FOSTER D. SNELL, INC

WEST 19 STREET NEW YORK N.Y.

CONSULTING CHEMISTS

ENGINEERS

FIRST QUARTERLY PROGRESS REPORT

TO

U. S. ARMY CHEMICAL CORPS

CHEMICAL AND RADIOLOGICAL LABORATORIES,

ARMY CHEMICAL CENTER, MARYLAND

ON

REMOVAL OF RADIOACTIVE CONTAMINANTS FROM SKIN

UNDER

CONTRACT NO. DA18-108-CML-2597, ORDER NO. 1-13034

28 September 1951

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Summary.

This is the first quarterly report under Contract No. DA18-108-CML-2597, Order No. 1-13034.

The origin and scope of the contract and the objectives of the project are covered.

The work of the first three months under the contract is reported and the work scheduled for the next three months is outlined.

Major attention during the first quarter was given to collection and study of relevant information from available sources. These sources included technical literature, U. S. Government publications, the U. S. Atomic Energy Commission, the U. S. Army Chemical Corps, current technical meetings, and others.

Three separate literature surveys are reported. One, made at Oak Ridge, was made available to us by the Chemical Corps, and its substance is reproduced as a supplement to this report. Another, made by Dr. Tyler of our staff, is given as a supplement to this report. The third, made by our radiological staff, is included in the body of this report.

Information obtained from other sources is reported in separate sections.

The problems of the project are considered in the light of the available information and preliminary experimental approaches are indicated.

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1. Introduction.

Attention of the Contractor was first directed to the subject research problem by a letter from Headquarters, Army Chemical Center, Maryland, dated 22 January 1951, signed by F. H. Schwanke for Colonel J. H. Rothschild, which read as follows:

"This Command is interested in a program of research which will develop a material for the removal of radioactive soils from the skin. This product would probably be a combination of two or more of the following: detergents, abrasives, coupling agents, and sequestering agents.

"The project would involve (1) exploring the field of available detergents to determine their efficacy on characteristic radioactive soils; (2) conducting fundamental studies of the mechanism of decontamination of radioactive soils; (3) developing an effective decontaminating agent for the removal of radioactive soils from the skin.

"It is desirous to learn whether your company would be interested in conducting this program on a contract basis."

Following further correspondence, and a conference on 7 February 1951 between Mr. Richard L. Moore for Foster D. Snell, Inc., and Lt. Col. Robbins and others for the Chemical Corps, a detailed proposal was submitted on 13 February 1951. There was further correspondence between Mr. Moore and Mr. J. Wm. Lange, Purchasing Negotiator, and between Mr. Moore and Colonel Rothschild, leading to submission to the Contractor

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of Contract No. DA18-108-CML-2597, Order No. 1-13034, with covering letter, dated 29 June 1951, signed by Harry T. Parks, Contracting Officer, and relevant forms. Said covering letter designated Lt. Col. Charles Robbins as Project Officer. The Contract was executed and returned on 30 June 1951, as requested, together with relevant security and royalty forms.

On 18 July 1951, Mr. Richard L. Moore and Mr. L. C. Cartwright, for the Contractor, conferred with Lt. Col. Charles S. Robbins and Capt. John A. Pierce, Jr., at Army Chemical Center, Maryland, on the subject project, and were informed that Capt. Pierce was replacing Lt. Col. Robbins as Project Officer under the Contract. This change was confirmed by a letter from Harry T. Parks, Contracting Officer, dated 2 August 1951, and acknowledged by a letter dated 23 August 1951.

On 11 September 1951 Capt. Pierce visited the Contractor's laboratories and conferred with staff members assigned to work under the subject Contract. On 19 September 1951 Mr. Joseph J. Pescatore and Mr. Gonzalo Segura visited Army Chemical Center, Maryland, and conferred with Capt. John A. Pierce, Jr., Maj. S. Dondes, Mr. Gerard C. Smith, and Lt. J. C. Price. On 20 September 1951, at Army Chemical Center, Maryland, Mr. Pescatore conferred with Mr. J. P. Mitchell, Lt. Col. Charles Robbins, and Lt. Col. S. R. Sinnreich on work under the Contract.

The purpose, scope, and duration of work under Contract No. DA18-108-CML-2597, Order No. 1-13034, are defined in the Contract as follows:

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"I. Statement of Work:

A. Scope. The Contractor shall:

1. Conduct a literature survey for information pertinent to the decontamination of radioactive soils from skin.

2. Procure and correlate information from institutions that have had experience with the problem, such as the AEC installations at Oak Ridge, Los Alamos, Hanford, Mound Laboratory, Miamisburg, Ohio, and Brookhaven, in addition to U. S. Naval Radiological Laboratory, San Francisco, California.

3. Evaluate existing detergents for their effectiveness in removing radioactive soils, and the development of a superior decontaminating agent for use on the skin.

B. Reports. Written progress reports (six (6) copies) will be required each three (3) months. A final report (six (6) copies) covering the whole project and giving all data and an interpretation of the results will be submitted upon completion of the contract.

C. Period of Contract. The work and services hereunder will be completed by 30 June 1952, unless the period is mutually extended by the Contractor and by the Contracting Officer."

The above is in substantial agreement with the original letter of inquiry of 22 January 1951 and the proposal of 13 February 1951. Through conference with representatives of the Chemical Corps, it is understood that major emphasis is to be placed upon decontamination of living human skin contaminated by radioactive fission products, and that

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it is desired that the "superior decontaminating agent" to be developed be in a form suitable for carrying and use by the individual soldier in the field.

This is the first quarterly progress report, as provided in the contract, covering a literature survey, information procured from other sources, preliminary experimental work, and an outline of work planned for the next quarter.

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2. Literature Survey.

In accordance with sound research practice, as indicated in our proposal of 13 February 1951, and in line with Contract No. DA18-108-CML-2597, Order No. 1-13034, first attention in this project has been given to a careful survey of technical literature and other sources of relevent information.

As a start in this direction, on 18 July 1951 Lt. Col. Charles Robbins gave us a copy of a two-part unclassified survey entitled: "Preliminary Literature Survey on Skin Decontamination--Unclassified Material", dated 1 March 1951, and "Literature Survey on Skin Decontamination--Unclassified Material: Part II", dated 19 April 1951, both by F. Sachs, Y-12 Area, Carbide and Carbon Chemicals Company, Oak Ridge. This survey covers some 82 references. Although only a few of these bear directly on skin decontamination, all contain material of some relevance to the general field of our project. The survey has been studied with care, and it will continue to be a valuable reference source. The substance of this survey is reproduced at the end of the present report for ready reference.

Much of the time of the members of our radiological staff, during the first three months of work under the contract, has been devoted to search and study of relevant literature and to consideration of the problem in the light of such study. There follows a discussion of various aspects of the problem, in the light of such study, with references to the bibliography at the end of the section.

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Precisely because there is so little published literature directly bearing on the removal of radioactive contamination from human skin, we deemed it essential to cover as thoroughly as possible the literature on related subjects, especially that on thorough cleansing of human skin and that on removal of radioactive contamination from surfaces in general. Even at the risk of some duplication of effort, this phase of the search was assigned to Dr. Cornelia A. Tyler, a member of our staff especially experienced in technical literature studies, independently of the survey made by our radiological staff. Her report, with bibliography and discussion, is appended immediately after the main body of this report.

A. Decontaminating Agents.

The most obvious and generally available agent for removal of radioactive contaminants from human skin is water. Without question, especially in most cases of gross contamination, much of the radioactive material could be removed by thorough washing with water. In general, the mechanism of such decontamination would be partly solution, dilution, and rinsing away of water soluble contaminants, and partly mechanical loosening and flushing away of insoluble contaminants. There are obvious and serious limitations to this method of decontamination. Were this not true, no problem would exist, and the present project would not have been initiated.

However, it is apparent that the soundest approach to our problem is to consider these limitations of water as a decontaminant, and how they may be most effectively overcome. This is especially true since our specified ultimate goal is the development of an article, and a method,

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presumably involving the use of water as an adjunct, for effective removal of radioactive contamination from the skin of military personnel in the field.

Of course, there are already well known various means of enhancing the effectiveness of washing with water in removal of radioactive contamination. Some of them are known to be very useful under certain circumstances, others under other circumstances, but all have their own limitations, many of which are yet to be established with certainty. Another statement of our goal under the present contract is that we are seeking the most generally effective and broadly applicable means of increasing the effectiveness of water in removing radioactive contamination from human skin, not under any specific circumstances of nature and degree of contamination, but under any conceivable circumstances to which military personnel may be subjected in the field.

The limitations of water as a decontaminating agent for skin may be attributed to the following factors:

(a) Insolubility of contaminants in water.

(b) Adhesion of insoluble contaminants to the skin.

(c) Sorption of soluble contaminants on the skin surface.

(d) Fixation of contaminants by reaction with the skin.

(e) Penetration of contaminants into pores of the skin.

(f) Permeation of contaminants through the skin.

These limitations may be more or less effectively reduced as follows:

(a) Insoluble contaminants may be rendered soluble by chemical reaction, as with strong mineral acids, or by increased temperature. Organic

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solvents may be added to or used in conjunction with or instead of water. Effective solubility may be achieved through use of sequestering or chelating agents, or through emulsification with surfactants. Obviously, resort to these methods, especially use of strong acids, organic solvents, or high temperature, will have severe limitations due both to danger of injury to skin tissue and to difficulty of making the agents available in the field.

(b) Adhering insoluble contaminants may be loosened by abrasion or other mechanical action, or displaced by surfactants, and flushed away with water.

(c) Sorbed contaminants may be displaced by surfactants or removed by chemical action or by sequestration, and flushed off, or they may be removed by removal of the surface layer of skin by abrasion or chemical action. Again the danger of serious injury to skin tissue is an important limitation.

(d) Contaminants affixed by chemical combination with the skin may be removed by abrasion or chemical action, with due consideration to skin injury, since either may involve removal of surface layers of skin.

(e) Contaminants which have penetrated deep into skin pores present a greater problem, but their removal may be aided by chemical reactants, surfactants, or sequestering agents. Aside from danger of injury to skin tissue, in this case there is the further danger that the increased mobility of contaminants necessary to remove them from skin pores may result in increased permeation through the skin into body tissues or sera.

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(f) The most difficult problem in skin decontamination may well result from permeation of contaminants through the skin. The obvious answer to this problem is precisely to remove the contaminants as quickly as possible from the skin surface and pores, and to avoid, in so far as possible, accelerating permeation in the process. Conditions favoring minimum permeation may often prove adverse to most rapid removal, and careful experimental work will be required to establish conditions optimum with respect to both processes. In such work account will be taken of the possibility of retarding permeation through use of astringents and vasoconstrictors without significant interference with rate of removal.

It is evident that, both in the initial letter of 22 January 1951 inviting us to consider this project and in our proposal of 13 February 1951, use of most of the means indicated above for increasing the effectiveness of water as a decontaminating agent were contemplated. Furthermore, the literature, as covered in this report, indicates that most or all of these means have been used, with more or less success, in removal of radioactive contaminants from human skin. The objective of the present project is, through consideration of such previous work and execution of properly designed experiments, to determine the most generally effective means of decontamination suitable for application in the field.

With no thought of final exclusion of any of the means indicated above, or of any other possible means of decontamination, the following discussion of the selection of decontaminating agents for use in conjunction with water is offered for initial consideration.

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I. Abrasives.

The function, operational mechanism, and value of abrasives as an adjunct to water in removal of radioactive contaminants from human skin are rather obvious. Although little mention of them is made in the available literature, they will not be overlooked in work under the present contract. However, since their action may, in general, be assumed to be substantially independent of, and supplementary to, that of other agents, they need no further treatment at this point.

II. Chemical Reactants.

In terms of the problem of removal of radioactive contaminants from human skin, these include not only strong mineral acids, but any substance capable of reacting with any contaminant to increase its water solubility or otherwise facilitate its removal from the skin. These, particularly strong acids, have received considerable attention in the literature, but they may be considered, in spite of various specific limitations, as adjuncts to other more generally effective decontaminants, and will be so treated in our work under the present contract.

