilsey, Richard R. Entwhistle, Robert J. French, and Harry I. West, Jr., 5 December 1954. SECRET-RESTRICTED DATA, Special Report.

(U) A preliminary report of this work was published as ITR-916; the final report as WT-916.

CRLR - 437 - A STUDY OF THE WASTE DISPOSAL ASPECTS OF RW DECONTAMINATION (U), Tracerlab, Inc. 30 June 1954. SECRET-RESTRICTED DATA, Special Report

[redacted] This report comprises a general study (Part I) and a detailed study (Part II) of the waste-disposal aspects of recovery of an urban area from a radiological warfare attack.

PART I

(U) The radioactive waste resulting from the reclamation of an urban area may be classified into two categories: agent suspended in a liquid and agent incorporated in a solid. Since the disposal of radioactive waste is similar in many respects to the disposal of the normal liquid and solid waste produced in a city, the disposition of the liquid and solid radioactive waste resulting from reclamation lends itself readily to a sanitary engineering analysis. The analysis was performed by Dr. E. A. Pearson, Sanitary Engineering Consultant, and is reported herein.

PART II

[redacted] St. Louis, Missouri, a typical inland industrial city, was selected for study as a hypothetical RW target area in order to illustrate the application of the waste-disposal principles developed in the general study.

[redacted] The waste disposal problems encountered in the recovery of a contaminated area are closely dependent upon the reclamation procedures used. Therefore, a detailed analysis is presented of the logistics of recovery for St. Louis, based on the given characteristics of the agent and its dispersion, as a prerequisite to consideration of the disposal of radioactive waste produced during the recovery operations.

(U) The land usage in St. Louis has been analyzed, and the tracts of the entire city classified into types corresponding to six typical districts. The area, population density, proportional roof and road coverage, and other pertinent characteristics of the area have been calculated.

(U) Other factors affecting recovery planning include the strategic value of the facilities within the assumed target area, the radiation level distribution, the human and material resources available for recovery work, and the recovery methods and their applicability. These factors are discussed and evaluated with reference to St. Louis.

(U) Each of the typical districts is analyzed in detail, and a composite representative area (one city block or more) is synthesized for each district. The detailed logistics of decontamination, by a variety of methods, of each representative area are calculated, and the results applied to 1-sq mi areas of their respective typical districts. Similarly, a detailed computation is made of the radiation levels throughout each representative area, and of the doses received by various reclamation workers cleaning up 1-sq mi areas of each typical district.

(U) The results were applied, in turn, to five probable target areas within the city and the manpower and equipment requirements, the doses received, and the liquid and solid wastes produced are calculated for the average target area.

(U) This report also appears under Contract DA-18-108-CML-3456, March 1962.

CRLR - 447 - THE QUALITY OF GAMMA RADIATION FROM AN EXTENDED SOURCE OF Ta^{182}.
Karl Eklund, P. E. Grant, S. S. Holland, and R. L. Liboff, 26 April 1955.
CONFIDENTIAL-RESTRICTED DATA, Special Report

(U) The object of this work was to determine the dose rate and the spectral energy distribution of gamma radiation above an extended plane source Ta^{182}.

(U) The differential number spectra, integral dose spectra, and the absolute dose rate are shown as measured on a contaminated area at Dugway Proving Ground and as determined by theoretical analysis.

([redacted] There is sufficient agreement between the results of the Spencer-Fano method and the experimental data to justify use of the theory in the analysis of RW contaminated fields. This theoretical attack yields, in the ideal case, spectral distribution for the number, energy, and dose as well as absolute determination of the dose rate.

(U) For an extended source of Ta^{182}, the per cent of the total dose due to photons with energies below 100 kev is negligible. Thus, since present military standard radiac instruments do not measure radiation energies below 80 kev, and are accurate to 5% to 10%, it is evident that the limitations of these instruments are not detrimental to their use in the case of Ta^{182}.

(U) For an infinite plane source of Ta^{182}, scattered radiation constitutes approximately 20% of the total dose, and so must be considered in determining the effects of such sources.

(U) At 3 ft above a uniform plane source of Ta^{182}, the dose rate, D, is given by: $D = (59.6 \times 10^{-4})S$ where D is in milliroentgens per hour and S is the source strength in curies per square mile. This equation applies only if the above ideal conditions are fulfilled. Recently it has been observed that in the production of Ta^{182} appreciable successive neutron capture occurs, making the determination of true source strength difficult. In such a case, one would then not expect agreement between measured and calculated dose rates.

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CRLR - 466 - INTERIM COMPREHENSIVE REPORT ON THERMAL RADIATION ATTENUATION, BY OIL-FOG SMOKE SCREENS.
Elmer H. Engquist, Charles W. Forsthoff, Benjamin Barnett, and J. J. Mahoney, 23 March 1955.
CONFIDENTIAL, Formal Report

(U) A summary of the theoretical investigation of the effectiveness of smoke by a six-flux resolution of the complex single particle scattering function is presented. Preliminary predictions of the effectiveness of smoke against a 20-KT atomic weapon are given.

(U) Results are given of the laboratory tests, the nonatomic field tests using the sun and photoflash bombs as sources of thermal radiation, and the Operation UPSHOT-KNOTHOLE atomic weapons field test of smoke. Excellent agreement was obtained between these data and theoretical predictions when comparison was made on the basis of attenuation as a function of path-length-concentration product of fog-oil smoke screens.

[redacted] The meteorological feasibility of establishing smoke screens over urban areas in the United States is reviewed. Adequate data are available to make a detailed analysis for smoke-screening purposes for 97 of the 106 cities with over 100,000 population. This study also shows that the feasibility for establishing adequate smoke screens is high, ranging from 75% to 86% of the time at night, and 24% to 64% of the time during the day, from line sources of generators. For an area array of smoke generators, the feasibility at the present time is estimated to exceed 90% of the time at night.

[redacted] An outline of the proposed logistics study of smoke screening with preliminary results is presented. For air-burst atomic weapons detonated over smoke screens, an operational concentration smoke screen established in accordance with the generator spacings given in FM 3-50, should provide a reduction of thermal radiation to less than 3 cal/sq in.

(U) Smoke screens are used to reduce thermal-radiation casualties to troops and to prevent the initiation of fires and thus the development of mass fires in strategic targets. Information is presented on the visibility in smoke screens and the toxicity of fog-oil screens. Visibility is markedly dependent on meteorological conditions. Fog-oil smoke screens are nontoxic in all concentrations normally experienced in the field.

CRLR - 479 - SOME USEFUL INTEGRAL FORMULAS FOR THE INITIAL REDUCTION OF THE TRANSPORT EQUATION (U).
Richard L. Liboff, 31 March 1955.
UNCLASSIFIED, Special Report

(U) The procedure for expanding the corresponding differential cross sections for light, gamma, and neutron scattering in convergent series of spherical harmonics is outlined and the related integrals are reduced through the appropriate formulas.

The formulas which are presented are a good expedient in overcoming the difficulties involved in reducing the integral term of the transport equation.

These formulas are useful in the application of the transport equation to problems of shielding (neutrons and gamma rays) or to the investigation of the scattering of electromagnetic radiation in aerosol clouds.

CRLR - 502 - APPLICATIONS OF INFINITE PLANE THEORY OF GAMMA SCATTERING.
Ralph Fullwood, Sam Holland, Richard Liboff, and Paul Grant, 8 May 1956.
UNCLASSIFIED, Special Report

(U) Work is reported on the following problems in the theory of gamma scattering from an infinite plane source: (1) the dose rate as a function of energy at 3 ft above the plane; (2) the dose rate as a function of height above the plane for source energies of 1 and 2.76 Mev; (3) the dose rate as a function of the radius of contamination for three source energies (1, 2, and 3 Mev); and (4) the dose rate received 3 ft below the surface in a hole 3 ft in diameter for a source energy of 1 Mev.

Within the accuracy of the infinite plane theory, the four problems have been adequately and validly treated with the possible exception of problem 4. The theory gives for this case results which may be high by a factor of about 2.

CRLR - 512 - STUDY OF THE ATTENUATION OF THERMAL RADIATION BY FOG-OIL SMOKE SCREENS (U).
Charles W. Forsthoff, 25 October 1955.
SECRET-RESTRICTED DATA, Special Report

(U) The objectives of the work described in this report were to (1) assemble in tabular and graphical form the information necessary to establish the logistical requirements and (2) predict the results to be accomplished by the employment of fog-oil smoke screens for attenuating thermal radiation.

(U) Two methods are developed for determining the attenuation of thermal radiation from nuclear weapons by fog-oil smoke-screen operations. One method is based on experimental data from laboratory and nonatomic field tests. The other method utilizes information derived from theoretical studies.

[redacted] In general, both the experimental and theoretical methods indicate that a high degree of thermal protection can be obtained for personnel in the area between the maximum radius of 8 lb/sq in. and 3 cal/sq in.

[redacted] Current smoke-screening doctrine developed for visual or overhead aerial obscuration is, in general, adequate for thermal-radiation-attenuating purposes.

CRLR - 530 - RADIOLOGICAL DIVISION RESEARCH AND DEVELOPMENT PLAN FOR PERIOD 1955 THROUGH 1965 (U).
Radiological Division.
4 November 1955.
SECRET-RESTRICTED DATA, Special Report

[redacted] The Radiological Division research and development plan for 1955 to 1965 is presented. It is divided into two broad categories: offensive RW and atomic and radiological defense. Conclusions and recommendations are presented with regard to each program.

CRLR - 561 - ABSOLUTE BETA MEASUREMENT OF MIXED NUCLIDES (U).
Fletcher Gabbard, Arnold Berman, and David Rigotti,
9 March 1956.
UNCLASSIFIED, Interim Report

(U) This report describes the applicability and efficiency of an absolute beta-counting system for sources composed of mixed radionuclides.

It includes a description of the physical setup necessary for such a study, a comparison of results with the theoretical results of standard sources and a discussion of the problem of self-absorption and self-scattering in the sample.

It is concluded that sources composed of mixed nuclides can be accurately measured by an absolute beta-counting system and that for samples having considerable mass-per-unit area self-absorption and self-scattering become important factors, especially for low-energy radiation. These effects can introduce large errors unless they are properly scattered.

CRLR - 571 - A LABORATORY INVESTIGATION OF THE EFFECTS OF CLIMATIC ENVIRONMENT ON AW AND RW DECONTAMINATION (C). Malcolm G. Gordon and Robert J. Smith, 9 April 1956. SECRET-FORMERLY RESTRICTED DATA, Interim Report

(U) The effects of environmental temperature, humidity, rainfall, wind speed variations, and type of soil upon the ability to clean surfaces contaminated by RW and AW agents are presented.

[redacted] The conclusions of this report are as follows:

1. A temperature of $0^{\circ}F$ and snow or ice can decrease decontamination efficiency by one half and thus increase the quantity of water waste by a factor of 2.

2. Softening of materials by heat, causing particulate matter to adhere, will decrease decontamination efficiency as much as 30%.

3. Strong winds will move 30% to 40% of RW materials on smooth surfaces, but may result in pockets of high radiation levels.

4. Rainfall will help in the decontamination of particulate matter, but may cause undesirable redeposition elsewhere. Decontamination efficiency may be reduced by 20% if performed after drying of moisture.

5. The disintegration rate of lead oxide pellets is dependent on humidity and temperature, while the ultimate particle size distribution is not appreciably affected.

6. Of the soils tested, only clay was resistant to removal by water spray.

CRLR - 580 - CMLC RADIOLOGICAL DISCUSSION PAPERS PREPARED FOR TENTH TRIPARTITE MEETING (U).
Radiological Division.
20 October 1955.
SECRET, Special Report

(U) This report consists of eight separate papers prepared by Radiological Division for presentation at Ottawa, Canada, September 1955.

The reports are as follows:

1. Protection of Eyes and Face Against Thermal Radiation.

2. Detection of Radioactive Contaminants in Potable Waters.

3. Potential of Industrial Smokes as Shields Against Thermal Radiation.

4. Applications of the Reciprocity Theorem in Gamma Shielding.

5. Helicopter to Ground Radiological Surveying.

6. Tank Vulnerability to Prompt Ionizing Radiation.

7. Calculation of Dose Rate from an Extended Source of Fission Products.

8. The Effect of Thermal Updrafts Over Cities Upon the Displacement of Radioactive Fallout.

CRLR - 594 - FALLOUT STUDIES (C).
WT-1119, Operation TEAPOT.
Michael J. Schumchyk and Edwin H. Bouton, 17 November 1955.
CONFIDENTIAL-FORMERLY RESTRICTED DATA, Special Report

[redacted] Ground and aerial radiation-intensity measurements made by this project have been used to arrive at contour lines which close the 100 mr/hr at H + 1 hr dose-rate line and nearly close the 10 mr/hr at H + 1 hr contour. These contours show that the area inside the 3,000 r/hr at

H + 1 hr contour to be roughly two times that predicted by existing scaling methods and the area within the 100 r/hr contour to be less than one third that predicted.

[redacted] The fallout pattern extended a shorter distance downwind than had been predicted by current scaling methods in spite of the fact that the cloud rose to a greater height than these methods predicted. Integration of the intensity areas from dose-rate contours accounted for 85% of the activity.

[redacted] An analysis of time of arrival of activity data, radiochemistry, photography, and other available data indicates that the base surge was the primary carrier of activity in the upwind and crosswind direction. Time of arrival data were obtained at seven locations from 300 to 4,500 yd from ground zero indicating fallout to have traveled downwind at the rate of less than 2 mph (ground speed), although the surface wind was 12 mph.

[redacted] At D + 8 days about 90% of the activity (6,000 to 12,000 mr/hr) on the crater lip was contained in the top 12 inches of soil. This distribution was also present 3 mo after the shot when an appreciable amount of activity (200 to 500 mr/hr) still remained in the lip, while in the crater 80% to 90% of the activity was covered by cave-ins and landslides to a depth of at least 3 ft. The radiation intensity of the crater lip at approximately 6 mo after the shot was 100 to 200 mr/hr.

(U) Gamma-intensity measurements made in the fallout area showed that the dose rate from H + 2 hr to D + 4 days followed $T^{-1.2}$ decay. A beta-decay curve was obtained which is similar to those found at other tests. Data were obtained which will furnish information concerning the effect of scaled depth upon such properties as specific activity, activity particle size distribution, and total activity associated with fallout.

(U) On aerial surveys, the rate at which intensity decreases with altitude is dependent on the position within the fallout pattern, i.e., air-ground correlation factors (intensity at 500 ft/intensity on ground) were found to vary from 0.12 to 0.45 for an altitude of 500 ft.

(U) The preliminary report of this work appears as ITR-1119.

[redacted]

CRLR - 603 - SURVEY OF RW AGENT AVAILABILITY FROM INDUSTRIAL POWER REACTORS, 1960-1980 (C).
Luther M. Hardin, 3 April 1956.
SECRET-RESTRICTED DATA, Special Report

[redacted] A survey of the availability of the Zr^{95}-Nb^{95} fraction of the waste fission products from reactors used for the production of commercial power in the period 1960 to 1980 is reported. Production of fission products at present AEC installations is not considered. Conclusions drawn from this work are as follows:

1. Waste fission products resulting from the industrial reactor program can serve as a source of RW agent material.

2. The amount of Zr^{95}-Nb^{95} resulting from nuclear reactors by 1965 will be several times that of the estimated present capability of AEC production facilities, and by 1980, greater than in 1965 by an additional factor of 20.

3. It is predicted that there could exist an RW stockpile large enough to contaminate fifteen 20-sq mi targets in 1965 and three hundred thirty-five 20-sq mi targets in 1980 to a level of 5 megacuries/sq mi; and an RW production rate large enough to contaminate three additional targets per month in 1965 and 70 additional targets per month in 1980.

4. The estimated quantity of Zr^{95}-Nb^{95} to be produced by 1965 is sufficiently large to warrant the early resumption of a research and development program geared to the development of a prototype agent-munition delivery system in 1965.

CRLR - 607 - APPLICATION OF RECIPROCITY TO GAMMA-RAY SHIELDING STUDIES (U).
Ralph R. Fullwood and Donald R. Roberts, 28 March 1956.
UNCLASSIFIED, Special Report

(U) The attenuation of gamma radiation by common structures is studied on the basis of reciprocating source and detector. The solution for an infinite plane field of radiation outside the structures is obtained by using the observation point as an influence function. The mathematics necessary to apply the reciprocity theory are developed. The attenuation of three buildings is obtained under conventional and reciprocal techniques. Suggestions for the improvement of the agreement between the two techniques are made and the advantages of the reciprocal technique are discussed. It is concluded that the reciprocal method appears to have merit.

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CRLR - 613 - ATTENUATION OF THERMAL RADIATION BY A DISPERSION OF WATER DROPLETS (U).
D. Anderson and R. Fullwood, 31 January 1956.
UNCLASSIFIED, Special Report

(U) The attenuation of thermal radiation by a plane-parallel water fog is evaluated for a point isotropic source located above the fog. A six-flux approximation to the solution of the transport equation is employed for three dispersion densities and for radiation of wave length 0.2 μ and 3.0 μ. Attenuation for water fog is somewhat inferior to that for a similar oil fog, and this relative inferiority increases with increasing fog density. The relative effectiveness of water and oil is discussed in terms of attenuation economics and logistics.

CRLR - 614 - PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION (U).
WT-1144, Operation TEAPOT.
J. J. Mahoney and E. H. Engquist, November 1955.
SECRET-RESTRICTED DATA, Special Report

(U) The final report of this work is WT-1144.

CRLR - 616 - TANK AND ARMORED PERSONNEL CARRIER VULNERABILITY TO IONIZING RADIATION (U).
Don S. McClelland, 28 March 1956.
SECRET-RESTRICTED DATA, Special Report

(U) The object of this work was to devise a concept for reducing the radius of casualty-producing doses of initial radiation from the detonation of a nuclear weapon to personnel in armored vehicles to the range of moderate damage to the vehicles.

(U) Theoretical calculations to give the thickness of lead shielding for gamma and graphite or polyethylene shielding for neutrons are presented. Weights of these materials to give adequate armored-vehicle protection for various situations are given.

[redacted] It was found that: (1) the crews of armored vehicles are vulnerable to the effects of nuclear weapons at greater distances than the vehicles themselves; (2) at the distance of moderate tank damage, the neutrons from the detonation of a nuclear weapon are more of a personnel hazard to armored vehicle crews than the gamma radiation; (3) the energy spectra for the radiation from a nuclear detonation are insufficiently known to accurately determine the thickness of shielding material required to reduce doses to "safe" levels. This is particularly true of neutrons. The radiation doses to personnel in armored vehicles can be reduced to militarily acceptable levels by a sufficient thickness of additional shielding material; the thickness and weight of material required to reduce the radiation doses at the distance of moderate tank damage to acceptable levels present serious difficulties, because of the reduction of the space in the armored vehicles and the weight added to the vehicles. If complete protection of the crews of armored vehicles from the effects of nuclear weapons is desired, consideration may have to be given in the formulation of doctrine governing the operation of armored units, to accepting additional weight in the design of armored vehicles, to operating with increased dispersion between individual vehicles or units, or to an intermediate solution involving some additional shielding with its accompanying weight increases and increased dispersion to reduce the number of casualties from a single nuclear explosion.