III. Surfactants.

This is probably the broadest and most important class of agents to be considered in the present project. Their functions as decontaminants include primarily preferential wetting and emulsification. As a class, they are logically divided into soaps and synthetic detergents, or syndets, as the latter are now generally designated.

a. Soaps. As generally used in aqueous media, soaps include the sodium, potassium and amine salts of higher fatty acids, either saturated or unsaturated. In terms of both tonnage and monetary value, the sodium salts of C_{10} to C_{18} acids constitute not only the most important soaps, but also the most important surfactants and the most important detergents in commercial use. For purposes of the present project, due to relative insignificance of cost considerations, no distinction is made between sodium, potassium and amine or other water-soluble soaps. On the other hand, there are certain inherent limitations in the applicability of soaps which probably render them of relatively less interest in the present work than syndets. This decision is based on the following properties of soaps.[1] (*

According to Schwartz & Perry, the outstanding disadvantage of soaps is their instability toward heavy metal ions, particularly the calcium and magnesium salts found in hard water, and towards acids. The calcium and magnesium salts of the fatty acids, as well as the free acids themselves, are quite insoluble in water. In fact, it was this shortcoming that gave the greatest impetus to the development of synthetic detergents.

Furthermore, with respect to wetting and penetrating power, the soaps are decidedly inferior to various synthetic surface-active products available today.[1]

Soaps are decomposed by acids and hydrolyzed to a certain extent even in pure water.[1] This hydrolysis lowers the concentration of the effective detergent by converting it to free fatty acid, devoid of detergent powers; the free fatty acid, in turn, is adsorbed onto the sur-

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Note(*): Superscripts in this section refer to corresponding items in the numbered bibliography at the end of the section (p. 32, 33). Since many of the references in this bibliography were used only for general background information, not all are specifically referred to in the discussion.

face. For the purposes of our problem, this is a phenomenon to be avoided, for an adsorbed film may trap contamination.

Yet another, though minor, objection to the use of soaps, is the fact that the relatively high pH of soap can cause sensitization in some individuals.[1]

b. Synthetic Detergents. Synthetic detergents may be classified as (A) cationic, (B) anionic, (C) non-ionic, and (D) ampholytic.

(A) Cationic surfactants will be adsorbed onto a negatively charged surface, such as human skin. Hence, they will tend to deposit soil rather than remove it; e.g., shampoos which are based on cationic agents are shown to deposit fatty material on the scalp after cleansing. In view of this observation, little attention has been given to cationic surfactants in connection with this project.

(B) The anionic syndets form perhaps the largest and best-known class of synthetic surfactants. Most important among them are a wide variety of sulfates and sulfonates, although other types are also of some importance.

(1) Sulfates may be divided into two classes: products in which the sulfate group is attached directly to the hydrophobic group and products in which there is an intermediate link between the sulfate and hydrophobic groups. The former includes sulfated oils, esters, acids, amides, alcohols, and olefins, while the latter includes products having ester, amide, and ether intermediate linkages. The various types will now be considered individually.

(a) Sulfated oils, generally and improperly called sulfonated oils, are usually prepared by direct treatment with sulfuric acid. The final product depends on the type of oil, fat, or wax used and on the degree of sulfation.

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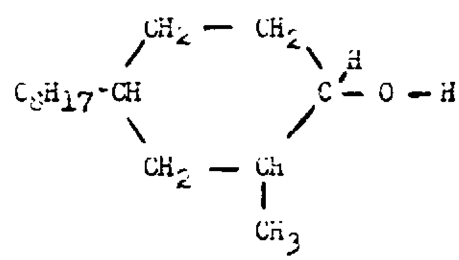
(b) Esters of fatty acids and low-molecular weight alcohols may be treated with sulfuric acid to give compounds of great foaming and wetting powers, among which are found Turfax W.O., Eni-Sol, and many others.

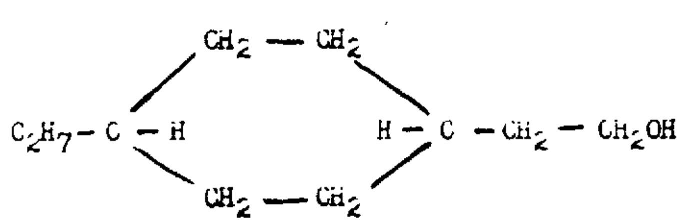
(c) Sulfation of fatty acids, particularly α-hydroxy acids, gives surfactants of some importance.

(d) Fatty acid amides have also been sulfated to produce effective surfactants, such as Dismulgan IV and Humectol CX.

(e) Of much greater importance than the types so far mentioned are the sulfated alcohols, among which we find Aurinol D, Cyclamon, Cyclopon, Dreft, Drene, the Duponols, Maprofix, Orvus, Tergavon, etc. In the case of the normal primary aliphatic alcohols, the hydrophobic groups are the same as those of soaps, hence the surface properties of sulfated alcohols and soaps are quite similar in many ways. Other types of alcohols that may be sulfated to give satisfactory surfactants include substituted cyclohexanols, such as



alkylated cyclohexylethanols like



halogenated alcohols, secondary and tertiary alcohols, glycols, sterols, naphthenyl alcohols, etc.

(f) Olefins will yield products quite similar to the sulfated alcohols. Among the starting compounds used are decarboxylation products from unsaturated fatty acids, cetene, squalene, terpenes, chlorinated olefins, many unsaturated polymers, etc.

(g) Surfactants having the sulfate group connected to the hydrophobic group through an ester intermediate linkage include Arctic Syntex

$$R-C(=O)-O-CH_2-C(H)(OH)-C(H)(H)-OSO_3Na,$$

various sulfated monoglycerides, sulfated glycol esters, etc. One disadvantage of some of these compounds is a tendency to hydrolize at extreme pH values.

(h) Amides from a variety of fatty acids may be sulfated to give surfactants. Among the most important starting materials are the ethanolamides of cocoanut fatty acids, which are sold under the names of Miranol LF, Xynomine, etc. Amides other than ethanolamides may also be used; for example

$$R-C(=O)-N(H)-CH_2-CH_2-CH(CH_3)-OSO_3Na,$$

$$R-N(H)-C(=O)-CH_2-O-C_2H_4OSO_3Na,$$

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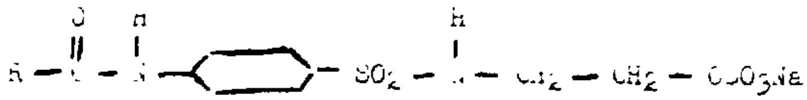
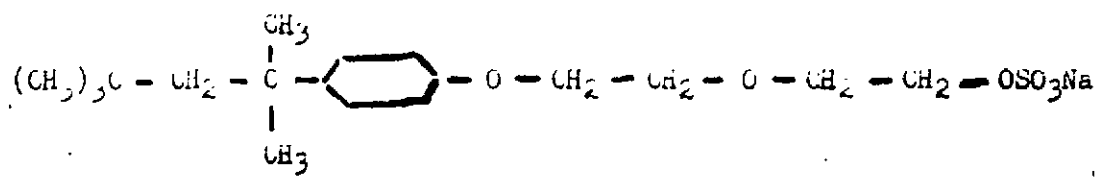


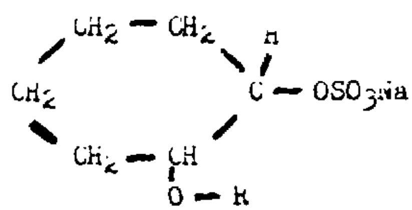
, etc.

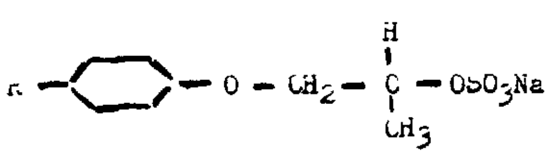
In general, these compounds are excellent detergents, but the commercial products often contain sufficient unsulfated impurities to reduce their efficiency appreciably.

(i) Ether-linked sulfates, although often possessing highly desirable characteristics, are less well-known than other types because of their greater cost. Aliphatic and aromatic mono-acid polyethers have all been used to prepare excellent detergents. For example

$$R - (OC_2H_4)_n - OSO_3Na$$







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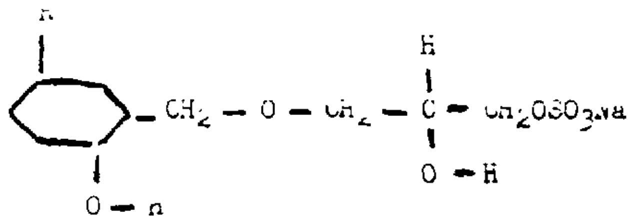
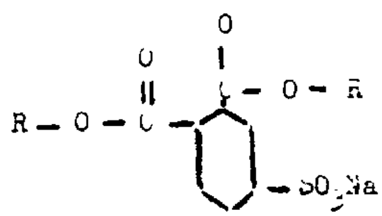
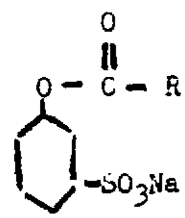
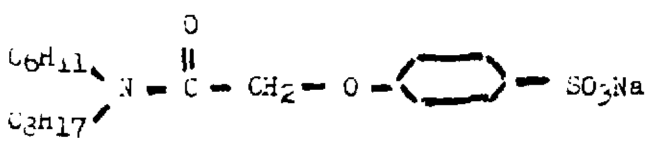


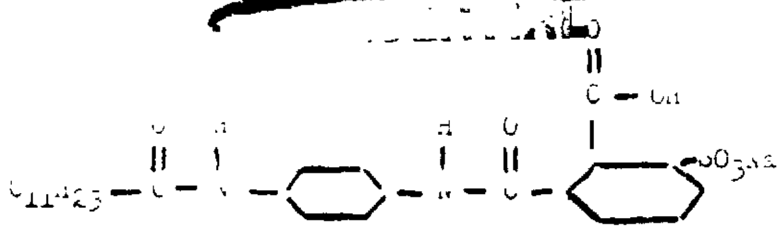
(2) Sulfonates corresponding to most of the sulfate types discussed above have been prepared and found to exhibit surface activity to a greater or lesser extent.

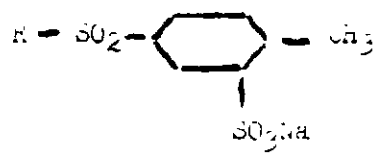
(a) Most widely used sulfonates are the alkyl-aryl sulfonates; i.e., compounds in which an aromatic nucleus forms an integral part of the hydrophobic group. Many of them are powerful wetting agents, dispersants, and emulsifiers. Among the simpler compounds are the propylated, butylated, or amylated naphthalene sulfonates, butylated diphenyl and substituted diphenyl sulfonates, etc. Similar structures, but of higher molecular weights, are marketed under the names of Nacconol NR, Santomerse, Ultrawet, etc. More complex structures are also well known; for example

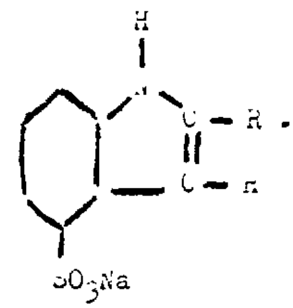












(b) In contrast to the alkyl-aryl sulfonates, the alkyl sulfonates have not become very important, with the exception of a few products like MP-189 and the Mersols. This may be due to the fact that many of the alkyl sulfonates are more expensive than the corresponding sulfates.

(c) Of considerable importance, however, are alkyl sulfonates having intermediate linkages between the sulfonate and hydrophobic groups. The intermediate linkages may, as in the case of the corresponding sulfates, be an ester, amide, ether, etc. The simplest of the alkane sulfonates with ester intermediate linkages are compounds having the formula

$$R - \overset{\overset{\displaystyle O}{\|}}{C} - O - CH_2 - CH_2 - SO_3Na$$

such as Igepon A, or

$$R - O - \overset{\overset{\displaystyle O}{\|}}{C} - CH_2 - SO_3Na$$

like Nacconol LAL. More complex structures, such as dialkyl sulfosuccinates,

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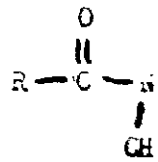
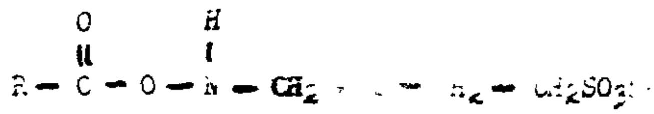
esters of sulfotricarboxy acid ... urface activity.

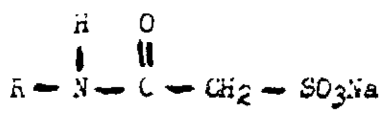
Products having ami ... ce in the field of detergency. One of

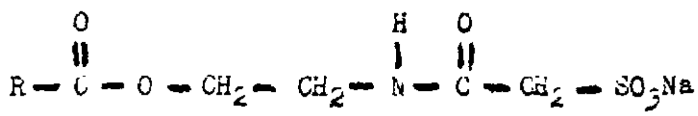


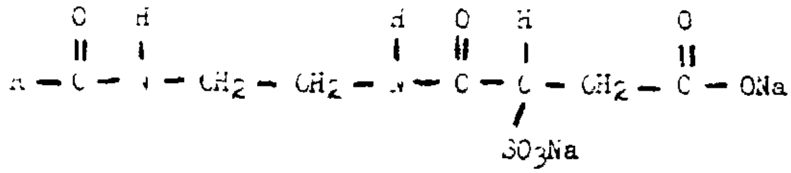
As might be expected ... Igepon T is more resistant to hydrolysis t ... it is a more powerful surfactant.

Many compounds of th ... ared; for example,



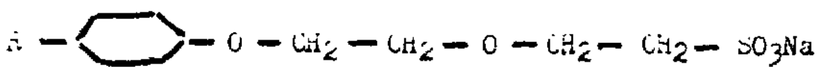




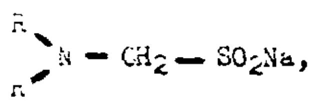


and many other more complex types.

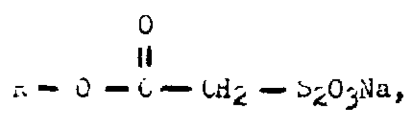
Ether-linked sulfonates include few well-known products other than Triton X-200,



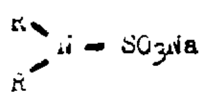
In addition to the sulfates and sulfonates, anionic surfactants containing other hydrophilic groups have been prepared, but relatively few have become important. Among these are found sulfinic acid salts



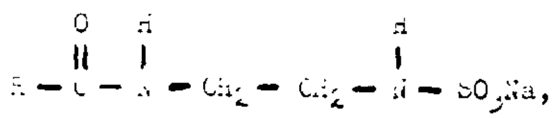
Thiosulfate esters



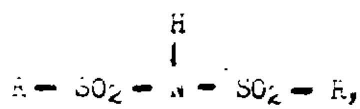
sulfamates like



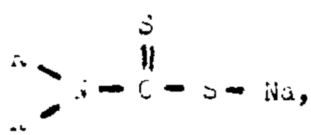
and



disulfonimides



dithiocarbamates



and the phosphate compounds corresponding to many of the sulfates mentioned above.

(C) The best-known non-ionogenic hydrophilic groups are ether linkages and hydroxyl groups. The most common non-ionic surfactants are thus polyethers and alcohols. These are often made by reacting hydrophilic hydroxy compounds such as phenols or alcohols with several moles of either ethylene oxide or propylene oxide.

[redacted]

$$R - OH + \underset{\diagdown O \diagup}{CH_2 - CH_2} \rightarrow R - O - CH_2 - CH_2 - OH$$

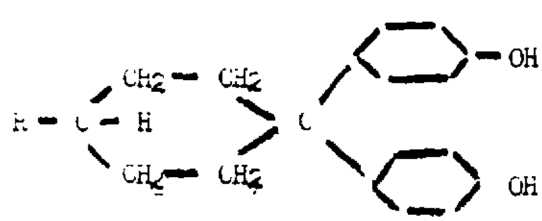
$$R - O - CH_2 - CH_2 - OH + \underset{\diagdown O \diagup}{CH_2 - CH_2} \rightarrow R - O - CH_2 - CH_2 - O - CH_2 - CH_2 - OH$$

etc., until sufficient oxyethylene groups have been added to render the resultant molecule water-soluble. Among the most common are Igepal C, Igepal A, Peregal O, the Tweens and Triton NE.

Variations include using high molecular weight alkyl mercaptans, complex alcohols like

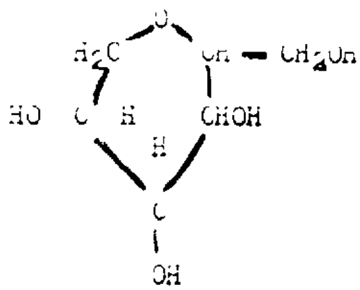
$$R - O - CH_2 - \underset{OH}{\underset{|}{CH}} - R'$$

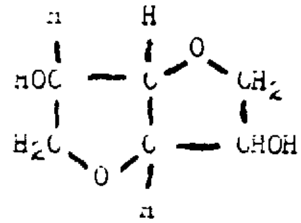
complex phenols such as,

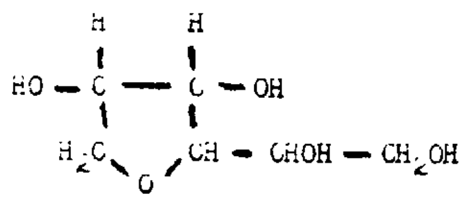


fatty acids, hydroxy esters, hydroxy amides of fatty acids, sulfonamides, fatty acyl derivates of trimethyl olaminomethane, fatty alcohol glucosides, higher fatty aldehydes which have been condensed with urea, fatty acid esters of anhydro sorbitols, such as,

[redacted]







phosphatides such as lecithin, disulfimides, etc.

Other types include mixed methylene-ethylene ether chains attached to hydrophobes; e.g.

$$R - O - CH_2 - CH_2 - O - CH_2 - O - CH_2 - CH_2OH,$$

glucosides of certain alkyl phenols and similar compounds.

Also of importance among the non-ionic surfactants are compounds formed by the reaction of one mole of a high fatty acid with two moles of diethanol amine. Important compounds of this type are the Ninols. Ninols may be reacted with certain chlorides such as thionyl chloride and chloracetic acid to produce surfactants that are particularly effective in acid solutions.

[redacted]

(2) Ampholytic surfactants are products which contain both basic and acidic groups in the same molecule. Although several compounds of this type have been prepared, they are not too well known and have not been considered in the preliminary studies.

IV. <u>Sequestering Agents</u>.

Among the oldest and still most popular sequestering agents are the polyphosphates, such as sodium tripolyphosphate, sodium pyrophosphate, sodium metaphosphate, etc. These compounds are very effective solubilizing agents for many cations, and their presence, even in very small amounts, prevents the precipitation of insoluble soaps. Newer in the field, but also highly effective, are certain organic compounds that form chelated structures with many cations. In this group we find the sodium salts of ethylene diamine tetracetic acid, which are sold under various trademarks, such as Versene and Sequestrene.

B. <u>Soil</u>.

As previously stated, the formulation of a realistic soil falls into the first phase of this program. Drs. Lambert and Sanders of the General Aniline and Film Corporation developed such a soil after two years of research. They felt that ordinary street dirt represents the commonest type of soil encountered. Samples of dirt from six cities were collected, screened through 200 mesh, and analyzed.[26]

The results are as follows: (in Per Cent)

[redacted]

[redacted]

TABLE I

Component	Pittsburgh	Detroit	Cleveland	Buffalo	St.Louis	Boston
Water Soluble	15.4	13.5	15.9	11.4	14.9	15.4
Ether Soluble	10.8	4.9	7.1	6.5	12.8	7.7
Moisture	-	1.7	3.0	-	-	2.1
Total Carbon	26.4	24.7	24.0	26.9	25.6	28.9
Ash	53.8	57.8	56.3	52.0	51.2	50.5
SiO_2 (total)	25.6	25.5	26.4	24.0	24.1	21.4
R_2O_3 (total)	11.6	9.9	11.1	9.5	9.4	11.1
CaO (total)	6.2	8.4	7.7	6.9	7.4	6.4
MgO (total)	1.7	2.0	1.7	2.0	1.6	1.7
CaO (Water Soluble)	0.3	0.4	0.7	0.3	0.4	0.7
MgO (Water Soluble)	0.1	0.2	0.2	0.2	0.2	0.2
N	-	1.6	-	-	-	2.1
pH (10% slurry)	7.0	7.3	6.7	7.2	7.0	7.3
Carbon Black Equivalent (%)	0.3	0.6	0.55	0.5	0.5	0.6

Examination by X-Ray diffraction showed considerable free silica in the dry soil and sodium chloride in the water extracts.

The analyses listed in Table I demonstrate the similarity of dirts collected from different localities.

Drs. Sanders and Lambert[1] did not investigate the nature of the 10% of ether soluble oily material. They used the results of Brown[4] who found the following fatty matter in soiled garments:

Free fatty acids (C_{18})	31.4%
Triglycerides of higher fatty acids (C_{18})	29.2%
Fatty alcohols and cholesterol	15.3%
Hydrocarbons (Saturated and Unsaturated, C_{20})	21.0%
Short chain fats and acids	3.3%

Based on all of the above considerations, a synthetic soil having the composition shown in Table II was formulated.

TABLE II

Synthetic Soil Composition

Component	Source	Per Cent
Humus	Hypernumus Co., Newton, N. J.	35
Cement	Alpha Cement Co. (Type I)	15
Silica	Davison Chemical Co. (200 mesh)	15
Clay	Harris Clay Co. (average grade)	15
Sodium Chloride	-	5
Gelatin	Keystone 431X, Ansco	3.5
Carbon Black	Binney & Smith (Molacco Furnace Black)	1.5
Iron Oxide	C. K. Williams (Red, N1860)	0.25
Stearic Acid	-	1.6
Oleic Acid	-	1.6
Palm Oil Fatty Acids	Harshaw Chemical Co.	3.0
Lanolin	Merck (anhydrous)	1.0
n-Octadecane	Connecticut Hard Rubber Co.	1.0
1-Octadecene	Humphrey Wilkinson	1.0
Lauryl Alcohol	-	0.5

C. Skin.

The human skin is a complex structure composed of an outer layer of hard, largely impermeable cells; several inner layers of varied cellular constitution; an extensive vascular system; and numerous openings of sweat and sebaceous glands, and hair follicles. Normally the surface of the skin is covered with an oil film, the product of the sebaceous glands.[22]

As noted above, the outer layer is largely impermeable to most substances, but sorption in appreciable amounts may take place through the pores. In general, water-soluble substances and certain organic compounds are sorbed most readily, while insoluble inorganic compounds such as many oxides and sulfates, are not sorbed to any appreciable extent. If a given decontamination procedure should be accompanied by the solubilization of some or all of the contaminant, any increase in the sorption rate should be investigated and kept to a minimum.

It may be possible, by the addition of a vasoconstrictor, to reduce the degree of transfer of contaminant from skin surface to vascular system during decontamination.[23]

D. Radiochemistry.

This project will ultimately lead to the use of human subjects in being contaminated with radioactivity and the removal of the contaminant thereby evaluated. To know the permissible dosage that a person may receive, the effects of radiation on skin surface must be studied. This work was undertaken by Marinelli et al.[24]

It is desirable to express doses in terms of roentgens. The roentgen, as defined by international agreement, applies only to X or gamma radiation; it can therefore be used for gamma ray emitting isotopes but not for alpha or beta. The roentgen is defined as "that quantity of gamma radiation such that the corpuscular emission per 0.001293 grams of air produces, in air, ions carrying one electrostatic unit of electricity of either sign."

Marinelli et al[24] established a comparable basis for beta ray dosage. They defined an "equivalent roentgen" as that amount of beta radiation which, under equilibrium conditions, releases in one gram of air as much energy as one roentgen of gamma rays."

The following data in Tables III and IV were taken, in part, from Tables I and II, respectively, of Marinelli et al.[24]

TABLE III

Physical data pertaining to calculations of radiation dosage resulting from beta rays and/or very soft x-ray radiation. The values of K_β and S_β are based on uniform and biologically stable concentrations of radioelements distributed in tissues of linear dimension large as compared to the range of the beta particles.

$K_\beta = 38\bar{E}_\beta T$ is the radiation dose expressed in equivalent roentgens due to beta rays emitted during the complete disintegration of 1μc of radioelement per gram of tissue.

$S_\beta = \frac{0.1}{K_\beta \times f_d}$ is the concentration of radioisotope expressed in μc/Kg which will deliver a dose of 0.1 e.r. to tissue during the first 24 hours of exposure.

[redacted]

TABLE III (Cont.)