CRLR - 617 - DUST DENSITY VS. TIME AND DISTANCE IN THE SHOCK WAVE (C).
WT-1113, Operation TEAPOT.
Malcolm G. Gordon, John F. Stoudt, and Arthur B. Francis, 17 January 1956.
CONFIDENTIAL-RESTRICTED DATA, Special Report

(U) The preliminary report of this work was published as ITR-1113, and the final report as WT-1113.

CRLR - 636 - RADIOCHEMICAL ESTIMATION OF TOTAL ACTIVITY INCLUDED WITHIN DOSE-RATE CONTOURS FOR BRAVO SHOT, OPERATION CASTLE (U).
Robert C. Tompkins, 28 March 1956.
SECRET-RESTRICTED DATA, Special Report

(U) Radiochemical and field-survey data obtained by the Chemical Corps at Operation CASTLE are used in conjunction with fallout-contour areas published by AFSWP to calculate the percentage of the total fission-product activity from Bravo Shot which was contained in fallout within various dose-rate contours.

[redacted] Radiochemical analysis of fallout from Bravo Shot leads to the conclusion that 48% of the fission-product activity fell to earth within the H + 1 dose-rate contour (14,700 sq mi) of 100 r/hr in good agreement with other, less precise measurements.

CRLR - 648 - A SURVEY OF RADIOACTIVE WASTE DISPOSAL (U).
Fritz A. Hedman, 7 June 1956.
UNCLASSIFIED, Special Report

(U) A summary is presented of (1) the responsibility of the Chemical Corps for disposal of radioactive waste, (2) the previously published government directives, (3) the pertinent AEC studies and procedures, and (4) general directions for waste disposal.

VI. (S-RD) CHEMICAL WARFARE LABORATORIES REPORTS. (CWLR)

(U) Construction and calibration of a thermistor disc calorimeter to measure thermal radiation for the TRAC studies are reported. Since this instrument is to be used at atomic weapons field tests it must be rugged, gamma insensitive, have a reception angle of 2π steradians, and be easily transported and installed. This instrument was tested successfully at one nuclear detonation at Operation TEAPOT under severe field conditions. The instrument performed satisfactorily.

CWLR - 2039 - SUBSIDENCE OF A COLUMN OF AIRBORNE PARTICLES (U).
Martin O. Harwit, 27 June 1956.
UNCLASSIFIED, Technical Report

(U) A theoretical investigation of the mechanism of the subsidence of dense suspensions is reported. The aggregate of particles forming the suspension was found theoretically to subside through the surrounding atmosphere, behaving as though it were a fluid of the same density as the suspension. The subsidence velocity of such a fluid is much larger than the terminal velocities of the individual falling particles. A method is outlined for calculating subsidence times and subsidence velocities for a given situation.

CWLR - 2046 - DEPOSITION OF AIRBORNE PARTICLES ON A LARGE HEATED SURFACE (U).
Martin Harwit, 17 August 1956.
UNCLASSIFIED TECHNICAL REPORT

(U) The effect of a large heated surface on the deposition pattern from a polluted atmosphere is studied. It is concluded that the use of heat to avert the deposition of particulate matter 20μ to 300μ in size is not practical.

CWLR - 2059 - MECHANISM OF FALLOUT PARTICLE FORMATION I (U).
Robert C. Tompkins and Philip W. Krey,
27 November 1956.
SECRET-RESTRICTED DATA, Technical Report

(U) Radiochemical data from Operation CASTLE are applied to the development of a mechanism of fallout-particle formation. The relationships between activity concentrations of several fission products and particle size in fallout from Bravo Shot are studied in detail. Emphasis is placed on those aspects which relate to the mechanism of particle formation. Results of microscope studies are also included.

(U) Much of the active fallout below 300μ from Bravo Shot reached the ground as loose agglomerates of fine particles. Below 50μ, these agglomerates were broken up in the sample processing so that the unit particles could be investigated.

(U) Below 50μ, activity concentrations in the unit fallout particles could be represented by a relation of the type:

$$A_m = ad^{\alpha}$$

(U) Where A is the activity concentration of a given nuclide in the active particles at zero time, in microcuries per milligram, d is the particle diameter, in microns, a is a characteristic constant for each nuclide, and α is indicative of the location of the activity in or on the particles.

(U) Activity occurred in three different ways in the Bravo particles:

1. More or less uniformly on the surface because of late condensation of nuclides with long-lived gaseous precursors, e.g., Sr^{89}, Ba^{140} ($\alpha = -1$).

2. Randomly on the surface because of scavenging of fine active particles by large inert particles swept through the early cloud. Most of the active particles larger than 300μ were of this type.

3. Throughout the volume, apparently concentrated toward the center of the particles, e.g., Mo^{99}, Ce^{144} ($\alpha < 0$).

[redacted] In the case of a high yield, surface-land detonation, it seems improbable that the lower portion of the column, from which a base surge might form, is appreciably contaminated.

CWLR - 2122 - THE EFFECTS OF ATOMIC ATTACKS ON THE OPERATIONAL CAPABILITY OF AAA MISSILE BATTALIONS (NIKE) (U).
Luther M. Hardin, David W. Einsel, Jr., and Harold E. Shaw, 29 April 1957.
SECRET-RESTRICTED DATA, Technical Report

[redacted] Individual batteries of AAA Missile Battalions must remain operational during and after successful enemy attacks on targets within their area of responsibility if their assigned mission is to be accomplished. Nike batteries, as presently disposed, are extremely vulnerable to the effects of nuclear attacks upon primary targets. The hazards associated with radioactive fallout are potentially the most serious. Megaton-yield surface bursts upon the primary targets, which the batteries surround, can produce contamination intensities of such magnitude that personnel who remain inside present operational facilities would receive lethal doses of radiation within 1 hr after fallout arrival. An operational capability can not be maintained in such a situation without effective preattack planning and preparation.

The basic defensive measure required against the residual radiation hazard provides, intrinsically, the best protection possible against the other nuclear effects to which the batteries may be subjected. An operational capability can be maintained during and after enemy attacks on probable primary targets by (1) "digging in" all vital elements of the batteries except the radar antennas and the launching platforms to provide at least 3 ft of earth cover, (2) covering all exposed heat-sensitive material, and (3) providing on site, replacement radar antennas.

CWLR - 2174 - DESCRIPTION OF AERIAL RADIOLOGICAL SURVEY METHODS (U).
John P. Johnson and Manfred Morgenthau, October 1957.
UNCLASSIFIED, Technical Report

(U) This report describes three aerial survey methods used in connection with nuclear weapons tests.

In the helicopter-to-ground method, the survey is made by lowering a suspendible detector probe from a hovering helicopter to obtain direct ground readings. This is the only method which provides the same degree of accuracy as ground survey. It is especially useful for accurate short-range survey work. In a variation of this method, a moving low-speed aircraft (rotary or fixed wing) traverses the area with the instrument probe just high enough off the ground to avoid obstacles. This method should give results similar to those obtained by taking readings continuously in a rapidly moving vehicle, in which the detector head extends on a horizontal probe of sufficient length to eliminate shielding or back-scattering effects from the vehicle.

In the standard equipment method, the survey is making by taking readings with a standard military portable radiac instrument which is carried inside the aircraft while flying over the contaminated area. This method requires a minimum of preparation and equipment and may be suitable for certain situations where large errors may be tolerated.

In the long-range method, the survey is carried out by flying a grid pattern and measuring intensities with a special, fast response detector carried inside the aircraft and telemetering the data back to a plotting station on the ground. This method is best suited for rapid surveys of large areas when only the general level and extent of fallout activity are desired.

CWLR - 2176 - A HISTORICAL DISCUSSION OF CONTAMINATING EVENTS OCCURRING DURING U. S. ATOMIC TEST OPERATIONS (U).
Luther M. Hardin, David W. Einsel, Jr., Harold E. Shaw, and Robert P. Beckelheimer, October 1957.
SECRET-RESTRICTED DATA, Technical Report

[redacted] A total of 83 nuclear weapons or devices has been detonated by the United States to date (March 1957). Of these bursts, 51 can be classified as contaminating events. A chronology of all United States nuclear detonations is given with dates, yields, locations, heights of burst, and indications whether a significant portion of the fireball was subtended by the land or water surface.

[redacted] The extent of the contaminated area and the radiation intensities produced by nuclear detonation depend upon the height of burst, the total yield, the wind velocity (up to altitudes equal to cloud height), and the specific properties of the surface over or under which the burst occurs. The 51 contaminating events are discussed by type; land surface, near-surface land, underground, water surface, near-surface water, and underwater.

(U) Idealized dose-rate contours are presented for both kiloton- and megaton-yield weapons. These patterns are useful for predicting the area and extent of fallout patterns.

CWLR - 2222 - A GEIGER COUNTER FOR LARGE DIAMETER SOURCES (U).
Leonard Bird, John Kinch, June 1958.
UNCLASSIFIED

(U) A 2π flow-type Geiger Muller counter with a 4-3/4 inch diameter window is described. The adaptation of this counter to 4π counting is discuss

It is concluded that the 2π counter described is suitable for counting large area sources up to 4 inches in diameter and can be adapted to 4π counting.

CWLR - 2272 - SURVIVAL IN FALLOUT AREAS (U).
Harold E. Shaw, Captain, CmlC, February 1959.
UNCLASSIFIED

This report attempts to summarize, amplify and clarify the current information available through participation in nuclear events and subsequent evaluation of the data obtained.

The report consists of four sections:

1. A nontechnical summation of information on the characteristics and method of formation of radioactive fallout.

2. A brief resume of the biological effects of fallout.

3. A discussion of the basic principles involved in the reduction of the hazards of radiological fallout and the application of these principles.

4. A summary of calculations useful in the evaluation of the fallout hazard.

CWLR - 2282 - AN ACTIVATION-TYPE NEUTRON DETECTION SYSTEM AND ITS CALIBRATION (U).
J. W. Kinch and D. L. Rigotti, July 1959.
CONFIDENTIAL - Formerly Restricted Data

[redacted] This report describes a method for measuring neutron flux and obtaining an indication of the neutron energy spectrum. The conversion of the flux and spectrum information to neutron dose is briefly discussed. Some materials in which radioactive isotopes are produced as the result of neutron-induced nuclear reactions can be used to measure neutron flux and are called activation detectors. Activation detectors whose reaction cross section precludes the formation of a radioactive product with neutrons other than those with energies greater than a certain value are called threshold detectors. The neutron activation detectors described in this report are: Au^{197}, Pu^{239}, Np^{237}, U^{238}, S^{32} and Zr^{90}.

[redacted] The calibration of these detectors is accomplished by the evaluation of a constant which accounts for counting geometry, cross

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section (considered constant), etc. This constant, called a calibration number is evaluated by exposing a foil of the detecting media to a known neutron flux and correlating this known flux with the counting rate observed. Complete calibration data taken from 1956 to the present time by this Laboratory are presented and discussed. The calibration numbers now considered valid for the system of detectors and counting equipment described are given.

CWLR - 2299 - AN EXPERIMENTAL STUDY OF THE INDUCTION OF GAMMA-EMITTING ACTIVITIES IN SEVERAL AMERICAN SOILS BY NEUTRONS OF VARIOUS ENERGIES (U).
John H. McNeilly and Eugene Eichler, September 1956.
UNCLASSIFIED

(U) This report describes experiments conducted at the Oak Ridge National Laboratories to determine the important gamma-emitting nuclides which are formed in soils by neutrons of various energies.

Two nuclear reactors were used as sources of neutrons. The gamma rays resulting from the activity induced in the soils were measured with a 20-channel, differential pulse-height analyzer. The resultant spectra were then analyzed to determine the amount of activity produced by a known neutron flux.

The conclusions established were:

1. The principle induced activities formed by thermal-neutron irradiation in the soils studied are Al^{28}, Mn^{56} and Na^{24}.

2. The induced activities due to thermal-neutron activation are proportional to the amounts of the parent element in the soils studied.

3. Induced activity from Mg^{27} was formed from neutrons with energies greater than 2 Mev. However, the dose rate due to Mg^{27} is insignificant because the dose rate due to Al^{28} predominates at similar times.

4. The majority of the induced activity resulting from the detonation of a fission nuclear device is due to the radioactive capture reaction, while (n, a) and (n, p) reactions of lost neutrons produce only small quantities of activity.

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CWLR - 2307 - THE FEASIBILITY OF REDUCING THE COST OF DISPOSAL OF REACTOR WASTES BY USING FISSION PRODUCTS AS HEAT SOURCES.
L. M. Hardin and R. P. Beckelheimer, November 1959.
UNCLASSIFIED

(U) The growth of the nuclear-power industry during the period 1960 to 1980 will be accompanied by a large increase in the annual quantity of fission-product wastes. These wastes must be processed, stored, and ultimately disposed of in a manner such that control over them will be maintained for periods of the order of hundreds of years. The eventual buildup of waste materials will pose problems of containment and will require the investment of large sums of capital for waste disposal.

The feasibility of reducing the cost of waste disposal by utilizing the energy of the decaying fission products for the production of useful heat is explored. For this purpose, it is assumed that an efficient fission-product "furnace" can be devised for converting both the beta and gamma radiation emitted by the fission products into heat. In order to show the overall magnitude of the potential heat-producing capability, the following predictions and calculations are presented:

(1) the rate of growth of the nuclear-power industry;

(2) the total fission-product power per unit reactor power;

(3) the useful fission-product heat output per unit reactor power;

(4) the useful heat output from all the fission products resulting from the nuclear power industry during the period 1960 to 1980.

The total useful radiation power available for the system postulated in this study ranges from $3.5X10^6$ Btu/hr (1000 Kw) in 1961 to $1X10^9$ Btu/hr (879,000 Kw) in 1980. These figures represent the useful power available when the initial use of mixed fission products begins 100 days after removal from the reactor and the energy is used as process heat.

The value of the heat produced by a given fission-product heat facility is compared with the costs of producing it. An analysis of the costs involved in the production of heat indicates that the overall costs are significantly greater than the value of the heat produced. In addition, a practical heat-use program cannot be completely substituted for the ultimate disposal system. The fission products must eventually enter the disposal system for long-term containment, since the specific activity of a given fuel loading will decrease to a level such that the use of it as a heat source is no longer profitable.

It is concluded that:

(1) The use of fission products as heat sources as a means of reducing the cost of waste disposal is not feasible.

(2) No justification exists for the initiation of a development project for the recovery of heat from fission products.

CWLR - 2353 - THERMAL ATTENUATION BY CHEMICAL SMOKES.
J. J. Mahoney, D. D. Keough and D. T. Kilminster,
January 1960.
UNCLASSIFIED

(U) The purpose of this investigation was to determine experimentally the relative capabilities of six smokes for protection against thermal radiation from nuclear detonations.

The six smokes used were fog oil, napthalene (carbon), titanium tetrachloride (FM), chlorosulfonic acid-sulfur trioxide (FS), hexachloroethane (HC), and silicon tetrachloride-ammonia.

A carbon arc was used as a point source of thermal radiation. Transmission of thermal radiation through various smoke concentrations and distances was measured.

From the results of these experiments it was concluded that:

1. An absorbing smoke, such as napthalene (carbon), is much more effective (by a factor of about 4) than a scattering smoke in reducing thermal radiation from a 6,000°K source, for smoke concentrations of 0.5 gm/sq m (384 gal/sq mi).

2. The transmissivity values of FM, FS, HC, and silicon tetrachloride-ammonia smokes are almost identical (within $\pm$ 5%) for any particular concentration less than 2 gm/sq m.

3. Fog oil smoke has moderately better screening properties than the FM, FS, HC, and silicon tetrachloride-ammonia smokes; its transmissivity value is about 20% less than the others for any particular concentration of smoke less than 2 gm/sq m.

4. Transmissivity values of smoke, as measured by photovoltaic cells, are too low and are, consequently, unreliable.

CWLR - 2370 - LABORATORIES AND FIELD STUDIES CANDIDATE RADIOLOGICAL WARFARE ADHESIVE AGENTS (U).
M. A. Schmoke and R. J. Smith, May 1960.
CONFIDENTIAL

[redacted] The objectives of this investigation were to conduct laboratory and field studies on the effects of varying climatic conditions on the adherence of certain candidate radiological warfare (RW) liquid adhesives to road surfaces under conditions of realistic military traffic on these adhesives. The adhesives tested were polymethyl methacrylate (Lucite) in ethylene dichloride, polystyrene in ethylene dichloride, and yellow traffic paint, Fed Spec TT-P-115a. Tracer quantities of zirconium-niobium oxide were mixed with all the adhesives to simulate the RW contamination and for radiological evaluation purposes.

Laboratory tests were made in the Atlas Weather-Ometer to determine the effects of moderate and high temperatures and humidities on the durability of the adhesives. Four field tests were conducted to determine the adhesives' durability under various traffic and climatic conditions: (1) winter, passenger vehicles; (2) summer and fall, passenger vehicles; (3) winter, tanks and heavy trucks; (4) fall, military armored convoy.

The conclusions to be drawn from this report are:

1. Varying weather conditions have no appreciable effect on the bonding properties of the polystyrene adhesive formulation.

2. The polystyrene adhesive formulation demonstrates excellent adhesive and wear resistance on asphaltic roadways under heavy and light military traffic up to the test traffic density of 3,000 vehicles a month.

3. The polymethyl methacrylate adhesive formulation shows very poor adhesive properties and wear resistance.

4. Traffic paint shows excellent possibilities as a bonding agent because it held up slightly better than polystyrene and was less troublesome to prepare.

CWLR - 2377 - EXTERNAL NEUTRON MEASUREMENTS 1952 through 1958 (U).
J. H. McNeilly, J. E. Frandolig, D. L. Rigotti, March 1960.
SECRET-RESTRICTED DATA

(U) The data are presented herein as a complete compilation of all the reported neutron-flux and neutron-dose measurements made by the

Department of Defense agencies utilizing the threshold-detector technique. The results as tabulated are for all nuclear weapons tests from Operation TUMBLER-SNAPPER (1952) through Operation HARDTACK (1958). The data are for all clear line-of-sight measurements. Neutron-dose information is presented where sufficient neutron-flux data were available to permit its calculation. It is expected that this compilation of data will be helpful to those whose work entails use of such measurements.

CWLR - 2378 - A PORTABLE LOW-LEVEL ALPHA COUNTER FOR FIELD USE.
A. Lind and J. C. Goshorn, Jr., March 1960.
UNCLASSIFIED

(U) In radiological work involving alpha emitters, a system should be available for detecting low-level alpha contamination. One of the preferred methods for detecting alpha contamination in the laboratory has been the swipe technique. If a portable instrument were available for reading the swipes, this method could also be employed in the field.