Element	A	Radiation	T (Half life in days)	Kβ (e.r./μcd per gram)	Sβ μc per kg.
Na	22	β^+, γ	1100.0	22,000.0	7.3
P	32	β^-	14.5	385.0	2.4
V	48	β^+, K, γ	16.0	245.0	9.7
Mn	52	β^+, K, γ	6.5	43.0	20.6
Fe	59	β^-, γ	47.0	496.0	13.4
Co	56	β^+, γ	35.0	4,900.0	2.6
	60	β^-, γ	1940.0	17,000.0	16.5
As	76	β^-, γ	1.12	115.0	1.9
Br	82	β^-, γ	1.5	20.0	13.5
In	114	β^-, (γ)	50.0	4,150.0	1.7
I	131	β^-, γ	8.0	144.0	8.3
RaE	210	β^-	4.85	141.0	5.3
C	14	β^-	$1.7x10^6$	$8x10^6$	32.0
S	35	β^-	88.0	420.0	30.0
Ca	45	β^-(?)	180.0	1,530.0	16.0
Sr	89	β^-	55.0	2,700.0	3.0
	90	β^-	9000.0	$17x10^4$	8.0
Y	90	β^-	2.6	200.0	~2.0
Sb	124	β^-, γ	60.0	3,430.0	2.4
Au	198	β^-, γ	2.7	76.0	5.7
Mn	54	K, γ	310.0	147.0	340.0
Fe	55	K, γ	1500.0	730.0	280.0
Co	58	β^+, K, γ	65.0	20.0	415.0
Zn	65	β^+, K, γ	250.0	130.0	185.0
Y	86	K, γ	105.0	46.0	310.0
In	111	K, γ	2.7	1.4	310.0

[redacted]

TABLE IV

Physical data pertaining to calculations of radiation dosage resulting from gamma rays.

I_γ is the exposure in roentgens at 1 cm distance in air from an unfiltered point source of 1 mc, for one hour; or milli-roentgens per microcurie hour.

$K_\gamma = 1.44tI_\gamma x10^{-3}$ is the number of roentgens at 1 cm distance in air from an unfiltered point source, per microcurie destroyed.

Group A - elements not decaying by electron capture, or x-ray emission following electron capture so soft that it can be treated like β radiation and hence making no significant contribution to I_γ.

Element	A	Radiation	t (Half life in hours)	I_γ at 1 cm mr/μc-hr r/mc-hr	K_γ at 1 cm r/μcd
Na	22	β^+, γ	26,500.0	13.2	500.0
	24	β^-, γ	14.7	19.1	0.40
Sc	46	β^-, γ	2,040.0	11.4	33.5
V	48	β^+, K, γ	384.0	16.3	9.0
Mn	52	β^+, K, γ	156.0	19.5	4.4
	56	β^-, γ	2.59	9.4	0.035
Fe	59	β^-, γ	1,128.0	6.55	10.7
Co	56	β^+, γ	2,040.0	17.95	37.2
	60	β^-, γ	46,500.0	13.5	900.0
Cu	61	β^+, K	3.4	4.8	0.024
	64	β^+, β^-, K	12.8	1.2	0.022
As	76	β^-, γ	26.8	2.2	0.083
Br	82	β^-, γ	36.0	15.1	0.79
Sb	124	β^-, γ	1,440.0	7.9	16.4
I	130	β^-, γ	12.6	13.05	0.237
	131	β^-, γ	192.0	2.65	0.735
Au	198	β^-, γ	65.0	2.4	0.22

[redacted]

TABLE IV (Cont.)

Group B - elements with x-ray emission following electron capture whose contribution to I_γ is not negligible

Element	A	Radiation	t (Half life in hours)	I_γ at 1 cm mr/μc-hr r/mc-hr	K_γ at 1 cm r/μcd
Mn	54	K, γ	7,450.0	4.9+(11)	52
Fe	55	K, γ	36,000.0	(10)	-
Co	58	β^+, K, γ	1,560.0	5.7+(7)	12.8
Zn	65	β^+, K, γ	6,000.0	3.0+(5)	26.0
Y	88	K, γ	2,530.0	14.4+(3.1)	52.5+(10.3)
In	111	K, γ	65.0	2.3+(1.4)	0.22+(0.13)

(The numbers in parentheses pertain to x-ray emission following electron capture.)

A related problem, investigated by Lauderdale and Emmons,[25] resulted in the development of a compact decontamination unit to purify water supplies that have been contaminated with fission products. With this device, water, made extremely radioactive by the addition of a complete mixture of fission-produced radioisotopes, was treated to give less than 10^{-4} μc/ml. The contaminated water was passed through the following materials arranged in series: steel wool, burnt clay, activated carbon, and a mixture of ion exchange resins.

[redacted]

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Bibliography

1. A. M. Schwartz & J. W. Perry, Surface Active Agents, Interscience Publishers, New York (1949)

2. F. D. Snell, Chem. and Ind., 1949, 539-545.

3. E. K. Rideal, Chem. and Ind. 1948, 403, 409

4. F. D. Snell, Ind. Eng. Chem., 24, 1051-7 (1932)

5. I. Reich & F. D. Snell, Ind. Eng. Chem. 40, 1233-7, 2333-7 (1948)

6. C. T. Snell, Am. Dyestuff Reporter, 1950, 485-7

7. R. C. Merrill & R. Getty, J. Phys. Colloid Chem., 54, 489-97 (1950)

8. F. D. Snell, Ind. Eng. Chem. 35, 107 (1943)

9. C. R. Caryl, Ind. Eng. Chem. 33, 731-7 (1941)

10. R. C. Palmer, J. Soc. Chem. Ind. 60, 56-60 (1941)

11. F. D. Snell, C. T. Snell, I. Reich, J. Am. Oil Chemists Soc., 27, 62-68 (1950)

12. I. Reich & F. D. Snell, Ind. Eng. Chem. 41 (1949)

13. C. T. Snell, Am. Dyestuff Reporter, 1950, 485-487

14. F. D. Snell & I. Reich, J. Soc. Chem. Ind. 68, 98-100 (1949)

15. F. Courtney-Harwood, Chem. Products, 12, 162-6 (1949)

16. E. K. Rideal, Chem. & Ind. 1948, 403-409

17. W. D. Scott & D. S. P. Roebuck, Chem. & Ind. 627-31 (1948)

18. F. D. Snell, J. Am. Oil Chemists Soc. 26 (1949)

19. G. S. Hattiangdi, W. W. Walton, J. I. Hoffmann, J. Research Natl. Bur. Standards 42 (1949)

20. R. C. Merrill & R. Getty, J. Am. Oil Chemists Soc., 26 (1949)

21. J. Dollinger, Soap Sanit. Chemicals, 25 (1949)

22. Becker and Obermeyer, Modern Dermatology & Syphilology, Lippincott, 1943.

[redacted]

23. Sutton & Sutton, Diseases of the Skin, C. V. Mosby Co., 1943

24. Marinelli, L. D., Quimby, E. H., Hine, G. J., Am. J. of Roentgenology & Radium Therapy, 59 (1948)

25. Lauderdale, R. A., and Emmons, A. H., Am. Waterworks Assoc. Vol. 43, No. 5 (1951)

26. Sanders, H. L., and Lambert, J. M., J. Am. Oil Chemists Soc. 27, 153-159 (1950)

27. Ringeissen, M., Teintex, 8, 31-7 (1943)

28. Baird, W., Brown, C. R., and Perdue, G. R. B I O S Final Report No. 518

29. Evans, J. G., Fitton, J., Jinks, J. R. A., & Whitehead, A. B I O S Final Report No. 778

30. Brown, C. B., Research, 1, 46-8 (1947)

3. Information from AEC.

Our radiological group conferred with Dr. Martin Gibbs at the Brookhaven National Laboratory. A general discussion on the problem of decontamination gave us some indications that the Brookhaven laboratory is not too actively engaged in this work. References to other research teams were made, notably those at Oak Ridge, The Mound Laboratory, Ohio, and the Naval Research Laboratory in California. We did, however, learn of their technics in measuring quantitatively a contaminated surface to give reproducible results.

The New York laboratory of the Atomic Energy Commission supplied us with literature on the subject of decontamination and suggestions by Mr. Merrill Eisenbud who is in charge of their health physics group, and Mr. E. Meservey of the Technical Advisory Branch. They have also recommended the above-mentioned laboratories as being actively engaged in this field. Contact will be made with Dr. Frank Mead of the Mound Laboratory for a meeting in the near future.

Our Mr. Pescatore met with Dr. Paul C. Aebersold, Chief, Isotopes Division, AEC, for a free exchange of information related to this project. In a letter to our Mr. Cartwright, Dr. Aebersold suggested Dr. Victor H. Witten as a qualified dermatologist to be consulted in our studies.

4. Information from Other Sources.

A meeting with Captain John A. Pierce, Jr. of the Army Chemical Center was held at our laboratories. We discussed the technic involved in contaminating a surface and the removal of the contaminant to give reproducible results.

At the General Aniline laboratories, Drs. C. F. Jelinek and Joseph Lambert gave us considerable information regarding their complex soil mixture. This soil is the one we have selected for our studies.

Mr. J. F. Mitchell, Lt. Col. Charles Robbins and Lt. Col. S. R. Sinnreich, during a conference at the Army Chemical Center, agreed that a good starting point in this investigation would be to label the soil first with carbon 14 and a second batch with fission products. The first batch contains a radioactive element as a component part of the mixture, whereas, the second is mechanically mixed with several of the radioisotopes. The two types will be evaluated for reproducibility and the more suitable one used for future studies.

The recent meetings of the American Chemical Society and the International Congress of Pure and Applied Chemistry gave us the opportunity to sit in on the following talks:

1. "Treatment and Disposal of Atomic Energy Wastes Containing Radioactive Isotopes" by C. C. Ruchhoft.

2. "Some Problems of Waste Processing in the Atomic Energy Industry" by J. H. Haynes.

3. "Complete Radioactive Effluent Control for a Radiochemical Laboratory" by Walter A. Rodger.

4. "Recent Developments in the Measurement of Radioactivity" by C. J. Borkowski.

5. "Present State of Possible Prediction in Radiation Chemistry" by Milton Burton.

6. "Theories of Radiation Chemistry" by S. C. Lind.

7. "The Distribution and Dispersion of Contaminants in the Atmosphere" by Morris Katz.

5. <u>Preliminary Experimental Work.</u>

Radiocarbon barium carbonate has been ordered from the Atomic Energy Commission, following their authorization. This material will be converted to amorphous carbon black, which is to be a component part of our soil mixture.

Due to the nature of the material used in this synthesis, it is advisable to conduct several "cold" syntheses before using the radioactive compound. The qualifying "cold" indicates the use of non-radioactive materials. This phase of the work is now under way.

Our laboratory is presently negotiating with Dr. Victor H. Witten, of the New York Skin and Cancer Hospital, to secure his services as a dermatologist in our studies. Dr. Witten has been engaged for some time, under an Atomic Energy Commission grant, on the treatment of human skin that has been exposed to radioactive contamination. Since this project is closely related to ours, the results of his extensive research should provide valuable guidance in our investigation.

The following samples have been obtained for their comparative evaluation in skin decontamination:

(1) Versene - Bersworth Chemical Company
(2) Radiac-Wash - Atomlab Inc.
(3) Sequestrene - Geigy Company
(4) Sodium Tripolyphosphate - Blockson Chemical Co.
(5) Tide - Procter and Gamble
(6) Flobar - Flo-Bar Ltd. (obtained from Lt. Col. Robbins)
(7) Triton N.E. - Rohm and Haas Co.
(8) Surf - Lever Brothers

6. <u>Tentative Schedule for Next Quarter.</u>

Work planned for the quarter ending on December 31, 1951 is centered on close cooperation with the radiological laboratories of the Army Chemical Center, Md. A member of our staff will be sent there for an indefinite stay, in order to learn at first hand the established technics related to our project, and thus avoid duplication of effort. With the use of their facilities, we can carry further our laboratory developments on a larger scale.

The initial experiments will be conducted along the following lines:

I. The preparation of realistic, reproducible contaminants, based on the synthetic soil described in this report. Some synthetic soil batches will be prepared with one or more radioactive components, while fission products will be mechanically mixed with other batches.

II. Setting up reasonably realistic, reproducible contamination procedures.

III. Development of reproducible decontamination methods.

IV. Evaluating the efficiency of various types of commercial detergents and sequestering agents in this investigation.

The preliminary experiments may well be performed on metallic or other inorganic surfaces, but some work will be done on skin of types suggested by our dermatologist.

It is also desired to have one of our men at the Nevada tests so that data may be obtained under field conditions.

[redacted]

Meanwhile, every effort will be continued to obtain additional relevant information from AEC, current publications and all other sources. In the light of such additional information, and further study of the literature covered in this report, a more detailed and comprehensive experimental program will be set up and initiated.

Respectfully submitted,

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SUPPLEMENTARY SURVEY OF LITERATURE RELATED TO DEVELOPMENT OF A CLEANSER FOR REMOVAL OF RADIOACTIVE SOIL FROM HUMAN SKIN

I. Introduction

The purpose of this search was to cover the literature which might supply information useful for development of a cleanser to be issued to combat personnel in the field. This cleanser should have particular effectiveness in decontaminating the skin after exposure to radioactive products.

Since this type of problem is relatively new the literature search was limited in general to about the last five years. However, Chemical Abstracts were covered from 1937 through 1950. The reason for this was the convenience of using the last decennial index which covers the years from 1937 through 1946. The Index Medicus was covered from Volume 40, 1946, through Volume 47, 1950. Such issues of Nucleonics as were available at the 42nd Street Public Library were searched. This is a journal dealing with nuclear fission products, which started in 1946. Several Government Documents dealing with hazards and methods of decontamination were also obtained. Superscripts refer to the list of references at the end.

II. Surgical Cleansing

Since relatively little information has been published on decontamination of skin exposed to radiation, it was felt that the related subject of methods of cleansing skin contaminated with bacteria should be studied in terms of the more recent developments. In surgery it is necessary for the operating surgeon to go through a special "scrub-up" procedure in order to free the skin from bactorial contamination. Similarly the skin of the patient to be operated on is given special cleansing to produce an aseptic condition. The procedures used result in a far more thorough cleansing of the skin than is required under any ordinary conditions. It therefore seems suitable to study these methods as the closest parallel to decontamination of the skin from radioactive material.

The usual method of surgical scrub-up is for the doctor to scrub his hands and arms for a period of ten minutes with one or two rinses in the interim, using a liquid soap. Within the last few years an antiseptic called Hexachlorophene, or G-11, has been added to soap to increase its bactericidal efficiency. In 1947 it was reported that 1 per cent of G-11 in liquid soap reduced the number of skin organisms below those found after conventional scrub-up procedures.[1] A scrubbing period of six minutes, once a day, five days a week, was found to have a cumulative effect in keeping down the number of organisms on the surgeon's hands.

Addition of 2 per cent of G-11 to liquid surgical soap reduced the number of bacteria on the hands and arms to 70 per cent of the count occurring when the same soap was used alone.[2]

A special product based on a synthetic detergent was developed which has a higher degree of surface activity than soap, in terms of surface tension. This product contains a sulfonated ether, petrolatum, lactic acid, and wool-fat cholesterols.[3] The product is of a consistency about like that of thick dairy cream. The sulfonated ether is the detergent, lactic acid serves to bring the pH down to 5.5—the average pH value of the skin. Cholesterols and petrolatum are present for the softening effect they have on the skin and to prevent its becoming over-dried. This product has been given the name of pHisoderm. The cream spreads easily, requires little water and rinses readily.

The combination of pHisoderm plus 3 per cent of G-11 has been found particularly effective as a skin cleanser. This combination of cleanser plus antiseptic is made by Winthrop-Stearns Inc. Because of its high efficiency, the preoperative scrubbing time can be reduced from the usual ten minute period. For example, a four-minute brushless scrub in 1500 clean operative cases resulted in a wound infection rate of only 1.6%, and in 430 potentially dirty cases, an infection rate of only 4 per cent. These results suggest that a shortened and brushless scrub with this particular agent furnishes a method as safe as any previously used. The technic used in the cases reported was for the surgeon to wash his hands and arms with about 2 ml. of the product for 1 minute, rinse with water, clean the fingernails with an orange stick, wash the hands and arms with another 2-4 ml. of product and a little water for 2 minutes, then rinse with water.

The antiseptic ingredient G-11, is reported to be sorbed by the skin so that it exerts a cumulative bacteriostatic effect on resident flora for several days. This antiseptic is nonirritating and nontoxic on intact skin. One investigator[5] recommends that the antiseptic pHisoderm be used for a scrub period of 8 to 10 minutes during the first several days, with the time gradually decreased when the product is used daily. Since G-11 is soluble in alcohol, the hands should not be rinsed in alcohol after its use. This would tend to break the emollient film and extract the G-11 sorbed on the skin.

A method has been described for the experimental evaluation of cleansing effectiveness of the skin in terms of reduction of bacterial count.[6] Because this was the only laboratory procedure found, a photostat of the original article carrying a picture of the equipment is attached to this report. In this study results were compared using distilled water, a 50 per cent solution of pHisoderm, a 0.1 per cent aqueous solution of Zephiran, a 50 per cent solution of pHisoderm containing 1.5 per cent of G-11, and a 50 per cent solution of a 40 per cent concentrate of olive-oil and coconut-oil soap. Of the four products, the increasing order of efficiency was the 50 per cent solution of pHisoderm, the soap solution, the Zephiran solution, and the pHisoderm plus G-11 solution. When the G-11 was increased to 3 per cent the effect was more striking.

Pre-operative skin cleansing of the patient must also be on an aseptic basis. A study over a four-month period showed 25 per cent decrease in the number of wound infections when G-11 was used for preparing the patient's skin in comparison with cleansing successively with soap, alcohol, ether, and Zephiran.[5] Another investigator[6] reports that, of the products he studied, pHisoderm plus 3 per cent of G-11 was the most effective for pre-operative preparation of the skin.

Zephiran is a cationic surface-active agent strongly sorbed on the skin. It is very useful as a mild antiseptic agent and has replaced 70 per cent alcohol in hospital usage, for example, in Presbyterian Hospital in New York City.[7] When Zephiran is used after soap cleansing, the soap must be completely removed because the two agents are opposite in ionic activity and precipitate each other. The film of Zephiran which forms on the skin may retain bacteria underneath.[8] This implies that bacteria are themselves very strongly sorbed by the skin, even more strongly than a cation-active compound. This effect is emphasized here because preferential sorption of cleansing agents, bacteria, or other contaminants is pertinent to the study of skin decontamination. This will be discussed again later.

III. Surface Decontamination Studies

Very little has been published on decontamination of skin from radioactive materials. Much more has appeared on decontamination of walls, floors, hoods, laboratory benches and so forth. In general these would not be referred to here because in most cases the studies would not be pertinent to this problem. However, where agents were used which would be suitable for skin cleansing, reference is made to this.

(1) Decontamination of Inert Surfaces In a laboratory study of agents for decontamination of glass, stainless steel, and lead, P^{32}, Ba^{140}, and I^{131} were used as the standard radioactive contaminants. The phosphorous was in the form of $H_3P^{32}O_4$ in hydrochloric acid, the barium in the form of $Ba^{140}Cl_2$ in hydrochloric acid, and the iodine in the form of NaI^{131} in sodium bisulfite

solution.[9] This work shows that the effectiveness of the decontaminant varies with the surface and more particularly with the radioactive material present. Reagents selected as standard decontaminants because of their high effectiveness were as follows:

For P^{32}: 3 N HNO_3-3 N H_3PO_4
For Ba^{140}: 6 N HNO_3
For I^{131}: 56% HI

The conclusion was reached that decontaminability is controlled almost completely by that fraction of the activity that can be removed in a short time. This fraction can be assumed to consist of ions which have not reacted with surface valences at all, or those that are loosely bound to the outer atoms of the double layer surrounding the surface. The most interesting aspect of this work is that detergents were often as good for decontamination as the strong acids. The detergents used included solutions of saturated Calgon, 1 per cent Mulsor 224, 1 per cent Sequestrene and 1 per cent Sapamine.

Further studies on the decontamination of working surfaces showed that practically all of the contaminant that can be removed in a reasonable time is removed very rapidly.[10] Although the effects vary with both the nature of the surface and the nature of the contaminant, the following syndets and wetting agents were as effective as the strong standard reagents for the decontamination of Lucite:

Cleaning Agent	Manufacture	Isotope	Nature of Agent
0.1% Nitron	Allied Chem. & Dye Corp.	I^{131}	anionic
1% Sequestrene A. A.	Alrose Chemical Co.	Ba^{140}	anionic
1% Amine O	Alrose Chemical Co.	Ba^{140}	cationic
1% Tergitol W A No. 4	Carbide & Carbons Chem. Corp.	P^{32}	anionic
10% CMS and 1% S-189	E. I. duPont de Nemours & Co.	P^{32}	anionic
1% Mulsor 224	Synthetic Chemicals Inc.	I^{131}	nonionic
1% Emulsor 224 & 10% CMS	— —	I^{131}	anionic

These results indicate that different types of detergents may be very effective in removal of radioactive products. A result to be emphasized is that the reaction of the detergent with the surface material contributes far more to its cleaning efficiency than does a reaction between the reagent and the radio element. These general conclusions would appear to be applicable to the cleansing of skin, even though the surface is different from that studied here.

The same workers found that a protective colloid used in conjunction with an anionic detergent caused a marked improvement in cleansing efficiency, but had no apparent effect when used with a nonionic detergent.[11]

(2) Skin Decontamination Quantitative results on skin decontamination have not been reported, but recommended procedures for washing contaminated hands have been prepared. One method is to wash for 2-3 minutes with a teaspoonful of Lan-O-Kleen soap, using a sufficient amount of tepid water to maintain a thin paste.[12] The paste is to be rubbed over the entire surface of the hands and fin-

gers then rinsed off completely with water. The washing and rinsing process is to be repeated at least three times. The use of hand creams after washing is recommended.

A similar procedure, still tentative, has been received from Gordon Dunning of the Bio-Physics Branch of the Division of Biology and Medicine of the U.S. Atomic Energy Commission.[13] This recommends for removal of light decontamination--washing for 2-3 minutes in tepid water with Ivory soap. This is with the use of a hand brush and lather. Hand cream is applied afterward. For heavier contamination a paste of titanium oxide containing a small amount of lanolin is applied first, followed by washing with soap. A chemical treatment used as a last resort is to pour on a 1:1 solution of saturated potassium permanganate and 0.2 Normal sulfuric acid. Scrub with a brush for no longer than two minutes and rinse. Next a 5 per cent sodium bisulfite solution is poured on with brushing for no more than two minutes, following by washing, rinsing, and the application of hand cream. According to ORNL-382 a number of syndets such as those already mentioned are believed to be satisfactory, also most of the common household detergents such as Tide and Dreft have been used successfully as decontaminants.

It was mentioned previously that the nature of the contamination influences the success with which it can be removed. Strong beta-rays are both highly absorbable and very active in their biological effect. When some beta-ray emitters are spilled on the hands it could happen that the person might retain some of the material until the outer cuticle is worn away.[14]

IV. Skin Irritation of Detergents

Frequent washing of the hands with either soaps or syndets usually results in skin dryness. A study of the irritant action of binary soap mixtures on the skin, designed to relate irritability to chemical composition of the soap, showed that a mixture of sodium laurate and sodium myristate was less irritant to the skin than combinations of the laurate with caprylate and oleate.[15] This suggests that soap made from saturated fatty acids of relatively long chain length should be less irritant than unsaturates and shorter chain lengths.

The effect of washing the hands with various syndets and soaps showed that greater irritation resulted from the syndets than from soap.[16] However, the presence of sodium carboxymethylcellulose lowers the skin-irritating action of syndets. This compound is similar to a methyl ether of cellulose called Tylose SAP, which has been found to have skin-protective properties.[17]

It might be mentioned here that anion-exchange resins have been added to talc to give powders having anti-irritation effects on the skin.[18] Such a mixture was intended to neutralize alkaline irritants. This modified talc should be suitable for dusting the inside of rubber gloves.

V. Suggested Approach To Problem

A cleanser to be used in the field for decontamination of skin from radio-active products should have a combination of the following desirable properties:

1. Be non-toxic
2. Be non-irritant
3. Be efficient with a relatively short cleansing period
4. Require relatively little water in use
5. Rinse off freely
6. Leave the skin soft, possibly by means of a sorbed protective emollient film.