In order to develop an instrument suitable for field use, a survey meter with an air proportional probe, nuclear Chicago model 2111 (Pee Wee), has been modified so as to result in a scintillation-survey meter with an enclosed chamber. The modified survey meter uses an end-window multiplier-phototube and a zinc sulfide phosphor mounted in a housing suitable for counting swipes. The swipe technique involves swiping the area suspected of contamination with a small piece of filter paper. The paper is then placed in the housing of the chamber and counted.

The modified instrument when used with swipes provides a reliable method of detecting very low levels of alpha contamination in the field. Very low levels of alpha contamination can be detected because the geometry of the chamber, and the elimination of a window, provide an overall counting efficiency of approximately 70% of 2π with a U_3O_8 standard.

The portable alpha counter enables one to extend the very sensitive swipe technique of detecting alpha contamination to areas only accessible with a portable instrument.

The modified instrument is convenient, sensitive, stable, and requires a minimum of maintenance.

CWLR - 2380 - THE FEASIBILITY OF USING A REACTOR AS A NUCLEAR-WEAPON SIMULATOR FOR SOIL-ACTIVATION STUDIES (U).
J. H. McNeilly and E. F. Wilsey, June 1960.
UNCLASSIFIED

(U) The experiment described uses a nuclear reactor as a neutron source to simulate a nuclear weapon for studying the residual gamma activity induced in soils. The results obtained are then compared with results obtained from a nuclear detonation.

The reactor-irradiation and nuclear-detonation data are in good agreement for sodium; however, the results with manganese are between 35% and 50% higher for the reactor irradiation than for the nuclear detonation.

The behavior of the thermal-neutron flux with relation to depth was very similar at depths greater than 15 cm. The nuclear-detonation neutron-flux data showed a peaking of the thermal flux at about 8 cm, but these peaks were not seen in the nuclear-reactor data. This was explained by the neutron-spectrum differences and the lack of optimum experimental conditions because of a rainstorm during irradiation by the reactor.

Although the feasibility of using a reactor in place of a nuclear detonation for studying neutron-induced activities in soil looks promising, it cannot be definitely established by the results of this study. A soil sample with the same characteristics as the one exposed to the nuclear detonation should be irradiated by a reactor under more suitable experimental conditions than were obtained during this experiment.

CWLR - 2385 - ALPHA-CONTAMINATION STUDIES AT OPERATION PLUMBBOB AND HARDTACK (U).
R. J. Smith, May 1960.
SECRET-RESTRICTED DATA

[redacted] Three recent detonations which produced alpha contamination are reviewed to provide background information for the successful operation of the Chemical Corps Plucon Teams. Weapons data, ground-zero layout, meteorological conditions, alpha-survey and air-sampling results are presented for Shots NTS-57, Operation PLUMBBOB, and Shots Quince and Hamilton, Operation HARDTACK. The effects of wind and the jet on the contamination pattern are discussed.

[redacted] The conclusions drawn from this report are:

1. Shot NTS-57, bottom detonated on the ground, produced a residual-hazard area which extended 1,500 ft downwind. High concentrations of respirable plutonium particles in the primary aerosol were observed at 5,000 ft downwind.

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2. Shot Quince, detonated on the ground, produced an alpha-hazard area (1,000 μg/sq m), before translocation, of no more than 100-yd radius from ground zero.

3. Shot Hamilton, detonated on a 50-ft tower, produced a hazardous alpha-contamination area within a 10-yd radius of the tower.

4. The alpha-contamination pattern can be significantly changed by translocation of contaminated particles by the wind.

5. More experimental evidence is necessary to confirm the validity of the jet theory.

CWLR - 2394 - SIGNIFICANCE OF THERMAL RADIATION AS A HAZARD TO TROOPS IN FOXHOLES (U).
J. J. Mahoney, J. C. Maloney and D. T. Kilminster,
May 1960.
CONFIDENTIAL

(U) Personnel in open foxholes are partly protected against the hazards of blast, neutron and gamma radiations, and thermal radiation from nuclear detonations. A study was made of the current theoretical and experimental data to determine the slant distances at which immediate casualties to troops may be expected because of these hazards. A series of curves is published in Capabilities of Atomic Weapons (U), Technical Manual 23-200, showing the distances for a 50 per cent probability of immediate casualties attributable to the above injury-producing effects to troops in the open field. The series of curves was used as a basis for determining the probability of immediate casualties to troops in standard 2 by 4 by 6-ft open foxholes.

[redacted] The most extensive measurements to date of thermal radiation in foxholes were done at Operation UPSHOT-KNOTHOLE. It was suspected that the thermal-measurement data were unreliable because of the thermal detectors used and certain assumptions made for the calculations. For purposes of rechecking some of these thermal data, the present work was undertaken by using thermal radiation from sunlight instead of that from a nuclear bomb. These solar-radiation measurements indicated that the thermal flux in the shaded portions of open foxholes is a significantly greater fraction of the total thermal flux than is indicated by the data obtained at nuclear tests.

[redacted] The following conclusions were reached as a result of this work:

1. When the thermal radiation is incident side-on (6-ft side), the thermal flux is equal to 10 to 25 per cent of the above-ground value

at all points in the shaded portion of the foxhole between 1 and 3 ft from the top, if the diffuse-reflection coefficient of the wall surfaces is one third or more and at least 1 ft of the back wall is exposed to direct thermal radiation.

2. When the thermal radiation is incident end-on (2-ft side), the thermal flux is equal to 10 to 35 per cent of the above-ground value at all points in the shaded portion of the foxhole between 2 and 3 ft from the top, if the diffuse-reflection coefficient of the wall surface is one third or more and at least 2 ft of the back wall is exposed to direct thermal radiation.

3. Caution must be used in the prediction of the thermal-radiant exposure in a foxhole, since there are a significant number of instances for which the radiant exposure is not proportional to the amount of wall exposed, or does not decrease with depth in the foxhole or does not decrease with distance from the exposed wall.

4. For a 5 per cent or greater thermal-transmission value for foxholes and bomb yields $>$230 KT, there is a range of slant distances in which there is a 50 per cent probability of immediate casualties attributable to thermal-radiation burns, while only minimal injuries are anticipated because of the initial nuclear radiation (200 rem or less) and overpressure (moderate damage or less to foxholes). In the instance of a 10 per cent thermal-transmission value for foxholes, this same conclusion holds for bomb yields $>$ 37 KT.

VII. [redacted] CHEMICAL WARFARE LABORATORIES TECHNICAL MEMORANDA. (CWL TM)

CWL TM - 34-1 - INTERIM MEASURES TO COPE WITH ACCIDENTAL ATOMIC INCIDENTS (U).
Robert J. Smith and Manfred Morgenthau, November 1957.
CONFIDENTIAL

(U) Interim measures to cope with accidental atomic incidents which spread plutonium alpha contamination are proposed. Included are instructions on how to delineate the contaminated area, use and selection of a monitoring instrument, safety procedures and equipment, permissible concentrations, and methods of decontamination and recovery of contaminated areas and personnel.

CWL TM - 34-2 - POTENTIAL AVAILABILITY OF RW AGENTS FROM THE U. S., CANADA, AND WESTERN EUROPE (U).
Luther M. Hardin, 7 January 1958.
SECRET-RESTRICTED DATA

[redacted] Forecasts of the growth of nuclear power and the resultant RW agent availability in NATO and other friendly nations are given along with the the revised estimates of United States capabilities to 1980.

[redacted] The current predictions of the growth rate of the United States [redacted]-power industry are lower for the next decade than previously reported in CRLR 603, but higher for subsequent periods. Estimates of agent availability/1,000 megawatts of nuclear power have been revised downward. In spite of these lower estimates, the combined capability of the United States and friendly nations will be appreciably greater than the previously predicted capability. After 1970 the United States capability is essentially the same as predicted in CRLR-603.

(U) A summary of the estimates of total power levels, total RW agent to become available, and total target capability for the United States, Western Europe, and Canada are presented.

CWL TM - 34-3 - PRE-TEST PLANS FOR DOSE RATE BUILDUP FACTORS INSIDE A CONCRETE BUILDING (U).
Ralph E. Rexroad and Murray A. Schmoke, March 1958.
UNCLASSIFIED

(U) This experiment was set up to correlate the experimental, gamma-dose-rate, buildup factors and other attenuation effects of buildings with theoretical calculations so that reasonably accurate predictions of the dose rates inside buildings can be made.

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Information is furnished on the layout to determine experimentally some effects of wall thickness, roof thickness, and photon energy on the buildup factor for gamma-ray dose rates inside a concrete building and also to determine their effects on the net attenuation furnished by the building.

VIII. (U) CHEMICAL WARFARE LABORATORIES SPECIAL REPORTS. (CWL SP)

CWL SP 3-5 - BIBLIOGRAPHY WITH ABSTRACTS OF RADIOLOGICAL DIVISION REPORTS FROM MAY 1954 to MAY 1958 (U).
Robert J. Smith, October 1959.
SECRET-RESTRICTED DATA

(U) This report presents a bibliography, with abstracts, of all research reports published from May 1954 to May 1958 by the Radiological Division. It supplements CRLR 413, Bibliography, with Abstracts, of Reports of Radiological Division, Chemical and Radiological Laboratories (U), prior to 1 May 1954.

Included in this report are abstracts of Chemical and Radiological Laboratories reports (CRLR) from May 1954 to 7 June 1956; Chemical Warfare Laboratories reports (CWLR) from 27 June 1956 to October 1957; technical memoranda (TM) from November 1957 to May 1958, interim test reports (ITR) and weapons test reports (WT) from May 1954 to March 1958. There are in addition a subject index, an author index, and a list of contract reports received by the Radiological Division in the period covered.

CWL SP 3-7 - DESCRIPTION AND OPERATION OF CHEMICAL CORPS HELICOPTER-TO-GROUND AERIAL SURVEY INSTRUMENT.
M. J. Schumchyk, J. P. Johnson and J. R. Lapic, September 1959.
UNCLASSIFIED

(U) This publication describes helicopter-to-ground aerial radiological survey instrument and its operation.

The instrument consists of a radiation detector mounted in a tripod connected by a four-conductor cable to an indicating meter through a power reel. While the helicopter hovers several hundred feet in the air, the radiation detector can be positioned 3 ft above the ground.

This instrument is especially suitable for an accurate point survey of radiation fields where survey by ground crews is impractical either because of excessive dose rates in the area or because of inaccessible terrain features.

CWL SP 3-8 - A PORTABLE REMOTELY OPERATED DEVICE FOR PRODUCING A GAMMA RADIATION FIELD.
R. E. Rexroad and M. A. Schmoke, December 1959.
UNCLASSIFIED

(U) This report describes a portable field device for lifting a high intensity gamma radiation source from its shield without exposing the personnel involved to harmful radiation.

The device raises the radioactive source from its steel-jacketed lead shield by air pressure. First, a lead plug is removed from the shield and replaced by a stainless-steel plug containing two concentric aluminum tubes that have an air-inlet hose near their base. The air hose is then connected to an electrically operated air compressor that forces air through the outer aluminum tube to the underside of the radioactive source, which is pushed upward into the inner aluminum tube. The radioactive source remains suspended in the inner aluminum tube until power to the air compressor is turned off and the air pressure reduced.

The portable remotely operated device described above for producing a gamma radiation field performs satisfactorily. High-level radiation fields can be produced with this system with very little exposure of test personnel to radiation.

IX. (U) CHEMICAL RESEARCH AND DEVELOPMENT LABORATORIES. (CRDLR)

CRDLR - 3005 - ESTIMATION OF GAMMA DOSE RATES FROM INDUCED ACTIVITY IN SEVERAL AMERICAN SOILS (U).
S. B. Kaufman, P. W. Krey, J. H. McNeilly and R. J. Smith, July 1960.
CONFIDENTIAL

(U) A theoretical equation for predicting the dose rates from neutron-induced activities in soil is derived. Dose rates calculated with the data from a nuclear device detonated at 524 feet above Nevada soil are compared to the empirically determined dose rates for the same detonation.

The dose rates generated over three other soils are calculated by the equations derived in this report and compared with the dose rates calculated by three other prediction methods.

The theoretical equation derived in this report to predict the dose rate produced by induced activity in soils agrees with empirical dose rates within 50%. The predicted dose rates are lower than the empirical values at small slant ranges and higher at slant ranges greater than 1,200 yards.

CRDLR - 3008 - MULTIPLE COLLISION THEORY NEUTRON DOSE VERSUS SINGLE COLLISION THEORY NEUTRON DOSE (U).
J. H. McNeilly, J. W. Kinch and D. L. Rigotti, July 1960.
SECRET-RESTRICTED DATA

(U) A comparison of neutron dose calculations based on the multiple collision theory is made with neutron dose calculations based on the single collision theory.

The comparison consists of experimental measurements made at nuclear weapons tests where 99 sets of data were obtained.

The results of this investigation show that the multiple collision theory dose is significantly greater than the single collision theory dose.

The average ratio of the multiple collision dose to the single collision dose is 1.49 ± 0.08.

The above ratio holds for all the measurements made by this laboratory for the devices studied.

CRDLR - 3020 - A SURVEY OF SOLID-STATE GAMMA/NEUTRON DETECTION SYSTEMS. R. Gminder, J. W. Kinch, A. L. Knipp, Jr., and J. H. McNeilly, July 1960.
UNCLASSIFIED

(U) This report, which is based on an extensive literature search and on personal contacts with some of the leading researchers in solid-state radiation detection, presents the major advantages and limitations of many solid-state detection systems. Some recently proposed and partially studied systems are also discussed. The systems have been classified according to the radiation-induced effect utilized for measurement. A total of 197 references was consulted in the preparation of this report.

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X. ([redacted]) CHEMICAL RESEARCH AND DEVELOPMENT LABORATORIES TECHNICAL MEMORANDA. (CRDL TM)

CRDL TM 50-1 - COLD WEATHER DECONTAMINATION STUDY.
J. C. Maloney, July 1960.
UNCLASSIFIED

(U) This report covers the following objectives:

(1) To collate existing data pertinent to radiological decontamination under cold weather conditions.

(2) To identify requirements for additional cold weather decontamination experimental data needed to provide input for a cold weather addendum to the manual TM 3-225 (NAVDOCKS TP-PL-13) "Radiological Recovery of Fixed Military Installations."

(3) To design an experimental program to provide the needed input data on cold weather decontamination.

CRDL TM 50-2 - PRELIMINARY FEASIBILITY STUDY OF THE BREMSSTRAHLUNG RAY GUN CONCEPT AS A U. S. ARMY WEAPON SYSTEM (S).
H. J. Donnert, February 1961.
SECRET

([redacted]) This report is a preliminary theoretical feasibility study to obtain an indication of the merits and the feasibility of using a linear electron accelerator as a battlefield bremsstrahlung ray gun.

XI. ([redacted] NUCLEAR DEFENSE LABORATORY TECHNICAL REPORTS. (NDL TR)

NDL-TR-1 - EFFECTS OF SUBKILOTON NUCLEAR WEAPONS (U).
L. M. Hardin, A. L. Knipp, Jr., R. Gminder, and E. F. Wilsey, October 1960.
SECRET-RESTRICTED DATA

[redacted] The development of very low-yield nuclear weapons and the evolution of the Davy Crockett weapons system resulted in a requirement for the experimental determination of the effects of such weapons. An extensive effects program was therefore conducted in conjunction with four test firings of a subkiloton device during the Eniwetok and Nevada phases of Operation HARDTACK. The resulting data are correlated and summarized in this report and realistic troop safety and casualty radii are presented for yields ranging from 1 to 200 tons.

[redacted] The experimental data from three subkiloton shots of Operation HARDTACK indicate that

(a) the initial nuclear radiation is the controlling effect for the determination of troop-safety distances and casualty radii,

(b) the safety distances and casualty radii specified by the conceptual studies of the Davy Crockett weapons system are realistic,

(c) with the exception of fallout and of blast overpressures below 10 psi, the weapons effects of interest agree generally with extrapolations of data from higher yield detonations.

NDL-TR-2 - SCATTERED RADIATION AND FREE FIELD DOSE RATES FROM DISTRIBUTED $COBALT^{60}$, and $CESIUM^{137}$, SOURCES.
R. E. Rexroad and M. A. Schmoke, September 1960.
UNCLASSIFIED

(U) The purpose of this work was to verify theoretical calculations that will predict the radiation level above a uniformly contaminated plane of gamma radiation and serve as the open-field data for later shielding experiments.

Two sources, cobalt-60 and cesium-137, were used to simulate the uniformly contaminated plane. The dose rates at various heights above

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the source plane were measured with ionization-chamber dosimeters. Analytical expressions of the buildup factor to account for the increase in dose caused by scattered radiation were developed, and experimental results compared with theory.

The conclusions established were:

1. Buildup factors to account for ground-and air-scattered radiation at a height, h, above an annular source of slant radius, r, may be expressed by $B(h,r) = a + b\ \mu r + c_o e^{-c_1 \mu r}$, as follows:

$$B_{Co\text{-}60}(h = 1\ ft) = 1.09 + 0.549\mu r + 0.189e^{-71.1\mu r}$$

$$B_{Co\text{-}60}(h = 3\ ft) = 1.11 + 0.529\mu r + 0.157e^{-86.1\mu r}$$

$$B_{Co\text{-}60}(h = 6\ ft) = 1.13 + 0.529\mu r + 0.150e^{-86.2\mu r}$$

$$B_{Cs\text{-}137}(h = 1\ ft) = 1.03 + 0.629\mu r + 0.164e^{-18.3\mu r}$$

$$B_{Cs\text{-}137}(h = 3\ ft) = 1.04 + 0.681\mu r + 0.158e^{-13.1\mu r}$$

$$B_{Cs\text{-}137}(h = 6\ ft) = 1.07 + 0.677\mu r + 0.118e^{-10.7\mu r}$$

2. The dose rate at height, h, above a uniformly contaminated disk of radius X may be determined by the expression above for the buildup factor and the following equation:

$$D(h,X) = D(h, R) = 2\pi D_o \left[a \left\{ \left[E_1\ (\mu h)\right] - \left[E_1\ (\mu R)\right] \right\} + b \left\{ e^{-(\mu h)} - e^{-(\mu R)} \right\} + c_o \left\{ \left[E_1 \left\{ (c_1 + 1)\ (\mu h) \right\}\right] - \left[E_1 \left\{ (c_1 + 1)\ (\mu R) \right\}\right] \right\} \right]$$

where $R^2 = h^2 + X^2$

3. For radii greater than approximately 70 feet, experimental results agreed within $\pm$ 5% with theoretical calculations of the gamma dose rate above uniformly contaminated planes of cobalt-60 and cesium-137.