Work in our laboratories has shown that many factors are involved in the general cleaning process. One of the most important, that should have particular significance in relation to this problem, is that some one or more ingredients in the cleansing agent should be powerfully sorbed by the skin. If such preferential sorption is great enough, soil and contaminating substances will be replaced. Although it is possible to study the degree of sorption, or perhaps better expressed as wettability, of a smooth surface, such as glass or metal, such a procedure would not be readily applicable to a study of the same effect on the skin. This measurement of contact angle is extremely useful in studying and comparing the effectiveness of detergent solutions in wetting a solid surface, and probably should be kept in mind as a possible laboratory method. A related approach in the study of the skin is to apply a layer of de-haired pork skin to a glass slide for use of the skin layer as a base. This is only to suggest an approach which is more or less fundamental in other detergency studies.

Practical experiments are suggested in which actual hand-washing tests would be used, more or less simulating the surgical scrub-up technic. From the above study, products to be compared in preliminary work might include the following:

1. Plain commercial surgical soap
2. West antiseptic surgical soap containing G-11
3. Ivory soap
4. Lan-O-Kleen soap, presumably containing lanolin
5. pHisoderm plus G-11
6. 0.1% Nitron
7. 1% Mulsor 224

Further work might combine the effect of titanium oxide paste followed by use of a cleansing agent.

It should be possible to determine the effectiveness of the various detergent products by patch-testing the skin with some relatively harmless radioactive material. Although details can be worked out in consultation by various staff members, the suggestion is made that a patch carrying the radioactive material in solution might be left on the hand for an hour, after which the patch would be removed and any liquid on the skin be allowed to dry. A count of activity on the surface should be made, after which a particular cleanser would be applied under controlled conditions. At the end of the cleansing process, another count of activity would be made of the hand and of the rinse water.

The statement has been made that the maximum permissible level of radiation on the hands is 700 counts per minute under predetermined conditions as measured with a G-M counter and scaler assembly.[19] This is used for routine checking of contamination of the hands where such may have occurred. If a higher level of contamination were to be used than is known to be harmless, this could be done on the shaved skin of experimental animals, possibly by patch testing the ears of rabbits.

This study has covered so little work done with radioactive isotopes that the selection of those most suitable for experimental use is left open.

Respectfully submitted,

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CAT:lms

28 September 1951

AN IN VIVO METHOD FOR EVALUATION OF DETERGENTS AND GERMICIDES

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THERE have been many techniques for the evaluation of skin detergents and germicides. That of Price[1] has contributed greatly to the knowledge of the bacteriology of the skin and is an effective method for determining the relative efficiency of germicides. Because there are several major variables in this technique which are uncontrolled and because at least seven days must elapse between determinations for the numerical recovery of the bacterial flora on a subject's skin, experiments are necessarily protracted and strictly comparable determinations are impossible.

The technique to be described was intended to permit multiple determinations on contiguous areas of human skin so that various agents can be tested on the same skin on the same day.

An apparatus, Fig. 1, was designed and built to standardize the various mechanical factors involved in scrubbing techniques. This device isolates adequate areas of skin and scrubs it at a constant rate with a specially designed brush pressed against the skin by a constant force. The machine has three elements: a mechanical reciprocating scrubber, a stable brush, and a vacuum seal to isolate and hold the skin against the brush.

The reciprocating scrubber is driven by a gear reduction motor at 30 strokes per minute. Briefly, it consists of a rocker shaft mounted on a balanced arm. At the pivoted end of the balanced arm, the rocker shaft is actuated by a hinged rocker arm bearing a slide block which is driven by a crank mounted on the motor shaft. At the opposite end, the rocker shaft carries a rocker arm which supports a detachable brush. A small tray at this end of the balanced arm accommodates the weights used to load the brush.

The brush§ was designed to withstand repeated (300 times) sterilization by exposure to saturated steam at 121° C. for thirty minutes without a significant change in brushing characteristics. The nonwetting Nylon bristles are 0.25 mm. on centers. Two rows of tufts set in a heat-resistant plastic back were used.

The vacuum seal is created in a space around a square aperture, 4 by 4 cm., in the concave bottom of a stainless steel pan. The edges of the aperture are bent downward 0.5 mm. The radius of the concavity is of the same length as

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‡Harvey Cushing Fellow, 1942-1943.

§No. 157, Prophylactic Brush Company, Florence, Mass.

[redacted]

the rocker arm and brush assembly so that the entire skin area is scrubbed uniformly and the bristles rub on the pan at either end of the stroke to divest themselves of organisms and detritus. The seal is made by mounting a second aperture, 4.2 cm. square, 1 mm. below the convex surface of the pan. Negative *reduced* pressure applied to the space between the apertures effectively seals the skin to the pan. The entire pan can be detached for sterilization. Stainless steel was used because it has minimal oligodynamic action. An adjustable rest faced with sponge rubber is mounted beneath the aperture to support the hand. The rocker arm and brackets that support it are long enough to extend over the back of a prone subject.

TECHNIQUE

The pan and brush are sterilized in saturated steam at 121° C. for thirty minutes. The surface of the remainder of the apparatus is washed with 0.1

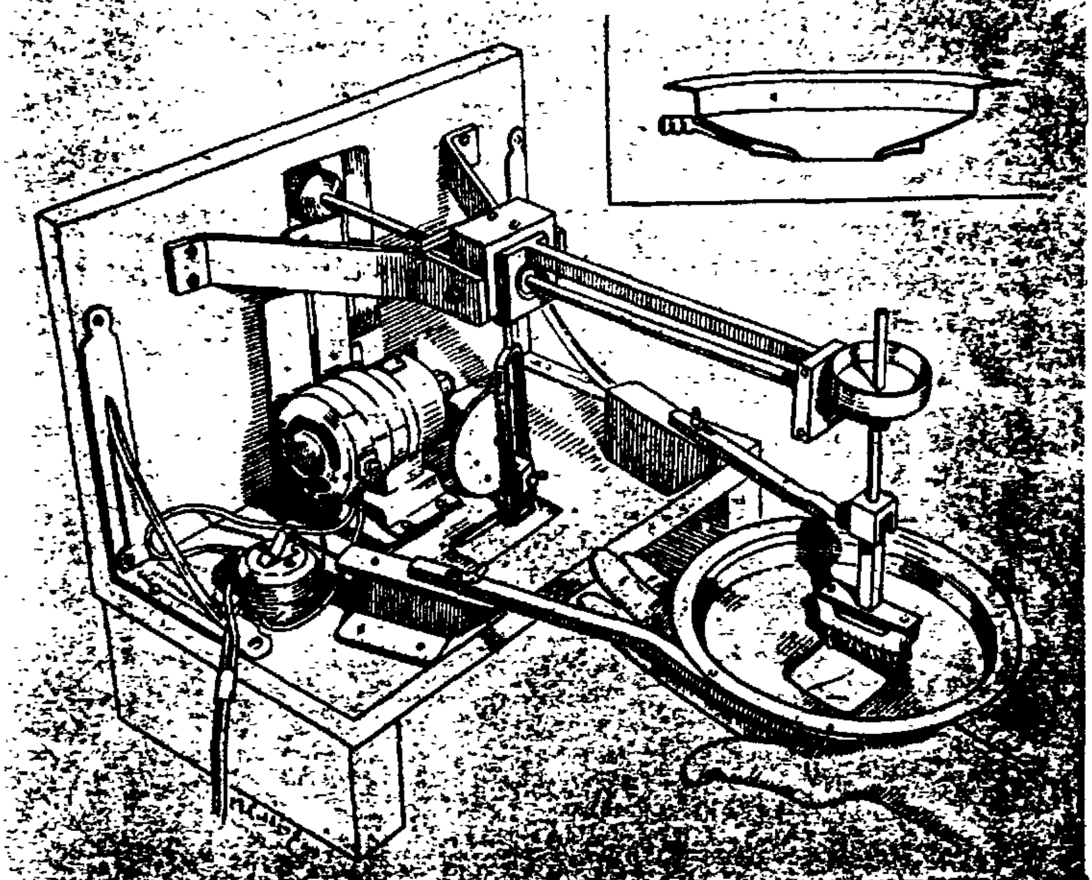

FIG. 1. [illegible]

per cent aqueous Zephiran and covered with a Pliofilm hood prior to each experiment to control air-borne contamination. The subjects are requested not to wash their hands for four hours before the test and are known not to have contacted germicidal solutions for four days. In this study the subjects were chosen at random from volunteers.

The hand is adjusted on the rest so that the flat mid-portion of the palm is in firm contact with the sealing chamber of the scrubbing pan and 250 mm. Hg negative pressure is applied to isolate the test area of skin. Five cubic centimeters of sterile distilled water are run on the test area of the skin. The brush is fixed in position and the skin is scrubbed with 110 Gm. pressure on the brush for ten complete reciprocating strokes. The water is aspirated with a sterile suction tip into a sterile test tube. Care is taken to remove as much water as possible. The same brush is used for subsequent test periods using similar amounts of distilled water and ten strokes. This process is repeated thirty times. On the thirty-first group of ten strokes, the pressure on the brush is made as hard as the subject can bear without discomfort. Thus, any remaining organisms which can be removed by increased pressure are detected. There were no cases in this study in which a variation beyond the predicted number was obtained, so that it appeared that at this point on the control curve there were few additional organisms available for removal. The complete series of scrubs was sufficiently traumatic to abrade soft skin such as that on either side of the midline of the back.

The technique for the evaluation of germicides is identical to that of the control curve except that the substance to be tested is introduced on the skin surface after the initial period of ten strokes with water, that is, at the second point of the curve. A new sterile brush is fixed and the hand scrubbed for ten strokes. The germicide then is aspirated, the brush removed from the pan, and, while the skin is rubbed with a cotton pledget, it is rinsed three times with 5 c.c. sterile water to remove the test substance. This simple washing with water and friction after an initial scrub with water removes an insignificant number of organisms. The original brush is then replaced and the scrub continued as in the control series, using 5 c.c. of water and ten strokes of the brush. The repeated scrubbing with fresh water further dilutes residual germicide beyond bacteriostatic levels and should break up any film the germicide may precipitate in the skin. Immediately following completion of the scrub, the contents of each tube are transferred to a sterile Petri dish and pour plates are made using Difco beef agar. Colony counts are made after twenty-four and forty-eight hours of incubation at 37.5° C. using a Quebec colony counter.

RESULTS

Control curves were obtained using sterile water. Colonies of "spreading" organisms on the plates caused a number of experiments to be discarded because it was impossible to count the colonies. Experiments yielding an initial count of below 500 colonies were likewise discarded because the paucity of organisms made these seem less reliable although, when plotted, the same general type of curve was obtained.