4. The experimental dose rates above a uniformly contaminated infinite plane are:

Source	Height above plane	Dose rate
	feet	mr/hr/curie/sq ft
Cobalt-60	1	614,000
	3	497,000
	6	430,000
Cesium-137	1	169,000
	3	138,000
	6	118,000

NDL-TR-3 - GROUND PENETRATING RADIATION (LIP CONTRIBUTION) IN A FOXHOLE FROM A FALLOUT FIELD SIMULATED BY COBALT^{60}.
M. J. Schumchyk and H. J. Tiller, December 1960.
UNCLASSIFIED

(U) The purpose of this work was to determine dose rates in a foxhole due to gamma radiation contamination on the area adjoining the foxhole (lip contribution) located in a residual fallout field.

A cobalt-60 gamma source was used to simulate the fallout field. The dose rate versus depth in a foxhole, 4 ft in diameter and 4 ft in depth, resulting from lip contamination was measured with 1- and 10-mr stray radiation chambers.

The lip contribution, i.e., the ground scattered dose rate from radiation that penetrates any finite amount of earth, to the total radiation received in a cylindrical foxhole, was calculated and compared with the measured results. Also calculated is the skyshine or air scattered dose rate obtained at different levels in the foxhole.

The conclusions established were:

1. The dose rate contribution from the lip of a 4-ft-diameter foxhole, located in an infinite contaminated field, averages 68% of the total dose received in the foxhole for the case where the lip contribution is measured and skyshine is calculated.

2. In the case where both are calculated from theory, the dose rate average is 4% lower.

3. Clearing an annulus 2 ft wide around the edge of the foxhole removes about 99% of the lip contribution; therefore, removing about 64% to 68% of the total radiation received in the foxhole.

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NDL-TR-4 - THE CONTRIBUTION OF SCATTERED RADIATION TO IMMEDIATE THERMAL CASUALTIES IN OPEN FOXHOLES.
J. J. Mahoney, April 1961.
CONFIDENTIAL

[redacted] Personnel in open foxholes are partly protected against the hazards of thermal, neutron, and gamma radiations and blast from nuclear detonations. A study was made of current data in order to develop a method for predicting the distances at which troops in open foxholes may be expected to become immediate casualties due to these hazards. In particular, calculations were made in order to predict the distances at which immediate casualties, due to thermal radiation, would occur where neither the initial nuclear radiation nor overpressure are sufficient to produce immediate casualties.

Sample calculations were made for the cases of Heights of Burst equal to $250W^{1/3}$ and $650W^{1/3}$ feet, where W is in kilotons. It was assumed in the sample calculations that the thermal radiation at certain representative points in the "shaded" portion of the foxhole was equal to 9% of the above-ground thermal radiant exposure. Further, this 9% was assumed to be made up of two parts, 5% diffusely reflected from the foxhole walls and the remaining 4% which entered the foxhole as atmospherically scattered radiation. These assumed percentages are based on previously published experimental works. Separate consideration for fission and thermonuclear types of bombs was necessary due to difference in character of the initial nuclear radiation in these two cases.

The following conclusions were reached as a result of this work:

1. The general formula for thermal radiation entering a foxhole, as used in the UPSHOT-KNOTHOLE work, was modified to take account of air scattered radiation.

2. For air burst bombs of yields greater than about 70 KT immediate thermal casualties are produced for troops in open foxholes at significant distances, calculated using available experimental data, for which the initial nuclear radiation and overpressure hazards are only nominal or negligible.

3. Contrary to previous doctrine, the thermal radiation which enters a foxhole as a result of atmospheric scattering is significant and should be considered in estimating casualties.

[redacted]

NDL-TR-5 - FAST NEUTRON CROSS SECTIONS OF MANGANESE, CALCIUM, SULFUR, AND SODIUM.
E. S. Troubetzkoy, et al. Contract DA18-108-405-CML-295.
Final Report (for) Phase II, January 1961.
UNCLASSIFIED

(U) A set of neutron cross sections for manganese, calcium, sulfur, and sodium has been prepared for energies up to 18 Mev. The cross sections tabulated include σ_T, σ_{nn}, $\sigma_{nn'}$, σ_{nx}, $\sigma_{n\gamma}$, σ_{np}, $\sigma_{n\alpha}$, $\sigma_{n,2n}$, $\sigma_n(\theta)$, $\sigma_{nn'}(E,E')$, and $\sigma_{nx\gamma}(E,E_\gamma)$.

NDL-TR-6 - ATTENUATION OF SIMULATED FALLOUT RADIATION BY THE ROOF OF A CONCRETE BLOCKHOUSE.
M. A. Schmoke and R. E. Rexroad, August 1961.
UNCLASSIFIED

(U) The purpose of this work was to experimentally verify theoretical calculations of the effect of roof thickness on the radiation level inside a concrete blockhouse from a plane of gamma radiation on the roof of the building.

Two gamma emitters, cobalt^{60} and cesium^{137}, were used to simulate uniform planes of radiation. The dose rates at various locations within the blockhouse were measured with ionization-chamber dosimeters. Reduction factors were calculated from the data and compared with theory.

The following conclusions were established:

1. Comparison of the experimental and theoretical reduction factors, which were made along the vertical center line of the structure, showed bery good agreement.

2. The corners of the blockhouse offered considerably more protection than did other locations with the building.

3. The experimental dose rates at the 3-ft height are from 50% to 70% higher at the center than at the corner for roof thicknesses from 3 to 50/lb sq ft.

NDL-TR-7 - A BROAD RANGE CHEMICAL DOSIMETER FOR GAMMA RADIATION.
N. Klein, April 1961.
UNCLASSIFIED

(U) This report describes the use of an air-saturated, aqueous benzene system as a simple chemical dosimeter that measures gamma dose in the tactical range and higher with accuracy and precision. The system described is a laboratory technique that may have field application. It is not currently suitable for consideration as a tactical dosimeter. However, this rather simple system is capable of measuring dose in the range 20 r to 35,000 r.

NDL-TR-8 - NEUTRON FLUX MAPPING FOR THE KUKLA FACILITY (U).
J. H. McNeilly and J. W. Kinch, September 1961.
UNCLASSIFIED

(U) Neutron dosimetry measurements were conducted by this Laboratory at the KUKLA Facility of the Lawrence Radiation Laboratories, Livermore, California, during the period April 5 - 11, 1961. The measurements were made to supply input data for the Boeing Airplane Company's study of the effects of radiation on electrical components.

The threshold detector system was used in making the measurements which included (1) neutron flux versus distance from the source, and (2) perturbation of the neutron flux caused by the electrical components exposed in the radiation field. The flux shows a slight deviation from a $1/R^2$ dependence at distances of less than 25 cm. There is little, if any, perturbation of the flux field due to the insertion of various electrical components.

NDL-TR-9 - THE EFFECTS OF BORON-10 SHIELDS ON THE CALIBRATION OF NEUTRON THRESHOLD DETECTORS (U).
J. H. McNeilly and J. W. Kinch, September 1961.
UNCLASSIFIED

(U) This report describes the results of an experiment designed to study the effect of boron-10 shields on the neutron flux and spectrum as measured by threshold detectors. The results include comparison of data obtained from threshold detectors exposed to a neutron field in the following environments: in steel spheres whose periphery is filled with boron-10, in pressed and sintered boron-10 spheres, in cadmium capsules, and unshielded.

It was found that there was no significant difference between results obtained from threshold detectors exposed in the pressed and sintered boron-10 spheres and the results obtained from threshold detectors exposed in steel spheres with boron-10 filled peripheries.

The cadmium spacers which separate the threshold detectors from each other in the boron-10 sphere have no significant effect on the measured neutron flux and spectrum.

There is a real effect of the boron-10 sphere on the neutron flux and spectrum as measured by the threshold detectors within the sphere. A thirty per cent attenuation factor is observed for the sulfur threshold detector. A quantitative attenuation factor was not obtained for neptunium-237 and uranium-238 because of the poor reproducibility of the data. Further, experimentation is necessary before a reliable attenuation factor can be applied for these two threshold detectors.

The calibration of an automated counting system contained within a mobile laboratory is included as an appendix.

NDL-TR-10 - THE IDENTIFICATION OF SOME PRODUCTS PRODUCED ON STORING TRICHLOROETHYLENE (U).
R. A. Sasse, N. Klein, and J. Harris, September 1961.
UNCLASSIFIED

(U) Trichloroethylene, which had been stored for an extended period in contact with aqueous NaOH, was found to acidify pure water. Experiments were carried out to determine whether this effect was due to spontaneous hydrolysis or to extraction of acid produced during storage.

Samples of the stored trichloroethylene and freshly purified trichloroethylene were stirred with conductivity water, and pH was measured as a function of time. Freshly purified trichloroethylene did not decrease the pH of water. The rate and degree of extraction of acids from the stored trichloroethylene varied with the initial pH.

Hydrochloric and glyoxylic acid were identified among the acids produced during the extended storage of trichloroethylene with base.

NDL-TR-11 - METHOD OF EVALUATION OF EXPERIMENTAL MEASUREMENTS OVER A RECTANGULAR SOURCE (U).
J. L. Meredith, April 1961.
UNCLASSIFIED

(U) Data analysis of field radiological decontamination tests involve evaluation of detector response over finite test areas. A method of calculation is derived for the theoretical detector response over a rectangular source by numerical integration of the function dA/r^2, where A is the source area and r is the distance between an element of source area and the detector. Numerical results for rectangle of dimensions of 20 X 100 feet and detector height of three feet are presented. Effects of uneven distribution of contaminant over source area are considered and method of statistical analysis of data is derived.

NDL-TR-12 - NEUTRON FLUX MEASUREMENTS OF THE TRIGA MARK F REACTOR (U).
J. H. McNeilly and J. W. Kinch, September 1961.
UNCLASSIFIED

(U) The neutron environment of the Triga Mark F Reactor was determined by using the neutron threshold detector system. A total of 107 measurements were made resulting in 562 separate neutron flux determinations. This report contains the results of the measurements and a description of the experimental procedure. An appendix is also included which presents neutron flux data obtained from the Triga Mark I Reactor during April 1959 and on 12 October 1960.

NDL-TR-15 - RECENT DEVELOPMENTS IN THE NEUTRON ACTIVATION THRESHOLD DETECTOR SYSTEM AS USED BY THE U. S. ARMY NUCLEAR DEFENSE LABORATORY (U).
J. H. McNeilly and J. W. Kinch, September 1961.
UNCLASSIFIED

(U) This report describes an experimental investigation of uranium-235, magnesium, and aluminum as activation-type neutron detectors and the calibration of recently installed automatic counting equipment used with the threshold detector system.

As a result of the investigation, uranium-235, magnesium, and aluminum have been added to the threshold detector system. Uranium-235 (threshold of 1.5 Kev) provides another energy band in the low energy portion of the spectrum and magnesium and aluminum (thresholds of 6.3 Mev and 8.1 Mev, respectively) provide two more energy bands at the high energy portion of the spectrum.

The calibration numbers for all the materials used in the activation-type neutron detection system when used with the NDL automatic counting system are given.

[redacted]

XII. [redacted] NUCLEAR DEFENSE LABORATORY TECHNICAL MEMORANDA. (NDL-TM)

NDL-TM-1 - A CLANDESTINE ANTI-AIRCRAFT DEVICE (U).
Nathan Klein, May 1961.
SECRET

[redacted] This report discusses the feasibility of a clandestine anti-aircraft device incorporating gallium metal. Specifically, this device employs gallium in the form of a pencil which would permit easy concealment. Application of the gallium to the aircraft results in destruction due to stress failure at the point of application.

[redacted]

XIII. [redacted] JOINT QMC-CMLC REPORT.

ETF - 760.931-1 - LAUNDERING DECONTAMINATION TEST CONDUCTED JOINTLY BY QMC and CMLC AT OAK RIDGE NATIONAL LABORATORY.
Howard James, John C. McWorter, Jr., John A. Pierce, Jr., William H. Carr, Jr., 9 September 1950.
CONFIDENTIAL

Published jointly by: Research and Development Division
Office of the Quartermaster General
Washington, D. C.

and: Chemical and Radiological Labs
Army Chemical Center, Maryland

[redacted] Preparatory to Operation GREENHOUSE, the Quartermaster Corps and the Chemical Corps ran joint tests on the decontamination of clothing contaminated by immersion in dilute dissolver solution. The standard Quartermaster laundry formulas were relatively ineffective in removing such contamination, but a specially developed formula (No. 77) was found to be effective. Synthetic detergents were found to have better decontaminating properties than fatty-acid soap, and citric acid was the most effective decontaminant tested. Naphtha dry cleaning proved unsatisfactory for clothing decontamination.

There were several related conclusions: (1) Standard Quartermaster Corps mobile laundry equipment proved suitable for laundering contaminated clothing. Where corrosion-resistant machines were used, no injury to the equipment resulted, nor was decontamination of the machines a problem. (2) The degree of its wear appeared to have no effect on the susceptibility to contamination or decontamination of khaki or fatigue clothing. (3) Synthetic fibers appeared to be more readily decontaminable than cottons or woolens. (4) The disposal of laundry waste water depends upon the contaminant decay rate and the degree of dilution. Contaminants in the waste water could not be removed by either a water-purification unit developed by the Corps of Engineers or by an electrophoretic filter.

XIV. [redacted] ATOMIC ENERGY COMMISSION AND OAK RIDGE NATIONAL LABORATORY REPORTS.

Y-685 - FILTRATION OF SO_3 GAS MOLECULES BY TYPE 6 PAPER.
Jess W. Thomas, 9 November 1950.
SECRET-RESTRICTED DATA

[redacted] Dry SO_3 gas when discharged into the air, forms a white fog due to the prompt combination of the gas with water vapor, resulting in a diffusion of sulfuric acid in the air. It was observed that if dry SO_3 were passed through an E1R2 aerosol canister containing two layers of Chemical Corps type 6 filter material, no visible cloud appeared as effluent. The observation promoted tests to determine whether this filter medium could indeed quantitatively remove such a gas or, as the author puts it, "atomic-size particulates."

Two experiments were conducted which showed that mole quantities of SO_3 gas were completely filtered, or sorbed, by two layers of type 6 paper construed to mean, within experimental error, that all heavy gas molecules flowing through the canister contact the filters en route and are sorbed. It was further concluded that newly formed, radioactive daughter-products of rare gases may be expected to behave similarly.

Y-700 - PREPARATION OF RADIOACTIVE METHYLENE BLUE FROM S^{35} LABELED SODIUM THIOSULFATE.
H. R. Bronstein and E. G. Struxness, 8 January 1951.
SECRET

[redacted] A tracer compound was synthesized for use as an agent in checking present methods of evaluating the efficiencies of smoke filters against particulate aerosols. Radioactive sulfur, S^{35} , was used in making sodium thiosulfate. This in turn was used in the synthesis of S^{35} labeled methylene blue by use of a modification of Bernthsen's method.

Y-791 - A FLOW-TYPE IONIZATION CHAMBER FOR MEASUREMENT OF ACTIVITY IN LOW ENERGY BETA EMITTING GASES.
R. L. Quinn, 1 August 1951.
UNCLASSIFIED

(U) A method is presented for the measurement of activity under conditions of flow over a wide range of activities of gases that emit low-energy beta rays. $S^{35}O_2$ gas was measured at flow rates of 32 liter/min with activities ranging from 10^{-10} to 10^{-1} curie/liter. Using this method, it is possible to continuously monitor the activity level of a radioactive-gas stream.

Y-793 - CALIBRATION OF A FLOW-TYPE IONIZATION CHAMBER WITH RADIOACTIVE SULFUR DIOXIDE.
J. W. Thomas and R. L. Quinn, 20 August 1951.
UNCLASSIFIED

(U) An ionization chamber equipped with a vibrating-reed electrometer and recorder was calibrated for continuously measuring radioactive sulfur dioxide in a flowing gas stream. The calibration was made by counting the S^{35} after conversion of gas samples to $BaS^{35}O_4$.

A calibration factor of 0.64×10^{-11} amp of ion current/μc/liter of $S^{35}O_2$ was established. The detectable limit was calculated to be 1.5×10^{-4} μc/liter. By using a collecting potential of 2,000 v, activities up to at least 3 mc/liter may be measured. At high voltages the ion current is proportional to the gas activity, no difference in ion current being noted when gas flowed through the chamber at 32 liter/min and when there was no gas flow.

ORNL - 1378 - GAS MASK CANISTER TESTS AGAINST RADIOACTIVE SULFUR DIOXIDE.
Jess W. Thomas, 2 September 1952.
SECRET-RESTRICTED DATA

[redacted] This report describes the development of an ultrasensitive method of gas-mask canister testing wherein a radioactive gas, $S^{35}O_2$, is used rather than a nonradioactive medium. Use of a radioactive test-medium makes possible readings of high sensitivity, and also permits the use of continuous-recording instruments for gas concentration determinations. S^{35} was selected as the test nuclide because it is a pure beta-emitter, so that shielding problems are negligible, and because its half-life of 87 days entails no serious, long-term decontamination problem.

The test apparatus and procedures are described. Penetrations as low as 10^{-3} mmg/liter could be estimated. The results indicate that the M11 canister has an efficiency greater than 99.98% against radioactive sulfur dioxide, (1 mc/liter) for the first 20 min of test.

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ORNL - 1414 - THEORY OF A DIFFUSION BATTERY.
Wendell DeMarcus and Jess W. Thomas, 16 October 1952.
UNCLASSIFIED

(U) A diffusion battery consists of a number of long, narrow rectangular channels arranged in parallel, through which an aerosol moves in streamline flow. The object of the work described was to develop an equation relating fractional penetration of aerosol with the diffusion constant of the aerosol.

An equation has been developed. Also a method is given for the calculation of the particle size and mass from the diffusion constant and the settling velocity.

ORNL - 1648 - THE DIFFUSION BATTERY METHOD FOR AEROSOL PARTICLE SIZE DETERMINATION.
Jess W. Thomas, 5 January 1954.
UNCLASSIFIED

(U) The object of the work described in this report was to design and construct several diffusion batteries and to investigate the validity of the diffusion method for size determination of sub-micron homogeneous aerosols. Two parallel-plate diffusion batteries were fabricated and used for particle size readings in the 0.1 μ radius range. The aerosol particle size as determined by the batteries was compared with the size as determined by a standard light-scattering method. The results agreed within 30%.

Circular-tube batteries were fabricated and used to check the applicability of the method to diffusion of particles as small as gas molecules. The diffusion coefficients of gas molecules obtained by the batteries agreed closely with the literature values.

It was concluded that the diffusion battery is a valuable instrument for study of the particle size of aerosols from atomic size up to particle radii of about 0.5 μ. Two batteries, with graphs of operating parameters, are now available for use in filter efficiency studies.

ORNL - 1655 - CLOUD CHAMBERS FOR MEASURING THE PARTICLE DENSITY OF AN AEROSOL.
Bernard G. Saunders, 19 February 1954.
UNCLASSIFIED

(U) This report summarizes the work performed in setting up and calibrating a continuous-action cloud chamber which determines the number of particles in a unit volume of aerosol.

The Green continuous-action cloud chamber has been placed in operation and calibrated. It was found suitable for measuring aerosol particle concentrations, regardless of particle size or size distribution, in the approximate range of 5×10^4 particles/cc to 2×10^6 particles/cc, with an accuracy of 5.2% standard deviation when a total of 500 particles is counted.

ORNL - 1656 - ELECTROSTATIC PRECIPITATOR FOR MEASURING PARTICLE-SIZE DISTRIBUTION IN AEROSOLS.
Bernard G. Saunders and R. L. Quinn, 8 February 1954.
UNCLASSIFIED

(U) This report summarizes the work accomplished in developing an electrostatic precipitator for the determination of particle-size distribution in smokes.

Devices of this sort have been constructed by other laboratories. Their operation depends on the depositing of particles by electrostatic means along a plate at distances corresponding to the particle size. Such devices have heretofore required that the deposited particles be counted under a microscope in order to determine the size distribution. The object of this project was to develop an instrument that would operate semi-automatically by indicating the particle distribution electrically. The scheme was to collect the charge-bearing particles on a series of collector plates. Particles of each size range would fall on a particular plate and impart charges at a measurable rate. Thus, a comparison of the beam currents would give the size vs number distribution.

A precipitator designed to meet this objective has been partially built and tested. Laminar flow of the smoke in the system was obtained. Under a given condition of laminar flow, the smoke stream can be seen to bend in an arc and diverge like a spectrum, as anticipated. It was hoped that the performance of the precipitator could be checked by measuring the diameters of the particles collected in various locations. Samples were collected on the plates for a variety of operating conditions. Electron photo-micrographs were made of the particles. At this reporting, none has been obtained which is sharp enough to permit measurement. Before further progress can be made, the problem of obtaining satisfactory micrographs must be studied.

ORNL - 1657 - ROTATING PRISM FOR USE WITH CLOUD CHAMBERS.
Bernard G. Saunders, 15 February 1954.
UNCLASSIFIED

(U) The use of a rotating prism is indicated when one wishes to observe moving cloud-chamber droplets and to measure their velocities.

Equations are developed here for computing the displacements of droplets and their rates of displacement as a function of the angular displacement and rotating speed of the prism. Also discussed are the limits of displacement and velocity of droplets that can be observed.

ORNL - 1660 - A SERVOMECHANISM FOR MEASURING AEROSOL PARTICLE SIZE AND A SERVOMECHANISM FOR CONTROLLING PARTICLE SIZE IN THE DIOCTYLPHTHALATE AEROSOL GENERATOR.
R. Louis Bradshaw, 29 January 1954.
UNCLASSIFIED

(U) Described herein is a servomechanism which continuously measures and records the particle size of homogeneous aerosols ranging from approximately 0.1 μ to 0.2 μ in radius. The principles of operation are explained and limitations of the instrument discussed with suggestions for improving its operation. Circuit diagrams and photographs of the instrument are shown.

A servomechanism for controlling particle size in the dioctylphthalate aerosol generator is also described. The principles of operation are explained and results of tests of the mechanism made on an analog of the generator are discussed. Reasons are advanced for the unsatisfactory operation of the instrument when applied to the actual generator, and suggestions for its improvement are made.

ORNL - 1666 - SOLID AEROSOL GENERATION.
W. D. Cottrell, 5 February 1954.
UNCLASSIFIED

(U) The problem under investigation was that of generating a homogeneous solid aerosol in sufficient concentration to permit its use for aerosol studies. The approach was by generating an aerosol of homogeneous liquid droplets from a suitable solution and then drying the droplets to form solid particles.

Several types of generators were investigated, the most promising being a highspeed airtop. The airtop was rotated at speeds up to approximately 20,000 rpm and gave liquid droplets as small as 20 μ in diameter. The minimum size of solid particles that could be produced from the droplets was not determined.

ORNL - CF-54-3-46 - CONSTRUCTION OF A LA MER TYPE THERMAL AEROSOL GENERATOR FOR RADIOACTIVE COMPOUNDS.
E. E. Grassel, 13 April 1954.
UNCLASSIFIED

(U) The object of this work was the design, construction, and evaluation of an aerosol generator capable of generating a stable, homogeneous, radioactive aerosol in the submicron-particle-size range.

This report describes the generator which F. A. Hedman (ORNL 1352) developed by modifying the La Mer aerosol generator. The author has constructed and tested a generator thus modified. Performance tests showed that the aerosol produced by the generator was stable over long periods of time and that the machine will operate on less than 500 mg of generating compound. The aerosol produced is relatively homogeneous as evidenced by the color bands visible in the aerosol when illuminated by a collimated beam of white light.

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XV. [redacted] WEAPONS TEST REPORTS.
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WT-19 - EVALUATION OF FILTER MATERIAL.
Operation GREENHOUSE.
Elmer H. Engquist, July 1951.
SECRET-RESTRICTED DATA

[redacted] Four types of Chemical Corps filter material and one type of Air Force air-sampling filter material were tested in sampling runs through radioactive clouds resulting from the air bursts of 3 atomic bombs of varying kiloton equivalents. Two or three passes were made through each of the atomic clouds by drone airplanes, at levels between 16,000 ft and 30,000 ft, within the first quarter hour following each detonation. A specially designed probe extended from the nose of each aircraft through which contaminated air was introduced into a closed duct. The air was exhausted from the duct through five test filters at a uniform flow equivalent to 32 liter/min at atmospheric pressure.

Results of the tests indicate that the high radioactivity associated with particulate matter of the clouds has no effect on the filtration properties of the various filter materials. The mean efficiency of Chemical Corps types 6, 7 and 8 respiratory-protective filter material was 99.7% to 99.8% against the gross particulate contaminant existing in an atomic bomb cloud 3 to 4 min after detonation. Under the same circumstances, the mean efficiency of Chemical Corps type 5 material was 84.1%, and that of Air Force polystyrene filter material was 74.3%.

WT-27 - CONTAMINATION-DECONTAMINATION STUDIES ALOFT.
S. R. Sinnreich, M. G. Gordon, and G. E. Fulmer, January 1953.
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(U) This report appeared as CRLR 104, 2 January 1953.

WT-42 - EVALUATION OF COLLECTIVE PROTECTOR EQUIPMENT.
Operation GREENHOUSE.
Frank G. Ort and Merton D. Mears, March 1952.
SECRET-RESTRICTED DATA

[redacted] To assay Chemical Corps collective-protector equipment under conditions of an atomic detonation, a reinforced-concrete-protected shelter was constructed 1,710 ft from ground zero of the tower burst of an approximate 50-KT bomb. A positive pressure of filtered air was maintained within the shelter by means of a collective protector. Antiblast closures were installed at the shelter inlet and exhaust pipes, both to prevent rupture of the filter material and to avoid a dangerous pressure buildup within the structure.

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Test results indicated that complete protection from an atomic explosion is afforded both personnel and equipment in a protected shelter installation of the type described. No functional damage to the shelter or to any of the installed quipment resulted from the blast. Increases of pressure and temperature within the shelter, due to the blast, were negligible. The antiblast closures functioned adequately in dampening the blast, in protecting the particulate filter-units from sandblast damage, and in preventing a hazardous pressure buildup within the structure. Protected-side pressures of not more than 12.6 lb/sq in. were measured in field installations located from 300 to 2,500 yd from ground zero. The indicated radiation level within the shelter closely approximated that which would be expected from direct radiation alone.

WT-72 - CLOUD PHENOMENA: STUDY OF GASEOUS AND PARTICULATE MATTER.
Operation GREENHOUSE.
Elmer H. Engquist and Thomas C. Goodale, October 1951.
SECRET-RESTRICTED DATA

[redacted] Samples gathered from atomic clouds indicated that the radiochemical composition of cloud particles varies with their size. Specific radioactivity was found to vary considerably in the particle size range of 0.1 μ to 27 μ. The ratio of inactive to active particles in a cloud was found to vary between 100:1 and 1300:1, depending on the specific shot. The ratio also varied due to the method of collection by different aerosol sampling devices.

The decay rate of the cloud particulate matter varied with particle size; the decay exponent, n, ranging from 1.05 to 1.25 during the period 2 to 40 days after detonation. The concentration of particulate beta activity in the cloud varied inversely with the size of the bomb. Beta energy of the cloud contaminant ranged from 0.36 to 0.59 Mev; gamma energy ranged from 0.6 to 1.0 Mev. Electrostatic-precipitator samples indicated that 1.1 to 1.3 beta particles were emitted per gamma ray.

Differing results were obtained when calculating the concentration of beta activity in samples collected by the electrostatic precipitator and by the cascade impactor, at H + 10 seconds after each of 3 shots. Electro-static-precipitator samples were calculated to range between 2.9 and 17.5 μc/cc. Corresponding values for the impactor samples were between 0.75 and 4.0 μc/cc.

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WT-394 - AIRBORNE PARTICLE STUDIES.
Operation BUSTER-JANGLE.
Charles Robbins, Hugh R. Lehman, David R. Powers, and
James D. Wilcox, July 1952.
SECRET-RESTRICTED DATA

([redacted] The airborne-particle studies reported here were undertaken by the Chemical Corps to supply data on the internal hazard due to radioactive particulate matter associated with the cloud and on the base-surge produced by surface and underground detonation of atomic weapons.

The highest sampled concentrations of radioactive materials in the near-ground dust clouds appeared to be about 10^{-3} and 10^{-1} μc of beta activity per cubic centimeter of air, for the surface and underground detonations respectively. These concentrations were found at downwind distances of about 2,000 to 4,000 ft, the concentrations falling off rapidly crosswind, and at greater downwind distances. These concentration values apply to an exposure averaged over the approximate interval between arrival and departure of the cloud, and with beta activity corrected at the average time of exposure.

The number-median diameters of the particles in the aerosols were 1.0 μ and 1.5 μ for the surface and underground shots, respectively, at stations 4,000 ft downwind. These values decreased to less than 0.1 μ for both shots at 50,000 ft downwind.

WT-400 - DECONTAMINATION OF PAVED AREAS.
Operation BUSTER-JANGLE, (Chapter 5).
J. C. Maloney, June 1952.
SECRET-RESTRICTED DATA

[redacted] Sections of paved roadway located 2,000 ft to 1 mi from surface and underground atomic-bomb detonations were decontaminated by eight different procedures: dry sweeping, vacuum cleaning, air-hosing, water-sprinkling, low-pressure hosing, high-pressure hosing, wet sweeping, and air-and-water hosing. A uniform grid was marked off on each test surface, and readings were taken before and after each decontamination process. Beta-activity readings were taken on the surface, at the center of each grid square; and gamma readings at heights of 3 and 6 ft above these locations. Some of the wide disparity between the readings obtained following the surface and underground shots may be accounted for by a heavy rain and high wind that followed the surface shot closely, removing practically all loose contamination from the test surface.

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Radiation intensity above the road was found to depend on the disposition of the contaminant removed from the road surface. High-pressure water-hosing was found to be the most rapid and effective procedure tested. Dry sweeping, requiring the least manpower, was initially effective but resulted in suspension of contaminant in the air above the cleared surface, so that recontamination occurred. None of the tested procedures resulted in significant contamination of the operator's protective clothing.

WT-400 - DECONTAMINATION OF CONSTRUCTION MATERIALS.
Operation BUSTER-JANGLE, (Chapter 7).
E. H. Dhein, June 1952.
SECRET-RESTRICTED DATA

[redacted] Test panels of representative standard construction materials were exposed, in positions corresponding to their normal use, to the effects of surface and underground atomic blasts 7,060 ft distant. All materials were tested with and without various protective coatings. Supplementary panels were prepared for the underground shot, and positioned with slopes ranging from horizontal to vertical, half of each panel being coated with oil. The effectiveness of various decontamination procedures was tested by measurement of the original and residual contaminations.

The results of these tests require cautious appraisal because of the possible removal and/or redisposition of contaminant by the rain, snow, and high winds that followed the surface shot. However, definite indication was given that the precise nature of a protective coating does not significantly affect contaminability decontaminability characteristics except insofar as it changes the smoothness, hardness, or continuity of surface of the test material. Contamination of wall surfaces was negligible as compared with that of roof surfaces, the degree of contamination appearing to vary inversely with the slope of the surface. Pre-exposure treatment of a surface with an oil film tends to protect the surface and to facilitate decontamination. Vacuuming is relatively ineffective as a decontamination process, but high-pressure hosing with a detergent solution is very effective.

WT-400 - TEST OF MATERIALS.
Operation BUSTER-JANGLE, (Chapter 9).
Gerald Smith, June 1952.
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[redacted] Described herein is an investigation of the possible relationship between the radiological contamination-decontamination characteristics

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of materials in common military use (cloth, paints, plastics, fibers, and metals), and the physical properties of their surfaces. Each of the surfaces tested represented a combination of one of three grades of surface roughness, porosity, and contact angle, and one of two grades of dye-retentivity. All samples were exposed horizontally to the solid particulate fallout from an underground atomic burst.

It was concluded that roughness, porosity, contact angle, and dye-retentivity are qualities pertinent to radiological contamination-decontamination. However, the magnitude of their respective effects is variable, and determined by the specific conditions of the contaminating event. Of these properties, only roughness, porosity, and contact angle produce effects of such magnitude as to warrant consideration in the qualitative selection of the contamination-decontamination properties of materials.

WT-400 - DECONTAMINATION OF VEHICLES.
Operation BUSTER-JANGLE, (Chapter 10).
P. H. Ugis, June 1952.
SECRET-RESTRICTED DATA

[redacted] This chapter deals with: (1) the radiological contamination of vehicles exposed to the effects of surface and underground detonations at 2,000 ft from ground zero, (2) the decontamination of such vehicles, (3) and the shielding afforded by the vehicles.

Vehicle-contamination levels were somewhat higher after the underground shot than after the surface shot, but no vehicle was contaminated to such an extent as to require decontamination during a tactical situation. Shielded vehicles, tanks and weasels which were operated for long periods near the craters were contaminated to so slight an extent that no hazard to their passengers would result. The integrated dose received by crew members is generally less than 10% of that which would be received outside the vehicles.

The results of decontamination procedures indicated no need for the addition of specialized decontamination equipment to the present equipment of field units. Radioactive contamination was found to adhere to vehicle surfaces as does dirt. For this reason, removal of the contaminated dirt eliminates the radiation hazard. No additional chemicals need be added to supply channels, the currently supplied detergent or soap being adequate for decontamination. As regards manpower requirements, it should take no longer to decontaminate a vehicle to safe levels than it would to remove ordinary dirt.

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WT-401 - EVALUATION OF MILITARY INDIVIDUAL AND COLLECTIVE PROTECTION DEVICES AND CLOTHING.
Operation BUSTER-JANGLE.
John R. Hendrickson, July 1952.
CONFIDENTIAL

[redacted] Under conditions resulting from surface and underground detonations of atomic bombs, evaluation and performance tests were conducted on Chemical Corps impregnated and unimpregnated protective clothing, individual protective covers, the M9A1 individual protective mask with M1 canister, E22 and E26 tank collective protector, and M5 protective ointment. Both impregnated and unimpregnated clothing were found satisfactory in the prevention of contact between radioactive dusts and the skin, and unimpregnated clothing demonstrated better contamination-decontamination characteristics than did impregnated clothing. Secondary radiation from all clothing was negligible. The protective cover was very effective in preventing contamination of clothing. The M9A1 mask with the M11 canister furnished complete protection against inhalation of radioactive dust. The filtering efficiencies of the E22 and the E26 tank collective protectors were very high, and no deficiencies were found in the units. Panels coated with M5 ointment were contaminated much more highly than were uncoated panels, leading to the conclusion that the radiological contaminability of human skin would be increased by the use of this ointment.

WT-402 - EVALUATION OF THE POTENTIAL RESPIRATORY HAZARD TO TANK CREWS REQUIRED TO OPERATE IN CONTAMINATED AREAS.
Operation BUSTER-JANGLE.
Elmer H. Engquist, July 1952.
SECRET-RESTRICTED DATA

[redacted] Two medium tanks (M26) were exposed to a surface atomic blast 2,000 ft upwind from ground zero and, following the blast, were operated to within 0.1 mi of ground zero. No contaminated area was traversed during this latter operation. During the underground blast, the two tanks and a personnel carrier (T18E1) were exposed 2,000 ft downwind from ground zero, an area which at H + $\frac{1}{2}$ hr was contaminated to a level of 550 r/hr. At H + 50 hr the vehicles were decontaminated and then driven to the crater lip and back. Immediately following the underground shot, and during operation through the contaminated area, the airborne activity far exceeded the maximum allowable (in $\mu c/l$) for lifetime exposure. Maximum allowable concentration for short time exposure (8 hr) was exceeded by factors of 10 to 380.

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It was determined that a respiratory hazard exists for armored-vehicle crews not wearing protective masks during the first 24 hr after a detonation. The degree of such hazard was not definitely established due to a lack of exact medical data on the effects of such exposure. However, adequate protection can be given personnel in an armored vehicle by using protective masks and/or a collective protector.

WT-519 - PRE-SHOCK DUST STUDIES.
Operation TUMBLER-SNAPPER.
E. H. Bouton, C. S. Elder, J. S. Kemper, and E. F. Wilsey,
October 1952.
SECRET-RESTRICTED DATA

[redacted] Previous atomic bomb tests had demonstrated that overpressures resulting from the blasts were generally between one-third to one-half of the predicted values. This delay of the air shock was thought to result from mechanical and/or thermal effects of the blast, such as the raising of dust from the ground by thermal radiation. Such dust might absorb additional thermal energy and thus magnify the loss of overpressure. The object of this project was to determine the concentration and the particle-size distribution of the dust raised by thermal radiation.

Molecular-filter samples were used to determine absolute particle concentrations in air, at selected positions with respect to ground zero, at ground level and at 10-ft elevations. Cascade impactors were also installed at each location to collect airborne particles in five size-gradations, from 0.1 μ to 100 μ. The very short air-sampling period between bomb detonation and arrival of the shock wave at the test position made it necessary to synchronize all test mechanisms so that the passage of air through the filters and impactors would start $2\frac{1}{2}$ seconds before detonation time. A blast-closure device stopped the sampling just prior to the arrival of the shock wave.

The presence of pre-shock dust in concentrations of from ten to several hundred times background was established. There was no significant difference in the particle-size distribution of pre-shock dust and background dust. Little variation was shown in dust concentrations from shot to shot. To determine the depth of the pre-shock dust layer, it is recommended that any future investigation of the phenomenon include the taking of samples at several heights ranging from zero to considerably more than 10-ft elevation.