[redacted]

Nineteen experiments were finally accepted. These showed an average of 2,320 colonies on the initial ten strokes. When the curve of the average control experiment was plotted in conventional manner, number of bacteria removed against number of brush strokes, it corresponded to that of a rectangular hyperbola following the general formula of $y = f(x)^{-1}$ and closely approximated the calculated curve, Fig. 2. Thus, the second ten strokes should yield one-half, and the third ten strokes one-third the number removed by the first ten. It should be noted that this is not a simple dilution curve. Cumulative totals of organisms removed in successive intervals of scrubbing, a concept introduced by

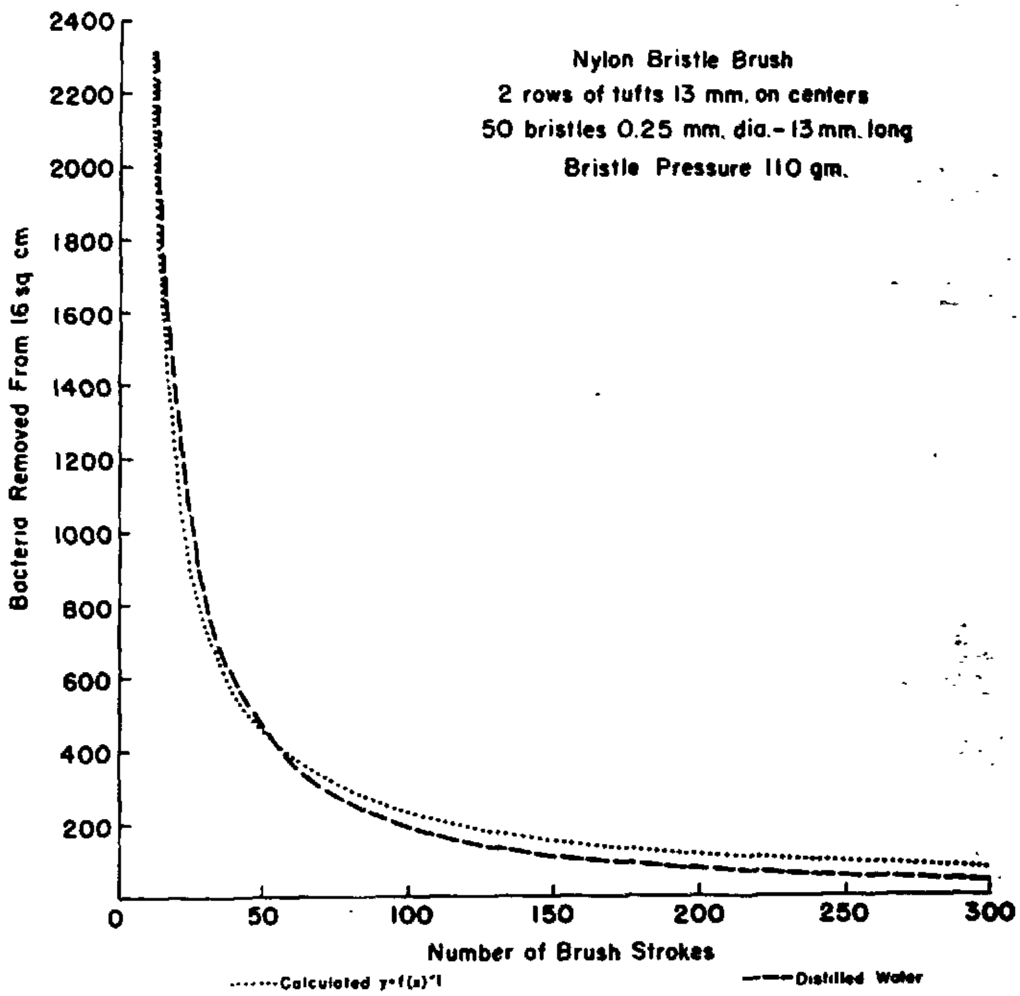

Fig. 2.—The effect of mechanical scrubbing. The distilled water, or control curve, demonstrates the effect of mechanical scrubbing alone. The curve expresses the average of nineteen experiments. It corresponds with that of the rectangular hyperbola $y = f(x)^{-1}$.

[redacted]

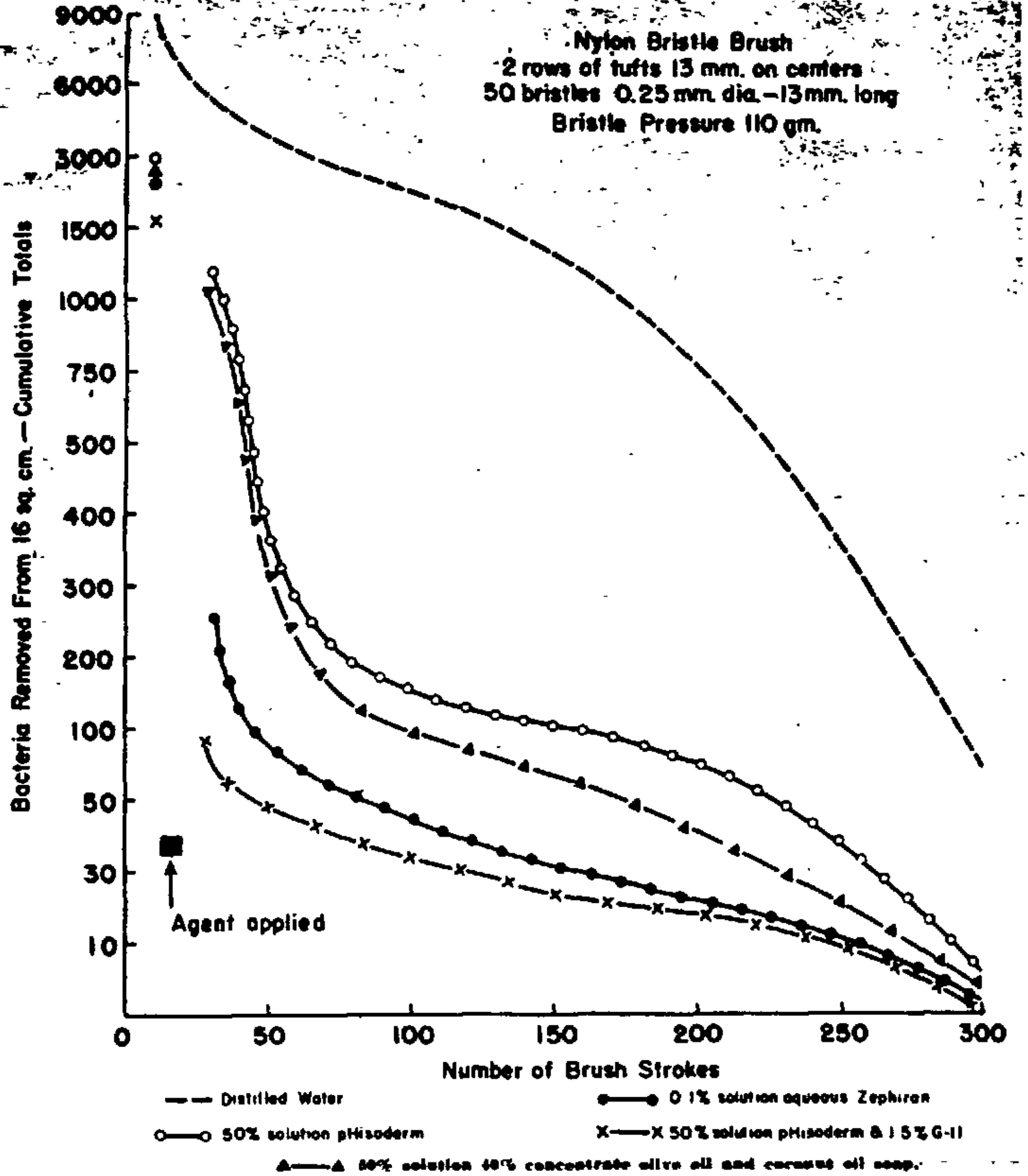

Fig. 3.—The comparative disinfecting effect of scrubbing, detergents, and germicides. The distilled water curve is made from the same data as Fig. 2, plotted cumulatively rather than in conventional fashion. The total counts for the other agents are given at ten brush strokes. The second period of ten strokes is that used to apply the agent. The third period, therefore, represents the total number of organisms removed following the application of the agent under study. The drop from the control curve portrays its relative effectiveness.

Price,[1] when plotted against the nu[illegible] of stro[illegible] applie[illegible] a curve [illegible] portrays best the contrasts between ex[illegible]ments, Fig. 3.

Germicides or de[illegible] were evaluated by appl[illegible] them during the second interval of scrub[illegible] were thus used to apply them to the skin. The agent was then removed by suction and by dilution. Since only a film of fluid covering the skin was left each time, the triple rinsing with water reduced the concentration of each agent well below bacteriostatic levels. The effectiveness of the agent applied during the second interval of scrubbing was [illegible] by comparing differences between the control curves and those obtained by plotting the counts of the subsequent periods of scrubbing with distilled [illegible].

The agents tested were a 40 per cent concentrate of equal parts of coconut oil and olive oil soaps diluted equal parts with water; pHisoderm, diluted equal parts with water; 0.1 per cent aqueous Zephiran N.N.R.; pHisoderm containing 3 per cent G-11, diluted equal parts with water. G-11 is 2,2'-dihydroxy-3,5,6-3',5',6' hexachlorodiphenylmethane, a promising new cutaneous germicidal agent.[9] A comparison of the result may be seen from Table I and Figs. 2 [illegible].

The curves for ten scrub[illegible] with coconut oil soap and pHisoderm [illegible] extremely similar. Both had average initial counts of close to 1700, and [illegible]

TABLE I

AGENT	CONTROL	COCONUT AND OLIVE OIL SOAP—20 PER CENT	PHISODERM #44 WATER 1A	ZEPHIRAN 0.1 PER CENT AQUEOUS	PHISODERM [illegible] 3 PER CENT G-11 WATER [illegible]
NUMBER OF EXPERIMENTS	19	10	10	10	10
SCRUB PERIOD			AVERAGE COLONY COUNTS		
1	2320	1703	1665	2502	1565
2	1410	agent applied			
3	802	469	640	131	7
4	605	275	185	28	5
5	496	116	90	15	4
6	355	67	46	1	4
7	285	22	30	[illegible]	[illegible]
8	282	16	23	[illegible]	[illegible]
9	244	15	21	[illegible]	[illegible]
10	208	11	13	4	[illegible]
11	204	9	12	[illegible]	[illegible]
12	130	[illegible]	[illegible]	[illegible]	[illegible]
13	165	[illegible]	7	[illegible]	[illegible]
14	140	[illegible]	7	[illegible]	[illegible]
15	124	[illegible]	[illegible]	[illegible]	[illegible]
16	110	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	100	[illegible]	[illegible]	[illegible]	[illegible]
21	90	[illegible]	[illegible]	[illegible]	[illegible]
22	71	[illegible]	[illegible]	[illegible]	[illegible]
23	64	[illegible]	[illegible]	[illegible]	[illegible]
24	60	[illegible]	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[redacted]

100 strokes, tube 9, had reached colony counts approaching ten in contrast to the control of 244.

Using Zephiran, however, the fall in the average number of organisms was much more rapid from an initial count of 2,500 to 130 organisms on the first ten strokes. Very few organisms could be removed after the ninth tube with an average of only two colonies per tube after that point and the majority of tubes were sterile. The total average number of organisms after the use of 0.1 per cent aqueous Zephiran for thirty seconds and ten strokes was 237 in contrast to 5,172 with water, 1,075 with coconut oil soap, and 1,207 with pHisoderm.

The results with pHisoderm and 3 per cent G-11 were even more striking. This agent was diluted with an equal amount of water before use. The initial count was 1,500 and the first tube after its use showed only seven colonies. Subsequent tubes showed further reduction and the total number of organisms removed by the water after its use averaged 65.

CONCLUSIONS

1. A technique is described which has been elaborated to permit multiple determinations of the bacterial flora of the human skin under standardized mechanical conditions.

2. The effectiveness of various agents is strikingly portrayed by the cumulative plotting of the data obtained.

3. The agents investigated are primarily detergents. The conventional practice is to use soap and pHisoderm for longer periods of time than employed in these experiments, yet comparable rates of removal of bacteria are detectable under the conditions employed. Zephiran exhibits marked germicidal properties on more prolonged exposure than the 60 seconds' maximal exposure possible in this technique.

4. Recent studies, to be elaborated in a subsequent report, indicate that pHisoderm fortified with G-11 displayed the most rapid disinfecting action. This combination appears to be more effective than any detergent commonly employed for the preoperative preparation of skin.

REFERENCES

1. Price, P. B.: The Bacteriology of Normal Skin: A New Quantitative Test Applied to a Study of the Bacterial Flora and the Disinfecting Action of Mechanical cleansing, *J. Infect. Dis.* 63: 301-318, 1938.
2. Traub, E. F., Newhall, C. A., and Fuller, J. N.: New Cutaneous Bactericidal Agent Used in Soap, Arch. Dermat. & Syph. 52: 385, 1945.

[redacted]

References

1. C. V. Seastone, Surg., Gynecol. & Obstet. 84, 355-60 (1947).
2. D. G. C. Clark, J. S. Lockwood, and F. Lewit, Surgery 22, 360-6 (1937).
3. B. T. Guild, Arch. Dermatol. & Syphilol. 51, 391-5 (1945).
4. R. F. Bowers, Am. J. Surgery 78, 859-63 (1949).
5. R. W. Painter, Connecticut State Med. J. 14, 201-4 (1950).
6. Charles A. Hufnagel, Carl W. Walter, and Rutledge W. Howard, Surgery 23, 753-9 (1948).
7. Personal communication to the author.
8. B. F. Miller, R. Abrams, Dorothy A. Huber, and M. Klein, Proc. Soc. Exptl. Biol. Med. 54, 174-6 (1943).
9. Paul C. Tompkins and Oscar M. Bizzell, Ind. Eng. Chem. 42, 1469-75 (1950).
10. Paul C. Tompkins, Oscar M. Bizzell, and Clyde D. Watson, Ind. Eng. Chem. 42, 1475-81 (1950).
11. P. C. Tompkins, O. M. Bizzell, and C. D. Watson, Nucleonics 7, 42-54, 87 (1950).
12. J. E. Wirth, "Genl. Rules and Procedures concerning activity Hazards", U. S. Atomic Energy Commission MDDC247.
13. Tentative Report by the Subcommitte on Waste Disposal and Decontamination of the Natl. Comm. on Radiation Protection.
14. W. E. Chamberlain et al, J. Am. Med. Assoc. 138, 818-19 (1948).
15. W.W. McKinney and L. D. Edwards, Oil & Soap 23, 198-200 (1946).
16. Lothar Peukert, Fette u. Seifen 52,415-19 (1950).
17. R. Kuchinka, Seifen, Ole, Fette, Wächse 76, 9-11, 29-31, 51-2 (1950).
18. Richard J. Block, U.S. Patent 2,501,927 (1950).
19. G. G. Manov and D. O. Lintz, Mech. Eng. 71, 991-98, 1030-31 (1949).