WT-533 - EVALUATION OF A FILTRATION SYSTEM FOR PRESSURIZED AIRCRAFT.
Operation TUMBLER-SNAPPER.
Frank G. Ort and Michael J. Schumchyk, November 1952.
CONFIDENTIAL

[redacted] Chemical Corps particulate filters for test were installed in the air ducts from turbosuperchargers of the engines on B-29 aircraft, which supply heated and pressurized air to the cabin, with the object of determining filter efficiencies in removing radioactive aerosols from influent air while passing through radioactive clouds. Filtration efficiencies in excess of 99.9% were obtained under the specified conditions. Preliminary tests indicated that type 7 filter material was superior to type 6 under the conditions of temperature and pressure in the air ducts. These conditions necessitated changes in the specifications for certain filter components of standard particulate filters. Operational test results were obtained by sampling filter influent and effluent air and monitoring the sampling filters for radioactivity. This procedure involved careful calibration of the sampling orifices at the varying temperatures and pressures incident to the varying speeds and altitudes attained by the aircraft. Such calibration was essential in the determination of the ratio of air-volume sampled to the total air-volume passing through the filters.

WT-536 - EVALUATION OF AIR MONITORING INSTRUMENTS.
Operation TUMBLER-SNAPPER.
Luther M. Hardin and D'Arcy Littleton, Jr., November 1952.
CONFIDENTIAL

[redacted] The CmlC Portable Air Sampler, E22, and the modified Tracerlab Continuous Air Monitor were tested for adequacy and applicability to radiological air-monitoring problems. Tests were made in the aerosols caused by shots 5, 6, 7, and 8 of Operation SNAPPER, and aerosols due to the redispersion of contamination from Operation JANGLE. It was shown that: (1) the E22 portable air sampler is a soundly designed instrument worthy of further consideration, but requires additional modification and tests before standardizing for this application; (2) the modified Tracerlab continuous air monitor is not suitable for field use, since it is bulky, fragile, complex, and not easily shielded from background radiation due to fallout; and (3) millipore filter material is very efficient in the removal of particles from the air-stream, but less efficient than CmlC type 6 filter material in retaining the separated particles on its surface.

WT-617 - FALLOUT AND CLOUD PARTICLE STUDIES, Operation IVY.
E. H. Bouton, P. B. Gordon, R. C. Tompkins, W. R. VanAntwerp, and E. F. Wilsey, June 1953.
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(U) The preliminary report of this work appeared as CRLR 112, the final report, as CRLR 215.

WT-617 - FALLOUT AND CLOUD PARTICLE STUDIES, Operation Ivy; Part II, Aerial Survey of Ground Contamination.
Charles S. Brice, Jr., June 1953.
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(U) This report also appeared as CRLR 196.

WT-617 - FALLOUT AND CLOUD PARTICLE STUDIES, Operation IVY. Part III, Cloud Sampling Techniques Using Snap Samplers.
Michael J. Schumchyk, June 1953.
SECRET-RESTRICTED DATA

(U) The preliminary report of this work appeared as CRLR 105, the final report, as CRLR 197.

WT-717 - RADIOACTIVE PARTICLE STUDIES INSIDE AIRCRAFT. Operation UPSHOT-KNOTHOLE (Spring, 1953).
John M. Roady, William M. Home, and Nicholas S. Capasso, June 1953.
CONFIDENTIAL

(U) The preliminary report of this work appeared as CRLR 188 and UKP-8, the final report, as CRLR 299.

WT-768 - PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION.
Operation UPSHOT-KNOTHOLE.
Elmer H. Engquist, June 1953.
SECRET-RESTRICTED DATA

(U) The preliminary report of this work appeared as CRLR 190 and UKP-58, the final report, as CRLR 298.

WT-769 - EVALUATION OF A THERMAL ABSORBING SMOKE SCREEN.
Operation UPSHOT-KNOTHOLE.
Elmer H. Engquist, February 1954.
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(U) The preliminary report of this work appeared as CRLR 191, the final report, as CRLR 283.

WT-916 - FALLOUT STUDIES, Operation CASTLE.
Edward F. Wilsey, Robert J. French, and Harry I. West, Jr., February 1956.
SECRET-RESTRICTED DATA

[redacted] Fallout stations were set up in various arrangements for shots Bravo, Romeo, Koon, Union, Yankee, and Nectar. Measurements were made to determine (1) the immediate hazards associated with residual contamination, (2) the mechanism of particle formation, and (3) the characteristics and significance of the radioactive debris.

[redacted] Within the atoll, there was no apparent trend of particle-size distribution with distance, direction, or time, Bravo particles appeared to be coral or crystalline; those for Koon appeared to be mostly crystalline, ashlike, or fused. Outside activity increased directly with particle size in the range 149 μ to 1,000 μ, while the percentage of uniformly radioactive particles decreased with size. These two types of particles accounted for about 90% of the radioactive particles examined. Activity was randomly scattered throughout the remaining 10%. There was no apparent correlation between the location of activity on the particles and their physical appearance. No samples were obtained in the base-surge region.

(U) The preliminary report of this work was published as ITR-916; a special report, CRLR 436.

WT-918 - RADIOCHEMICAL ANALYSIS OF FALLOUT.
Operation CASTLE.
Robert C. Tompkins and Philip W. Krey, February 1956.
SECRET-RESTRICTED DATA

(U) The objectives of this project were to study the chemical and radiochemical composition of solid fallout as a function of particle size, zero-point environment, time and distance of collection, and gross decay characteristics, and to investigate the chemical and radiochemical nature of liquid fallout and base surge.

[redacted] A sample of solid fallout from Shot 1 was separated into 14 particle-size fractions, which were analyzed for Sr^{89}, Zr^{95}, Mo^{99}, Ba^{140}, Ce^{144}. In each case, the activity per unit weight of active particles below 50 μ was found to decrease regularly with increasing size, but in a different manner for each nuclide, indicating radiochemical fractionation. Above 50 μ the relationships were obscure. The gross decay did not vary at all with particle size at early times, and only slightly at later times.

(U) In the fallout from Shots 1 and 3, Sr^{89} and Ba^{140} showed a greater tendency to concentrate in the liquid phase than the other fission products studied.

(U) Shot 4 fallout samples, principally liquid, obtained from a project 2.5b intermittent fallout collector, indicated that the relative concentrations of Sr^{89} and Ba^{140} increased with the time of collection.

(U) The base surge sampling program was unsuccessful.

(U) No information was obtained on variations of composition with distance.

(U) The preliminary reports of this work appeared as ITR-918; a special report, CRLR 435,

WT-928 - DECONTAMINATION AND PROTECTION.
Operation CASTLE.
Joseph C. Maloney, Ernest H. Dhein, and Manfred Morgenthau, August 1955.
CONFIDENTIAL-RESTRICTED DATA

(U) Test panels, 4 ft sq, of 14 building materials were mounted on the weather surfaces of two remotely controlled ships and a stationary barge.

[redacted] All surfaces were contaminated significantly with tenacious fallout. Vertical surfaces facing upwind became equally or more highly contaminated than horizontal or pitched surfaces, probably due to wind currents impacting the tenacious contaminant onto surfaces normal to it. A sequence of hosing and vigorous scrubbing operations resulted in contamination reductions of 40% to 70%, but with reductions on most surfaces being less than 50%. Scrubbing was the most effective decontamination method. Under the conditions of this test, painting and joint sealing had little effect while the washdown countermeasure reduced the initial contamination over 90%.

[redacted] It is concluded that contamination from fallout encountered in these tests presents a serious decontamination problem on buildings and paved areas.

(U) The preliminary report of this work was published as ITR 928; a special report, CRLR 420.

WT-1113 - DUST DENSITY VERSUS TIME AND DISTANCE IN THE SHOCK WAVE.
Operation TEAPOT.
Malcolm G. Gordon, John F. Stoudt, and Arthur B. Francis, June 1957.
CONFIDENTIAL-RESTRICTED DATA

[redacted] Studies were made of the dust present at 3- and 10-ft levels on desert and asphalt surfaces during passage of MET Burst Precursor. These were made by continuous measurements of total air density with the beta densitometer and determination of the ratio (ρ dust/ ρ total) and particle size distribution in the shock wave. The beta densitometers operated satisfactorily and camera records were obtained; however, the records could not be used for total air density because of excessive radiation exposure. The ratio (ρ dust/ ρ total) was determined and is accurate to $\pm 50\%$. The results of the dust sampler are indicative of a good approach and an approximate answer in attempting to understand the relationship of air and dust densities to dynamic pressure. The sampler unit with modification and reasonably good shock-wave data should be capable of obtaining necessary dust data. It should be stressed, however, that the unit must be calibrated and tested under simulated field conditions prior to extensive field use.

(U) The preliminary report of this work was published as ITR-1113; a special report, CRLR 617.

WT-1119 - FALLOUT STUDIES.
Operation TEAPOT.
M. J. Schumchyk and E. H. Bouton, July 1958.
CONFIDENTIAL-FORMERLY RESTRICTED DATA

[redacted] (Supersedes ITR-1119). A study was made of the fallout from Ess Burst to obtain data required to construct closed contours for dose rate levels down to and including 1-r/hr at H + 1 hour. Information is presented concerning: (1) the role of the base surge as a primary carrier of activity; (2) radiation intensities in areas contaminated by fallout, base surge, and in the craterlip region; (3) time of arrival of activity at various distances from ground zero; (4) depth of burial of activity in the crater and on the lip, and (5) air-to-ground radiation intensity correlation factors calculated from data obtained during aerial surveys of the contaminated areas.

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WT-1121 - SHIELDING STUDIES.
Operation TEAPOT.
John R. Hendrickson, Elmer H. Engquist, Robert Marmiroli, Paul E. Grant, and Samuel S. Holland, August 1956.
SECRET-RESTRICTED DATA

(U) Nuclear-shielding studies were carried out on a variety of surface and underground structures, shelters, field fortifications, foxholes, vehicles, and vehicle trenches. Total gamma dose was obtained using the Evans Signal Laboratory - National Bureau of Standards film packet in a standard holder. Two types of chemical dosimeters were also used: the Chemical Corps E1 and the University of Texas laboratory model. Total neutron dose was obtained using gold, sulfur, and fission threshold detectors.

(U) In most instances, gamma-ray and neutron measurements were made at more than one height above a shelter floor and at entranceways as well as the interiors of many shelters, in order to determine interior dose contours.

[redacted] The average attenuation factors for armored vehicles against initial gamma radiation were determined to be 0.1, 0.6, and 0.7 for the M48 tank, the T97 self-propelled gun, and the AIV-M59 personnel carrier, respectively. Greater protection was afforded when the T97 and M59 were oriented rear-on to the burst. The average attenuation factors for the same vehicles against residual gamma radiation were 0.2, 0.4, and 0.6, respectively.

[redacted] Gamma-shielding data were determined on 38 field fortifications and neutron data on 29 field fortifications. The covered bunker type of fortification, with 12 to 25-ft line-of-sight earth cover, afforded greater protection. The gamma attenuation factors were 10^{-3} to $\frac{1}{4}X10^{-3}$ for this structure. The neutron-attenuation factors were 10^{-5} for fast neutrons (above 2.5 Mev) and 10^{-4} for slow neutrons (below 1 ev). The remaining field fortifications offered less protection. The gamma-attenuation factors varied from 10^{-6} to 10^{-3}, and the thermal-neutron attenuation factors varied from 10^{-4} to 10^{-1}.

[redacted] The studies showed that for devices where a high neutron to gamma ratio exists, such as thin high-explosive tactical weapons, a neutron exposure results inside shelters, emplacements, etc., when only line-of-sight shielding is present, due to scattering of thermal neutrons. In underground shelters and field fortifications where sufficient line-of-sight thickness of shielding material is present to shield out all the direct rays from a conventional air-burst atomic weapon, the main hazard is from air-scattered neutrons and gamma rays, which proper and adequate baffling of entranceways reduces to a minimum.

(U) The underground structures afforded the greatest amount of protection against neutrons and gamma radiation; the OCE concrete shelter, UPSHOT-KNOTHOLE, Project 3.8c, with 8 ft of earth cover, offering the greatest protection. The attenuation factors were 10^{-4} and 10^{-5} against neutrons and gamma radiation, respectively.

(U) The value of providing minimum earth cover for all structures to increase gamma and neutron protection was demonstrated; 2-$\frac{1}{2}$ ft of earth cover reducing the gamma dose by a factor of 1,000 at close-in ground ranges.

(U) The neutron measurements made at the bottom of foxholes showed that the protection was high, 96% to 98%, against fast neutrons and lower, 40% to 75%, against thermal neutrons. Results of instrumenting foxholes with sulfur, gold, and fission detectors in Shots 3, 11, and 12 indicated conclusively that the angular distribution of the incident neutrons became more isotropic as the distance from ground zero became greater. Owing to this increasing isotropic nature of the incident neutron flux with increasing distance from ground zero, it was impossible to correlate the total neutron-roentgen equivalent physical dose with the partial neutron-roentgen equivalent physical dose as represented by the corresponding sulfur measurements (neutron flux above energy of 2.5 Mev).

(U) The studies on film-badge orientation in foxholes reveal that when a line-of-sight or near line-of-sight condition exists, the variation in dose due to orientation is relatively insignificant; on the order of 7% or less. However, at deeper positions in the foxhole, orientation variations are more significant; on the order of 20% or less.

(U) The preliminary report of this work was published as ITR-1121; a special report, CRLR 597.

WT-1144 - PROTECTION AFFORDED BY OPERATIONAL SMOKE SCREENS AGAINST THERMAL RADIATION.
Operation TEAPOT.
J. J. Mahoney and E. H. Engquist, August 1956.
SECRET-RESTRICTED DATA

(U) The evaluation of oil fog smoke screens was conducted on Shot 5 with an operational smoke screen set up with smoke generators.

[redacted] Total radiant exposure measurements in the air-zero direction, as received under the smoke screen on 2π-steradian field of view calorimeters, indicate exposure ranged from 17 cal/sq cm at 1,000-ft ground range to 1.5 cal/sq cm at 2,400-ft ground range. These values represent an attenuation of 78% to 90% of the radiant exposure, which would have been received had no smoke screen been present.

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[redacted] The goniometric distribution of radiant exposure was measured at ground ranges of 1,000, 1,400, and 1,900 ft. These measurements indicate that the maximum therma-radiant exposure would be received on a 2π-steradian receiver oriented more nearly vertical than in the air zero direction.

[redacted] The smoke screen used in this test shows there is no significant effect upon the blast wave in the precursor or the Mach-front region except to reduce the range over which the precursor extends.

(U) The preliminary report of this work was published as ITR-1144; a special report, CRLR 614.

WT-1312 - DECONTAMINATION AND PROTECTION (U).
Operation REDWING.
J. C. Maloney and M. A. Schmoke, April 1957.
CONFIDENTIAL

[redacted] (Supersedes ITR-1312). Investigations were made to study (1) the contamination characteristics of various types of building surfaces exposed at various angles and orientations to the fallout from high-yield-nuclear explosions and (2) the effectiveness of various decontamination procedures in order to obtain data on the radiological recovery of military installations constructed from these materials. Panels of various construction materials were mounted on board two specifically equipped liberty ships, which were operated through regions of fallout after Bursts Cherokee, Zuni, Flathead, Navajo, and Tewa. With the exception of Burst Tewa, the fallout contamination deposited on the ships from these events was insignificant with respect to fulfilling the objectives of this project. The contaminated Burst Tewa panels were exposed to heavy rainfall prior to receipt for study. The most heavily contaminated surface, on asphalt and gravel builtup roofing panel, read approximately 500 mr/hr when received from Burst Zuni at H + 60 hours. Contamination levels were generally reduced by factors of two-to-four by detergent scrubbing of the most heavily contaminated panels.

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WT-1313 - NEUTRON-FLUX MEASUREMENTS.
Operation REDWING.
C. W. Luke, D. L. Rigotti, J. W. Kinch, R. Fullwood, and
D. Anderson, September 1959.
SECRET-RESTRICTED DATA

[redacted] Measurements were made of neutron flux and spectrum from Bursts Cherokee, Yuma, Kickapoo, Blackfoot, Erie and Osage during Operation Redwing. Neutron-dose measurements made by chemical and semiconductor dosimeter were compared with the dose calculated by the single-collision theory from the neutron flux and spectral data. The effect of the presence of different proportions of borax and sulfur on the shielding efficiency of concrete against neutrons was studied during Burst Blackfoot. No data were obtained during Burst Cherokee because of the difference between the actual and intended ground zero. The variation of the neutron flux and the device fired from Bursts Yuma and Kickapoo was energy dependent. There is little or no increase in the attenuation of fast-neutrons by adding borax or sulfur to concrete. The attenuation of the thermal-neutron flux is increased by adding borax. The measured neutron dose per unit yield was higher for all bursts than was predicted by TM 23-200. However, only the Yuma, Blackfoot, Kickapoo, and Osage data fall beyond the factor or reliability stated in the manual.

WT-1319 - LAND FALLOUT STUDIES (U).
Operation REDWING.
M. Morgenthau, H. E. Shaw, R. C. Tompkins, and P. W. Krey,
February 1960.
SECRET-RESTRICTED DATA

[redacted] (Supersedes ITR-1319). The objectives of the project were to obtain fallout samples and perform radio-physical and radiochemical measurements on the samples, prepare dose-rate contours in the immediate area of the atoll, and evaluate the role of base surge in the transport of radioactive material. Time-incremental and gross fallout samples were collected on islands of Bikini Atoll, on a barge in Bikini Lagoon, and on three ships in the downwind fallout area after Burst Cherokee, an air burst, Bursts Zuni and Tewa, land-surface bursts. Gross fallout samples were collected on island of Eniwetok Atoll after Burst Lacrosse, a land-surface burst. Ground contamination was measured after Bursts Lacrosse, Zuni, Flathead, Mohawk, Navajo, and Tewa by lowering a probe from a helicopter to a height of 3 ft above ground. Factors for converting dose-rate readings from various altitudes to detectors were installed at a few close-in stations for Bursts Zuni, Flathead, Navajo, and Tewa. Early decay of gamma dose rate agreed well between field and laboratory. Most of the fallout radioactivity from land-surface bursts was associated with particles between 149 and 420 microns, and the activity per unit weight increased with distance from ground zero. The aerial-survey technique proved a practical way of measuring surface contamination in high-radiation fields.

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WT-1340 - EVALUATION OF SELF-RECORDING THERMAL RADIATION INSTRUMENTS.
Operation REDWING.
L. K. Goodwin, et al; Final Report, March 1959.
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[redacted] (Supersedes ITR-1340). Three types of self-recording thermal indicators were tested for response to maximum (40-cal/cm^2), optimum (20-cal/cm^2), and minimum (3-cal/cm^2) values of radiant exposure from a nuclear detonation. These were the Chemical Corps self-recording calorimeters, Type 1 and Type 2, and the Kidde pulse recorder. The Chemical Corps thermistor calorimeter was used as a relative standard. The tests of the Type 1 and Type 2 Chemical Corps self-recording calorimeters on Burst Cherokee resulted in the conclusion that the Type 1 instruments were unsatisfactory and that the Type 2 instruments successfully integrated radiant exposures of long duration. Because of station contamination resulting from a burst prior to Blackfoot, instrument functioning for short-duration pulses was not determined; therefore, the Kidde pulse recorder did not receive a valid test. The actual air zero for Burst Cherokee deviated considerably from the planned air zero, resulting in a significant angle of incidence of the thermal energy on the instruments. The data obtained with these instruments were compared with that obtained by NRDL at essentially the same locations. This comparison of the results as measured by the thermistor instrument, Type 2 self-recording calorimeter, and NRDL disk calorimeters shows good agreement (within ± 12%) of the mean values.

WT-1410 - SOIL ACTIVATION BY NEUTRONS.
Operation PLUMBBOB.
Philip W. Krey, Edward F. Wilsey, John H. McNeilly, Doris D. Peterson, and Ernest W. Bloore, May 1960.
SECRET-RESTRICTED DATA

[redacted] (Supersedes ITR-1410).. An investigation was made of the induction of gamma-emitting radioisotopes in homogeneous soils by nuclear detonations and the subsequent generation of hazardous radiation levels in the vicinity of these detonations, so that the radiological hazard to personnel in these areas could eventually be predicted. Three test soils were used: Dade fine sandy loam which has a high silicon content and low mineral content; Chester loam which has a strong aluminum concentration and a fairly high manganese content; Nevada Test Site soil which has a large sodium composition, significant aluminum and manganese content, and is the natural terrain over which the detonations at Plumbbob took place. The test soils were exposed during Burst Owens at distances of 200 to 500 yards from ground zero, and core samples of each soil were recovered. Induced field surveys were made during Bursts Franklin, Lassen, Wilson, Priscilla and Owens. On the basis of the soils tested and the data obtained, the induced dose rates generated by a nuclear detonation over the soils tested can be predicted by the method of Kaufman within a factor of two-to-three from either copper or thermal-

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neutron flux calculations. Induced dose rates from soils similar to Nevada and Chester (but not Dade) soils can be predicted by the method of Cowan or Camu and Dolan within a factor of about three.

WT-1412 - NEUTRON FLUX FROM SELECTED NUCLEAR DEVICES.
Operation PLUMBBOB.
D. L. Rigotti, J. W. Kinch, H. O. Funsten, and B. B. Binkowski, April 1960.
SECRET-RESTRICTED DATA

[redacted] (Supersedes ITR-1412). Measurements were made to obtain data on the neutron flux and spectra for certain selected devices being tested during Plumbbob and to provide neutron flux, spectra, and dose measurements in support of other projects. For Bursts Franklin, Wilson, Laplace, and Owens the measured dose values exceeded the predicted values obtained by use of the neutron dose curves from previous data by factors of 2.4, 2.9, 3.0, and 5.6, respectively. For Burst Priscilla, the measured dose was lower than the predicted dose by a factor of 1.2. Beyond 300 yards from ground zero there was no variation with increasing distance of the neutron energy spectrum above the thermal energies. The extrapolation of the straight-line portion of the curve of neutron flux times slant distance squared vs the slant distance to close-in distances was invalid, since experimental data from Plumbbob confirmed that the relationship was nonlinear at close ranges. The foil-detector system for measuring neutron flux gave reproducible results, further verifying its suitability for use in making measurements in nuclear weapons tests.

WT-1413 - NEUTRON AND INITIAL-GAMMA SHIELDING (U).
Operation PLUMBBOB.
R. C. Tompkins, C. F. Weaver and G. A. Peterson, January 1961.
SECRET-RESTRICTED DATA

[redacted] (Supersedes ITR-1413). The objectives were to: (1) perform neutron- and gamma-shielding tests on structures, shelters, fortifications, Ontos vehicles, and M-48 tanks; (2) determine relative neutron and gamma inside/outside dose ratios for two types of tank armor; (3) perform neutron- and gamma-attenuation studies in soil in order to obtain an indication of the variation of gamma dose, neutron dose, and neutron spectrum with depth. The shielding characteristics of M-48 tanks, Ontos vehicles, hemispheres of standard and plastic laminated tank armor were studied during Bursts Franklin, Lassen, Wilson, and Hood. The attenuation of neutrons and gamma rays by prepared Nevada Test Site (NTS) soil was investigated during Burst Owens. Field fortifications and underground shelters were instrumented for Burst Priscilla. Results indicate that plastic-laminated armor reduced the neutron dose twice as effectively as the standard armor. The thermal-neutron flux in dry soil increases. The modified, two-man foxhole gives no better radiation protection than the standard foxhole with one-third cover. The buried concrete arches provided inadequate radiation protection but would be satisfactory with improved entranceway design.

WT-1622 - NEUTRON FLUX FROM LARGE-YIELD BURSTS.
Operation HARDTACK.
J. W. Kinch, D. L. Rigotti, J. Anderson, R. L. Bain, and J. H. Rugheimer, May 1960.
SECRET-RESTRICTED DATA

[redacted] (Supersedes ITR-1622-1 and ITR-1622-2). Measurements were made of neutron flux and dose as a function of distance for two megaton-range detonations. The Hurst fission-foil method was used to measure flux. Au^{197}, Pu^{239}, Np^{237}, U^{238}, S^{32}, and Zr^{90} were employed as detecting materials. Twenty-five stations were placed at distances varying from 917 yards to 4,100 yards for two large-yield devices. Neutron dose was calculated from the measured fluxes by using the single-collision theory of dose contribution per neutron. Limited neutron flux and dose measurements were made as a function of distance [redacted] DELETED

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Steel buoys were used to support the detecting materials in the Eniwetok lagoon. Results indicate that the buoy system of placing passive detecting media over water is effective in areas with overpressures up to 90 psi and can be made effective in overpressures up to 300 psi by minor modification.

ITR-1622-1 - NEUTRON FLUX FROM LARGE-YIELD BURSTS.
Operation HARDTACK.
J. W. Kinch, et al, August 1958.
SECRET-RESTRICTED DATA

([redacted] Measurements were made of neutron flux and dose as a function of distance [redacted] The Hurst fission-foil method was used to measure flux. Detecting materials were Au, Pu^{239}, Np^{237}, U^{238}, S and Zr. Steel buoys were used to support the detecting materials in the Eniwetok Lagoon. Twenty-five stations were placed at distances varying from 917 yd to 4,100 yd for both bursts. Neutron dose was calculated from the measured fluxes by using the single-collision theory of dose contribution per neutron. Neutron-flux and dose measurements were made in support of Projects 6.3 and 8.6. DELETED

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DELETED The effectiveness of the Hurst fission-foil method of measuring neutron dose is limited by the long recovery times necessary at the Eniwetok Proving Grounds. The buoy system of placing passive detecting media over water is effective in areas with overpressures up to 90 psi, and can be made effective in higher overpressure areas by minor modifications.

ITR-1622-2 - NEUTRON FLUX FROM A VERY-LOW-YIELD BURST.
Operation HARDTACK.
D. L. Rigotti, et al, October 1958.
SECRET-RESTRICTED DATA

([redacted] Attempts were made to measure neutron flux and dose vs ground range [redacted] The threshold detector system for making neutron measurements utilized Au, Pu, Np, U, and S as detector elements. No results were obtained from Burst Quince, DELETED

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DELETED Within the ranges at which the measurements were made, there was no variation of the neutron energy spectrum above the plutonium threshold (3.7 kev) with increasing distance from the point of detonation. However, the total number of neutrons decreased with increasing distance from the point of detonation. Personnel stationed beyond 1,000 yards from this detonation would have received no appreciable neutron dose. DELETED

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WT-1676 - THERMAL RADIATION FROM VERY-LOW-YIELD BURSTS.
Operation HARDTACK.
J. J. Mahoney, J. C. Maloney, S. D. Furrow, D. T. Kilminster, N. J. Alvares, T. S. Dahlstrom, and J. C. Ulberg, June 1960.
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[redacted] (Supersedes ITR-1676). Measurements were made [redacted] to determine the thermal radiant exposure (cal/cm^2) vs distance from ground zero for a fractional-kiloton device and the total luminous flux ($lumens/ft^2$) as a function of both time and distance from ground zero.

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The luminous flux was sufficiently high to saturate the illumination sensor system, therefore no peak luminous flux information was recorded. The measured values for thermal radiation agree with the established scaling laws for a surface detonation. Measurements were made during Burst Hamilton to determine the thermal radiant exposure vs distance for a fractional-kiloton detonation, and to compare the experimentally obtained radiant-exposure values with those calculated from existing scaling laws. Radiant exposures Burst Hamilton were measured at horizontal distances of 175 to 700 ft from ground zero using thermistor calorimeters. The results were, in general, inconclusive because of the very-low yield of the device and also perhaps because shielding material in the bomb tower partially obscured the thermal line of sight.

WT-1677 - GAMMA DOSE FROM VERY-LOW-YIELD BURSTS (U).
Operation HARDTACK.
J. C. Maloney and M. Morgenthau, August 1960.
CONFIDENTIAL-FORMERLY RESTRICTED DATA

[redacted] (Supersedes in part ITR's - 1677, 1679 and 1680).
The objectives [redacted] were: (1) to document the initial gamma dose vs ground range and (2) to measure the total gamma dose received at a point as a function of time, at distances of military interest, for a fractional-kiloton nuclear surface burst. The objectives during Bursts Hamilton and Humboldt were: to provide gamma-dose-measurements in support of the biomedical Project 4.2 and (2) to document the initial gamma dose vs ground range. In addition, secondary objectives of this project were to document residual radiation intensities and to determine the field gamma-decay rate. Results of the measurements are discussed and data are tabulated.

[redacted]

WT-1678 - RESIDUAL RADIATION FROM A VERY-LOW-YIELD BURST (U).
Operation HARDTACK.
M. Morgenthau and M. Schumchyk, December 1960.
SECRET-RESTRICTED DATA

([redacted](Supersedes ITR-1678). Surveys were made [redacted] to determine the radiation intensities of contaminated areas resulting from a very-low-yield, surface nuclear detonations. The area at ground zero [redacted] at Eniwetok Proving Ground was prepared by substituting soil from the Nevada Test Site (NTS) for the Coral soil within the expected crater volume and over areas that were expected to contribute debris to the cloud. [redacted] Decontamination of a 30-degree sector extending 300 ft downwind from ground zero would have been necessary. The highest alpha air concentration was less than 2 per cent of the 1-hour emergency exposure of $2 \times 10^{-2} \mu c/cm^2$. The radiation intensities at the lip and crater [redacted] were above 10,000 r/hr at H + 26 minutes, a level that would have necessitated avoidance of these areas by troops. The fallout consisted of NTS soil and coral particles and the size fractions above 420 microns contained most of the activity. However, fused silicate particles in the 420-to 840-micron fraction contributed 95 per cent of the total activity, although they were only 9 per cent of the total weight.

WT-1679 - NEUTRON FLUX FROM VERY-LOW-YIELD BURSTS (U).
Operation HARDTACK.
D. L. Rigotti, J. W. Kinch, J. H. McNeilly, J. L. Tarbox, N. Klein, P. A. Pankow, and T. R. Adams, August 1960.
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[redacted] The objectives of these projects were to: (1) measure neutron flux and dose vs ground range for very-low-yield nuclear devices; (2) measure neutron, thermal, and gamma radiation up to an altitude of 1,500 ft; (3) provide dose measurements in support of a biomedical project; and (4) determine neutron flux and spectrum for induced-activity studies. The threshold-detector technique was used to measure neutron flux. National Bureau of Standards film badges were used to measure total gamma dose. Chemical Warfare Laboratories thermistor calorimeters were employed for thermal measurements. [redacted] an Aerocap balloon was used to support the instrument line almost directly above ground zero. For Bursts Hamilton and Humboldt, in addition to the standard-foil system, a chemical-dosimeter system was employed to measure neutron and gamma dose simultaneously. [redacted] Results indicate that the balloon technique for instrument location is effective for free-air measurements.

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The threshold-detector system indicated free-field neutron doses from 13,400 rep at 25 yards to 22.6 rep at 400 yards for Burst Hamilton and from 273,000 rep at 10 yards to 428 rep at 300 yards from Humboldt. The chemical-dosimetry technique resulted in no useful data.

WT-1680 - SOIL ACTIVATION BY NEUTRONS FROM A VERY-LOW-YIELD BURST. Operation HARDTACK.
E. F. Wilsey, J. H. McNeilly, and R. J. Spitznas, July 1960.
SECRET-RESTRICTED DATA

[redacted] (Supersedes in part ITR-1680). Soil samples were exposed to Burst Hamilton in order to (1) document the neutron-induced gamma field produced by a fractional-kiloton nuclear device detonated on a wooden tower 50 ft high, and (2) determine empirical factors relating the gamma dose rates measured over this large neutron-induced field with dose-rate measurements made over small samples of the same activated soil. The presence of induced activity in the soil samples was determined by gamma spectrometer analysis. The major contributions to the gamma spectra in the soil samples were Al^{28}, Mn^{56}, and Na^{24} at H + 16 minutes, Na^{24} and Mn^{56} at H + 7 hours, and Na^{24} and Fe^{59} at H + 54 hours. The low-energy neutron flux was found to peak at 5 to 8 cm below the ground surface of normal Frenchman Flat soil and at the ground surface in more-moist Frenchman Flat soil. Empirical factors relating field dose rates with sample dose rates could not be determined because of the low-level of induced activity produced and the fission-product contamination of the project-station exposure area. The presence of fission products was indicated by the typical fission-product dose-rate decay demonstrated by the residual field and by the presence of low-energy, fission-product-like peaks in the gamma spectra of a ground-surface soil sample recovered from the vicinity of ground zero at H + 31 hours.

XVI. CONTRACT REPORTS[1].

ETF 760.93-4/Final	REMOVAL OF RADIOACTIVE CONTAMINANTS FROM SKIN. Contract DA-18-108-CML-2597, Foster D. Snell, Inc., 30 June 1952. FOR OFFICIAL USE ONLY.
ETF 760-312/1	EXTRAPOLATION OF ATOMIC WEAPONS DATA, Operation JANGLE. Quarterly Progress Report, Contract No. DA-18-108-CML-3844, Stanford Research Institute, August 1952. SECRET-RESTRICTED DATA.
ETF 760-367/Final	EVALUATION REPORT SEDIMENTATION SCINTILLATION COUNTER. Contract DA-18-108-CML-724, Tracerlab, Inc., November 1952. UNCLASSIFIED.
ETF 760-181/Final	REPORT ON TEST JANGLE. Contract DA-18-108-CML-2532, Tracerlab, Inc., J. Shearer, C. Sherman, R. Epple and E. Field, November 1952. SECRET-RESTRICTED DATA.
ETF 760-142/Final	FINAL REPORT ON TRACERLAB SNAP SAMPLER. (Including Results of "Greenhouse" Analyses). Contract DA-18-108-CML-724, Tracerlab, Inc., T. H. Mansfield, R. P. Epple, L. R. Zumwalt, J. W. Shearer and E. L. Field, 25 February 1953. SECRET-RESTRICTED DATA.
ETF 760-271/Final	THE EFFECTS OF SOIL, YIELD AND SCALED DEPTH ON CONTAMINATION FROM ATOMIC BOMBS. Contract DA-18-108-CML-3842, Stanford Research Institute, R. D. Cadle, June 1953. SECRET-RESTRICTED DATA.
ETF 760.934-1/2	REMOVAL OF RADIOACTIVE CONTAMINANTS FROM HUMAN SKIN. Contract DA-18-108-CML-4747, Foster D. Snell, Inc., 15 June 1953, SECRET-RESTRICTED DATA.
ETF 760-467/Final	COMPARISON OF IVY AND JANGLE FALLOUT. Contract DA-18-108-CML-3842, Stanford Research Institute, R. D. Cadle and C. F. Schadt, December 1953, SECRET-RESTRICTED DATA.

[1]The "ETF" report numbers listed are the CRDL Technical Library call numbers.

ETF 090.5-13/Final	PORTABLE ION CHAMBER SURVEY METER. Contract DA-18-108-CML-5071, Victoreen Instrument Company, April 1954, UNCLASSIFIED.
ETF 150.2-11/Final	ATTENUATION OF THERMAL RADIATION BY A DISPERSION OF OIL PARTICLES. Contract DA-18-108-CML-4695, Engineering Research Institute, University of Michigan, C. M. Sliepcevich, S. W. Churchill, G. C. Clark and Chiao-Min Chu, May 1954, UNCLASSIFIED.
ETF 760.9-3/1 (REVISED)	A GUIDE TO RADIOLOGICAL WARFARE COUNTERMEASURES. Contract DA-18-108-CML-5068, Stanford Research Institute, F. R. Holden, I. G. Poppoff, R. D. Cadle and L. F. Ney, June 1954, SECRET-RESTRICTED DATA
ETF 760.931.2/Final	A STUDY OF THE WASTE DISPOSAL ASPECTS OF RW DECONTAMINATION. Contract DA-18-108-CML-3456, Tracerlab, Inc., L. Leventhal, D. L. Forrest, D. H. Perkel, J. K. Bowker, 30 June 1954, SECRET-RESTRICTED DATA.
ETF 095-9/Final	DESIGN AND CONSTRUCTION OF AN AEROSOL CAMERA. Contract DA-18-108-CML-5094, Stanford Research Institute, R. D. Cadle, E. J. Wiggins and C. Schadt, July 1954, UNCLASSIFIED.
ETF 760.92-2/Final	DEVELOPMENT OF A RADIOACTIVE-DUST COLLECTOR. Contract DA-18-108-CML-5095, Battelle Memorial Institute, W. A. Spraker and R. D. Ellsworth, 23 September 1954, UNCLASSIFIED.
ETF 150.2-12/Final (AFSWP 995)	THE EFFECT OF BOUNDARY REFLECTION ON THE ATTENUATION OF THERMAL RADIATION BY A DISPERSION OF OIL PARTICLES. Contract DA-18-108-CML-5515, Engineering Research Institute, University of Michigan; S. W. Churchill, G. C. Clark, P. H. Scott, J. H. Chin and C. Chu, April 1956, UNCLASSIFIED.
NDA 2111-3 Volume A/ Final	DIFFERENTIAL ELASTIC NEUTRON SCATTERING CROSS SECTION OF OXYGEN. Contract DA-18-108-405-CML-295, Nuclear Development Corporation of America, H. Lustig, 1 November 1959, UNCLASSIFIED.

NDA 2111-3 Volume B/ Final	CONTINUUM THEORY OF GAMMA RAY SPECTRA FOLLOWING INELASTIC SCATTERING. Contract DA-18-108-405-CML-295, Nuclear Development Corp. of America; E. S. Troubetzkoy, 1 November 1959, UNCLASSIFIED.
NDA 2111-3 Volume C/ Final	FAST NEUTRON CROSS SECTIONS OF IRON, SILICON, ALUMINUM AND OXYGEN. Contract DA-18-108-405-CML-295, Nuclear Development Corp of America; E. S. Troubetzkoy, 1 November 1959, UNCLASSIFIED.
DA-18-108-405-CML-473	THE AVAILABILITY OF FISSION-PRODUCT Zr^{95}-Nb^{95}. Contract DA-18-108-405-CML-473, Radiation Applications Incorporated, December 1959, SECRET-RESTRICTED DATA.
DA-18-108-405-CML-198	DEVELOPMENT OF A TACTICAL GAMMA NEUTRON DOSIMETER. Contract DA-18-108-405-CML-198, Controls for Radiation, Inc.; I. A. Berstein, R. C. Fix, J. E. Mayer, Jr., and P. F. Russo, June 1960, UNCLASSIFIED.
NDL-TR-5 (NDA 2133-4)	FAST NEUTRON CROSS SECTIONS OF MANGANESE, CALCIUM, SULFUR AND SODIUM. Contract DA-18-108-405-CML-295, Nuclear Development Corp. of America; E. S. Troubetzkoy, M. H. Kalos, H. Lustig, J. H. Ray and B. H. Tropin, January 1961, UNCLASSIFIED.

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APPENDIX

RECLASSIFICATION ACTIONS

During the preparation of this document the following reports were reclassified as indicated.

Report No.	Old Classification	New Classification
TCIR 562	SECRET	CONFIDENTIAL-RESTRICTED DATA
TCIR 627	CONFIDENTIAL	UNCLASSIFIED
TCR 60	SECRET	UNCLASSIFIED
CRLIR 24	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLIR 25	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLIR 49	CONFIDENTIAL RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLIR 94	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLIR 126	SECRET-RESTRICTED DATA	UNCLASSIFIED
CRLIR 137	SECRET-RESTRICTED DATA	UNCLASSIFIED
CRLIR 170	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLIR 196	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLR 14	SECRET	UNCLASSIFIED
CRLR 71	SECRET	UNCLASSIFIED
CRLR 104	SECRET	UNCLASSIFIED
CRLR 109	SECRET-RESTRICTED DATA	UNCLASSIFIED
CRLR 116	CONFIDENTIAL	UNCLASSIFIED
CRLR 117	CONFIDENTIAL	UNCLASSIFIED

Report No.	Old Classification	New Classification
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CRLR 159	CONFIDENTIAL	UNCLASSIFIED
CRLR 160	CONFIDENTIAL	UNCLASSIFIED
CRLR 162	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
CRLR 186	SECRET-RESTRICTED DATA	CONFIDENTIAL
CRLR 190	SECRET-RESTRICTED DATA	SECRET-FORMERLY RESTRICTED DATA
CRLR 191	SECRET-RESTRICTED DATA	SECRET-FORMERLY RESTRICTED DATA
CRLR 211	CONFIDENTIAL	UNCLASSIFIED
CRLR 241	SECRET-RESTRICTED DATA	CONFIDENTIAL
CRLR 242	CONFIDENTIAL	UNCLASSIFIED
CRLR 243	SECRET-RESTRICTED DATA	CONFIDENTIAL
CRLR 268	SECRET-RESTRICTED DATA	SECRET-FORMERLY RESTRICTED DATA
CRLR 283	SECRET-RESTRICTED DATA	SECRET-FORMERLY RESTRICTED DATA
CRLR 298	CONFIDENTIAL	CONFIDENTIAL-FORMERLY RESTRICTED DATA
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CRLR 308	CONFIDENTIAL	UNCLASSIFIED
CRLR 319	CONFIDENTIAL	UNCLASSIFIED
CRLR 320	SECRET-RESTRICTED DATA	CONFIDENTIAL-FORMERLY RESTRICTED DATA
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CRLR 614	SECRET-RESTRICTED DATA	UNCLASSIFIED
Y 700	SECRET	SECRET-RESTRICTED DATA
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WT 27	SECRET	UNCLASSIFIED
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WT 400	SECRET-RESTRICTED DATA	CONFIDENTIAL-DEFENSE INFORMATION
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47 Chief, Veterinary Division, Office of the Surgeon General, Department of the Army, Washington 25, D. C.

48 Director, Walter Reed Army Institute of Research, Walter Reed Army Medical Center, Washington 12, D. C.

49 Commander, U. S. Army Medical Research and Development Command, Main Navy Building, Washington 25, D. C.

50 Commanding Officer, U. S. Army Medical Research Laboratory, Fort Knox, Kentucky

51 Surgeon, U. S. Army Chemical Arsenal, Rocky Mountain Arsenal, Denver 2, Colorado

52 Commanding General, Army Medical Service School, Brooks Army Medical Center, Fort Sam Houston, Texas

53 Commanding Officer, First U. S. Army Medical Laboratory, 90 Church Street, New York 7, New York

ORDNANCE CORPS

54 Office of the Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: ORDTB-Ballistics

55 Office of the Chief of Ordnance, Department of the Army, Washington 25, D. C., ATTN: Safety Branch, IS&S Office, The Pentagon, Annex 2, Room 304

56 - 57 Commanding Officer, U. S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland, ATTN: ORDBG-T

58 -	59	Commanding General, Building 313, Aberdeen Proving Ground, Maryland, ATTN: Technical Library
	60	Commandant, U. S. Army Ordnance School, Aberdeen Proving Ground, Maryland
	61	The Superintendent, U. S. Military Academy, West Point, New York
	62	Commanding Officer, Army Research Office, Box CM, Duke Station, Durham, North Carolina
63 -	64	Commanding Officer, Picatinny Arsenal, Dover, New Jersey ATTN: Technical Information Section 171N
	65	Headquarters, Ordnance Ammunition Command, U. S. Army, Joiliet, Illinois, ATTN: ORDLY-S
	66	Commanding General, Ordnance Weapons Command, Rock Island, Illinois, ATTN: ORDOW-TX
	67	Commanding Officer, Ordnance Tank Automotive Command, Detroit Arsenal, Detroit, Michigan, ATTN: Library
	68	Commanding Officer, Ordnance Tank Automotive Command, Centerline, Michigan, ATTN: ORDMC-RB.2
69 -	71	Commander, Army Rocket and Guided Missile Agency, Redstone Arsenal, Alabama, ATTN: Technical Library ORDXR-OTL
	72	Commandant, U. S. Army Ordnance and Guided Missile School, Redstone Arsenal, Alabama
	73	Commanding Officer, Ordnance Materials Research Office, Watertown Arsenal, Watertown 72, Massachusetts ATTN: P.S.&C. Division
	74	Commanding Officer, Watertown Arsenal, Watertown 72, Massachusetts, ATTN: Technical Information Section
	75	Commanding Officer, U. S. Army Ordnance, Frankford Arsenal, Philadelphia 37, Pa., ATTN: #0270, Library
	76	Commanding General, Frankford Arsenal, Philadelphia 37, Pa. ATTN: Medical Director
	77	Commanding General, Frankford Arsenal, Philadelphia 37, Pa. ATTN: 1610, Library, Building 40

QUARTERMASTER CORPS

	78	Commandant, Quartermaster School, U. S. Army, Fort Lee, Virginia, ATTN: Chief, Quartermaster Library
79 -	80	Commander, Quartermaster Research and Engineering Command, U. S. Army Quartermaster R & D Center Laboratories, Chemicals and Plastics Division, Natick, Massachusetts, ATTN: Chief, Program Coordination and Administration Office
81 -	82	Commanding General, Quartermaster Research & Development Command, Quartermaster R & D Center, Natick, Massachusetts ATTN: CBR Liaison Officer
	83	Commanding General, Quartermaster Research & Engineering Command, U. S. Army, Natick, Massachusetts

84 - 85 Commanding General, Headquarters, Quartermaster Research & Engineering Command, Quartermaster R & E Center, Natick, Massachusetts, ATTN: Chief, Special Weapons Protection Branch, Chemicals & Plastics Division

SIGNAL CORPS

86 Commanding Officer, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, ATTN: Chief, Radiac Instruments Section, Applied Physics Division

87 Commanding Officer, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, ATTN: Dr. W. Ramm, Research Group, Exploratory Research Division "S"

88 Commanding Officer, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, ATTN: SIGFM/EL-SAT

89 - 90 Commanding Officer, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, ATTN: Technical Documents Center, Evans Area

91 Commanding Officer, U. S. Army Signal Research and Development Laboratory, Fort Monmouth, New Jersey, ATTN: Atomics Branch

TRANSPORTATION CORPS

92 Office, Chief of Transportation, Planning & Intelligence Division, Special Weapons & Studies Branch, Room 2825, Bldg T-7, Washington 25, D. C.

93 Commanding Officer, U. S. Army Transportation Research Command, Fort Eustis, Virginia, ATTN: Research Reference Center

ARMOR

94 Commandant, U. S. Army Armor School, Fort Knox, Kentucky ATTN: Special Weapons Branch, Command & Staff Department

95 - 96 President, U. S. Army Armor Board, Fort Knox, Kentucky

ARTILLERY

97 President, U. S. Army Artillery Board, U. S. Continental Army Command, Fort Sill, Oklahoma

98 Commandant, U. S. Army Artillery & Missile School, Fort Sill, Oklahoma, ATTN: Combat Development Department

INFANTRY

99 President, U. S. Army Infantry Board, Fort Benning, Georgia

OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

100 Chief, Life Sciences Division, Army Research Office, Office of the Chief of Research and Development, Room 3D442, The Pentagon, Washington 25, D. C.

101 Chief, Combat Materiel Division, Office, Chief of Research and Development, Department of the Army, Washington 25, D. C.

102- 103 Chief, Research and Development, Department of the Army, Washington 25, D. C., ATTN: Atomic Division

CONTINENTAL ARMY COMMAND (CONARC)

104- 106 Liaison Officer, USCONARC, Building 330, Army Chemical Center, Maryland

107 Commanding General, U. S. Continental Army Command, Fort Monroe, Virginia, ATTN: Chief, Materiel Developments, ATDEV-3

108 Commanding General, U. S. Continental Army Command, Fort Monroe, Virginia, ATTN: Chemical Officer

109 Director, Office of Special Weapons Development, USCONARC, Fort Bliss, Texas

OTHER ARMY ACTIVITIES

110 Senior Army Representative, Department of Health, Education, and Welfare, Room 5412, South Building, Washington 25, D. C.

111 Deputy Chief of Staff for Military Operations, Department of the Army, Washington 25, D. C., ATTN: SW-AT

112 Commanding General, United States Army Combat Development Experimentation Center, Fort Ord, California

113 President, U. S. Army Airborne and Electronics Board, Fort Bragg, North Carolina

114 Commanding General, United States Army Surveillance Agency, 1124 N. Highland, Arlington, Virginia

115- 116 Commandant, U. S. Army Command and General Staff College, Fort Leavenworth, Kansas, ATTN: ARCHIVES

117 Commandant, U. S. Army Aviation School, Fort Rucker, Alabama, ATTN: Librarian

118 President, U. S. Army Aviation Board, Fort Rucker, Alabama

119 Commanding General, U. S. Army Electronic Proving Ground, Fort Huachuca, Arizona, ATTN: Technical Library

120 President, U. S. Army Air Defense Board, Fort Bliss, Texas

121 Commandant, U. S. Army Air Defense School, Fort Bliss, Texas ATTN: Department of Tactics and Combined Arms

122 Chemical Corps Liaison Officer, CA&S Division, C&S Department, Box 9390, U. S. Army Air Defense School, Fort Bliss, Texas

123 Commander, Arctic Aeromedical Laboratory, APO 731, Seattle, Washington, ATTN: AALP (Library)

124 President, U. S. Army Arctic Test Board, APO 733, Seattle, Washington

AIR FORCE

125 Chief, Preventive Medicine Division, Office of the Surgeon General, ATTN: Special Weapons Defense Officer, Headquarters, USAF, Washington 25, D. C.

126 Commander, Air Research and Development Command, Andrews Air Force Base, Washington 25, D. C., ATTN: RDTHAL

127 Directorate of Operations, DCS/O, Headquarters, USAF, Washington 25, D. C.

128 Directorate of Research & Development, DCS/D, Headquarters, USAF, Washington 25, D. C., ATTN: AFDRD-HF

129 Assistant for Atomic Energy, Headquarters, USAF, Washington 25, D. C., ATTN: DCS/O

130- 131 Commander, Air Technical Intelligence Center, Wright Patterson Air Force Base, Ohio, ATTN: AFCIN-4E2a

132 Commander, Headquarters, Air Materiel Command, Wright Patterson Air Force Base, Ohio, ATTN: MCMTM-S

133 Headquarters, Air Materiel Command, Wright Patterson Air Force Base, Ohio, ATTN: MCTSS

134 Office of the Surgeon, Headquarters, Air Materiel Command, Wright Patterson Air Force Base, Ohio

135 Chief, Physics Division, Air Force Special Weapons Center, Kirtland Air Force Base, Albuquerque, New Mexico

136- 138 Commander, Air Force Special Weapons Center, Kirtland Air Force Base, New Mexico, ATTN: SWOI

139- 140 Commander, Tactical Air Command, Langley Air Force Base, Virginia, ATTN: TMAR-W

141 Commander-in-Chief, Strategic Air Command, Offutt Air Force Base, Nebraska, ATTN: DIET

142 Commander, 3415th Technical Training Wing, Lowry Air Force Base, Colorado, ATTN: OTP-T

143 Director, Air University Library, Maxwell Air Force Base, Alabama, ATTN: AUL-8879

144- 145 Commandant, School of Aviation Medicine, U. S. Air Force, Randolph Air Force Base, Texas, ATTN: Research Secretariat

146 School of Aviation Medicine, U. S. Air Force, Brooks Air Force Base, Texas, ATTN: SAMRSCH

147 Commander, Air Proving Ground Center, Eglin Air Force Base, Florida, ATTN: Technical Library, PGTRIL

148 Commander, Ogden Air Materiel Area, Hill Air Force Base, Utah, ATTN: OORET

149 Director, USAF Project RAND, Via: Air Force Liaison Office, The RAND Corp., 1700 Main Street, Santa Monica, California, ATTN: Library

150 Assistant Chief of Staff, Intelligence, Headquarters, U. S. Air Force, Washington 25, D. C. ATTN: Physical Vulnerability Division

NAVY

151 Chief, Bureau of Aeronautics, ATTN: AD-4, Department of Navy, Washington 25, D. C.

152 Chief, Bureau of Aeronautics, ATTN: AE-514, Department of Navy, Washington 25, D. C.

153 Bureau of Yards and Docks, (Code D-440C), Department of the Navy, Washington 25, D. C.

154 Chief, Bureau of Medicine & Surgery, Special Weapons Defense Division, (Code 74), Department of the Navy, Washington 25, D. C.

155 Chief of Naval Operations, Op-341E, Washington 25, D. C.

156 Chief of Naval Operations, Op-922G, The Pentagon, Washington 25, D. C.

157 Director, Biological Sciences Division, Office of Naval Research, Department of the Navy, Washington 25, D. C.

158 Director, U. S. Naval Research Laboratory, Washington 25, D. C., ATTN: Code 6140

159 Director, U. S. Naval Research Laboratory, Washington 25, D. C., ATTN: Code 2027

160- 161 Commander, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland, ATTN: Librarian

162- 163 Commander, U. S. Naval Radiological Defense Laboratory, San Francisco 24, California, ATTN: Code 222

164- 165 Commander (Code 753), U. S. Naval Ordnance Test Station, China Lake, California

166- 167 Director, Special Weapons Defense Division, Damage Control School, U. S. Naval Schools Command, Treasure Island, San Francisco, California

168 Officer in Charge (Code L31), U. S. Naval Civil Engineering Research & Evaluation Laboratory, Port Hueneme, California

169 Commanding Officer, Nuclear Weapons Training Center, Pacific Naval Station, San Diego, California

170- 171 Commander, U. S. Naval Missile Center, Point Mugu, California ATTN: Technical Library

172 Commanding Officer, Naval Medical Field Research Laboratory, Camp Lejeune, North Carolina, ATTN: Library

173 Commanding Officer, U. S. Naval CIC School, U. S. Naval Air Station, Glyco, Brunswick, Georgia

174 Director, Material Laboratory, New York Naval Shipyard, Brooklyn 1, New York, ATTN: Library Code 912B

175 President, U. S. Naval War College, Newport, Rhode Island

176- 179 Commandant of the Marine Corps, Headquarters, U. S. Marine Corps, Washington 25, D. C.
180- 181 Commandant, Marine Corps School, Quantico, Virginia
182 Bureau of Ships Technical Library, Department of the Navy, 18th and Constitution Ave., N. W., Washington 25, D. C.
183 Commanding Officer, Naval Medical Research Institute, National Naval Medical Center, Bethesda 14, Maryland
184 Commanding Officer, Nuclear Weapons Training Center, Atlantic, U. S. Naval Base, Norfolk 11, Virginia
ATTN: Nuclear Warfare Department

OTHER DEPARTMENT OF DEFENSE ACTIVITIES
OTHER GOVERNMENT AGENCIES

185 BW-CW Division, Office, Biological & Chemical Warfare, OASD (R&E), Room 3E, 1071, The Pentagon, Washington 25, D. C.
186- 187 Chief, Defense Atomic Support Agency, Washington 25, D. C.
ATTN: Document Library Branch
188 Director, Armed Forces Institute of Pathology, Washington 25, D. C.
189 Director, Weapons Systems Evaluation Group, Room 1E880, The Pentagon, Washington 25, D. C.
190 Director, National Bureau of Standards, Washington 25, D. C., ATTN: Radiation Physics Section
191 Director of Defense Research and Engineering, Washington 25, D. C., ATTN: Technical Library
192- 193 Superintendent U. S. Navy Postgraduate School, Monterey, California, ATTN: Classified Documents Librarian
194 Commander, Field Command, DASA, Sandia Base, Albuquerque, New Mexico, ATTN: FCTG
195 Commander, Field Command, DASA, Sandia Base, Albuquerque, New Mexico, ATTN: FCWT
196- 197 Technical Library, Room G-2B, Office of Civil and Defense Mobilization, ATTN: Director, Technical Library, Battle Creek, Michigan
198 U. S. Weather Bureau, Washington 25, D. C.
ATTN: Special Projects Section, Office of Meteorological Research

ATOMIC ENERGY COMMISSION ACTIVITIES

199- 200 U. S. Atomic Energy Commission, Technical Reports Library, Washington 25, D. C., ATTN: DMA

	201	Research Library, Brookhaven National Laboratory, Upton, Long Island, New York
202-	203	Director, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tennessee, ATTN: Library
204-	208	U. S. Atomic Energy Commission, Office of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee
	209	Radiation Effects Information Center, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio
210-	211	Commanding General, White Sands Missile Range, New Mexico, ATTN: ORDBS-OM - Technical Library
	212	Sandia Corporation, Sandia Base, Albuquerque, New Mexico ATTN: Classified Document Division
213-	214	Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico, ATTN: Report Librarian
215-	216	Director, Argonne National Laboratory, P. O. Box 299, Lemont, Illinois, ATTN: Library