1. "Radiation Hazard Control", Argonne National Laboratory. AECU-108 (ANL-4146) May 3, 1948; 60 p.

The purpose of this manual is to acquaint personnel with the hazards involved and the precautions which should be taken in handling radioactive materials. Among the topics discussed are the permissible exposures for both external and internal radiations, precautions to be observed in handling radioactive materials, and general safety and emergency procedures.

2. "H. I. Lecture Series, Part I." Hanford Engineer Works. AECD-2943 July 1, 1947; Decl. Aug. 2, 1950; 77 p.

These lectures are part of the regular training course for men assigned to radiation protection duties. They are aimed primarily at those who have a technical degree; for example, B. S. Ch.E., or the approximate equivalent. The lectures are given under the following respective headings: scope of health instrumentation; fundamental concepts of nuclear physics; properties of the elementary particles; ionization of gases; G-M counters and other particle detectors; electrometers, scalers and related circuits; health instruments; radioactivity; fission and fission products; effects of the radiation on the body; radiation dosimetry; tolerance dose; protection methods; special hazards bulletin No. 1; and other special hazards bulletins.

3. "Lecture Notes; Health Physics Training Lectures, 1948-1949", Oak Ridge National Laboratory. AECU-817. Sept. 29, 1950; 10 p.

A series of lecture notes, issued in conjunction with lectures given during the fall of 1948 to persons working in the field of health physics at the Oak Ridge National Laboratory, are reproduced. The notes are essentially in the form written or approved by the lecturer. A discussion of the place of health physics in written or approved by the lecturer. A discussion of the place of health physics in industry and the health-physics organization at ORNL is followed by a series of lectures on fundamental nuclear physics. Application of physics to health-physics and radiation-detection methods and techniques are covered in 20 lectures, and 14 lectures are given to applied health physics and practical problems.

4. "Medical Aspects of Civil Defense Against Atomic Weapons" Hale, William F. et. al. UR-112; November 3, 1950 - Unclassified. (2) SDL.

Health and Biology

5. "Air-borne and Short-wave Radiation Hazards in the Project at the University of California" Ballenger, H. F. (University of California Radiation Laboratory) AECD-2358; Sept. 10, 1945; 27 p.

This report brings together the results of approximately two years of study into the problem of detecting and eliminating sources of hazard due to the presence of toxic gases or vapors of uranium and its products and to radiation. The report is separated into two main divisions: first, a summation of the dust-, vapor-, and gas-hazard problem and second, a summation of the radiation problem. Methods of <u>collection</u>, <u>analysis</u> and study of <u>hazards</u> for <u>uranium dust</u>, mercury vapor, and carbon monoxide are discussed. <u>Methods for detection of radiation and methods to eliminate hazards of α and β particles, γ rays, x rays, and neutron flux are included</u>.

6. "Pathologic Effects of Ionizing Radiations and Radioactive Materials" Brues, A. M. Biochemical Journal 42, p. XXII, 1948. (Abstract of paper presented at meeting of Biochemical Society).

Included in this are certain purely chemical effects of ionizing radiations are understood. These include the dissociation of water into H and OH radicals and the inhibition of certain enzymes such as those containing sulphydryl groups. In addition to these proximate effects, various forms of genetic and cell damage have been extensively studied. The relation of these changes to most clinical radiation effects remains largely to be established.

7. "Health Chemistry and Physics, Sect. 3, Medical and Health Physics Quarterly Report; April, May, and June 1950" Garden, N. B., and B. J. Moyer (University of California Radiation Laboratory) AECD-2928 (sect. 3). July 26, 1950. Decl. Sept. 8, 1950; 3 p.

<u>Health Chemistry</u>. New processes have been developed which provide further safety features for handling radioactive materials. Work on monitoring, transportation of radioactive materials decontamination, disposal, storage, and processing equipment is briefly reported.
<u>Health Physics</u>. Study of the fast-neutron fields outside the shielding of the 184-in. cyclotron has been continued. It has been found that the area survey meter in the region studied showed intensities closely correlated with the neutron intensities, and may therefore be used roughly as a neutron monitor for this region. A bismuth-fission ionization-chamber counter with efficiency increased at least tenfold over those formerly employed in high-energy-neutron research has been developed. A statistical summary of the monitoring program is given.

8. "The Metabolic Properties of Plutonium and Allied Materials, Sect. 1 of Medical and Health Physics Quarterly Report; April, May, and June 1950" Hamilton, J. G. (University of California Radiation Laboratory) AECD-2928(Sect. 1). July 26, 1950; Decl. Sept. 8, 1950; 42 p.

<u>Radioautography and Histology</u>. Studies on the histopathology of astatine, At^{211}, have continued following two lines: (1) the toxicity of the element to body tissues in general, and (2) the points of localization and destruction of thyroid tissue.

(3. cont.)

Tracer Studies in Rats with Radioactive Materials. Studies on the deposition of tantalum in rats using Ta^{182} as a radioactive tracer have been continued. In general, these studies show that tantalum is rather readily eliminated from the body. That which remains deposited in the body 64 days after administration is primarily found in liver and kidney, skeleton, skin, and the musculature. Carrier-free Re^{183} has been administered to rats intravenously and its fate studied for 1, 4, 24, and 48 hr. With the exception of a relatively large accumulation of this isotope by the thyroid, rhenium was not deposited to any great degree in any of the tissues studied. The fate of carrier-free Os^{185} has been studied in rats following intramuscular administration. One day following administration, relatively large amounts of osmuim were found in kidney and in the intestinal contents, with lesser amounts being deposited in liver, blood, and spleen.
Chelating Experiments. Necessary characteristics of chelating agents for hastening excretion of radioactive material are discussed. In view of the importance of the toxicology of beryllium, a number of chelating agents were screened in vivo for possible use for removing beryllium which has been deposited in the body. Numerous cations have been tested for reaction with ethylenediamine tetracetic acid (EDTA) to form soluble chelates.
A Preliminary Report on the Effect of Whole-body Radiation on Extra- and Intra-cellular Electrolytes. Experiments have been aimed at establishing the pattern in rats of fecal and urinary excretion of electrolytes in acute radiation injury. Na^{22} was injected subcutaneously in an amount of 2.0 uc 36 hr. before various irradiations. The reactions of the animals are described, and the change in Na^{22} concentration in tissues and excreta is presented.
Decontamination and Bone-Metabolism Studies. A study was made of the curves for distribution in rats of Ce^{144}, Nb^{95}, Y^{90}, and Pu^{239} during the first hour following intravenous injection. An initial rapid fall in blood level during the first 10 min. was followed by a much slower decline.

"The Metabolic Properties of Plutonium and Alled Materials, Sect. 1 of Medical and Health Physics Quarterly Report; April, May, and June 1950"

Treatment with massive doses of zirconium citrate prolonged the initial rapid rate of urinary excretion and fall in blood level. After injection of Ca^{45} into normal young rats, feeding a phosphorus-deficient diet resulted in an immediate and marked increase in the urinary excretion of radiocalcium, with accelerated removal from the skeleton. This procedure would appear to have possibilities for decontamination of radiostrontium.
The Effect of Calcium-Versene Complex on the Excretion of Radiocalcium in the Rat. Calcium-versene complex injected 0 or 15 min. after administration of Ca^{45} resulted in a very significant increase in the urinary excretion of radiocalcium. This treatment also produced a small reduction in the amount of Ca^{45} in bone.

(8. cont.)

<u>Radiochemistry</u>. The 52.9-day Be^7, produced by (d, 2n) reaction on lithium, was isolated by dissolving the target in water to give a solution of lithium hydroxide containing the Be^7 as a radiocolloid which is removed by passing the solution through a sintered-glass filter. The long-lived radioisotopes of tantalum, $Ta^{178,182}$, were prepared by α-particle bombardment of hafnium according to the reaction Hf(d,αpn)Ta. A carrier-free procedure was developed for isolating the radiotantalum from the hafnium oxide target material and from the radiotungsten concurrently produced by (α,xn)reaction. The shorter-lived radioisotopes of tantalum, $Ta^{176,177}$, were prepared by deuteron bombardment of HfO_2 according to the reaction Hf(d,xn)Ta. A more rapid procedure has been developed for the separation of At^{211} from bombarded bismuth foils. The bismuth is heated to 425°C in a stream of nitrogen carrier gas at a pressure of 10^{-2} to 10^{-3} mm. The At^{211} is collected on a cold finger which is covered with a thin layer of ice.

9. "Chemical Problems in Atomic Energy" Lawroski, S. (Argonne National Laboratory) AECU-770; Nov. 29, 1949; 15 p.

Some of the special techniques and precautions required in the processing of radioactive materials are discussed in light of past experience and their shortcomings noted. Areas in which improvement is needed are indicated. Recovery and decontamination of source and fissionable materials, recovery of useful by-product isotopes, processing of active waste streams for recovery of valuable chemicals and for concentration of radioactivity for storage, and <u>corrosion resistance</u> and decontaminability of construction materials are some of the areas discussed.

10. "Radioactive Contamination; Lecture No. 4." (Lecture given at Chalk River on 9th, 16th and 23rd August, 1949) Lewis, W. B. (Atomic Energy Project (Canada)) EL-4; Aug. 9, 1949; Unclassified; 16 p.

Defines radioactive contamination and briefly describes the harm of it, examples of it, prevention of it and what to do with it.

11. "Present Laundry Procedures at ORNL" McAlduff, R. J., Jr. ORNL-600 Mar. 1, 1950; Unclassified; 10 p.

Collection and checking of clothing; special treatment of alpha-contaminated clothing; washing cycle; protection of laundry personnel.

12. "The Surgical Treatment of Irradiation Injuries" Mason, Michael L. Illinois Med J 95; January (1949) p. 20-26

The 5 large groups into which irradiation injuries of the skin and subcutaneous tissues may be grouped are reviewed. Examples are given of injury treatment which consists in removal of all involved skin and plastic repair of the resultant defect. Additional irritants, particularly irradiation of any sort, must be avoided since they increase the severity of the process and delay surgical repair.

13. "Protective Precautions in the Handling of Radioactive Materials" Morgan, J. William. "Proceedings of the Auburn Conference on the Use of Radioactive Isotopes in Agricultural Research, December 18-20, 1947", Auburn, The Alabama Polytechnic Institute (1948) p. 54-59

This comprehensive and compact paper contains discussions of the following topics: medical examinations for prospective radioisotope workers, planning a radioisotope laboratory, shielding, personnel monitoring, safe practices, selection of experimental apparatus, planning and monitoring operations, surveying areas for contamination, decontamination, and disposal of radioactive materials.

14. "Protective Measures for Personnel" (Volume XX Chapter III) Nickson, J. J. AECD-2424 (CH-3763) December 13, 1946 Decl. December 16, 1948 (For publication in NNES) 62 p.

The problem of protective measures for personnel was increased greatly by the increase in the number of individuals potentially exposed and in the amount of the radioactive materials handled. In general, the solution of the problem of protection lay primarily in the proper training of the worker who was to handle radioactive materials. From a physical point of view the use of shielding to absorb external radiation and utilization of measures to prevent internal disposition of radioactive materials were of prime importance. Protection from contamination of the skin with elements radiating alpha particles was of importance primarily as a means of preventing the ingestion of such radioactive materials. Control of radioactive materials that may get into the body and continue to irradiate the person indefinitely was even more difficult than the control of radiation originating outside of the person. For the most part ingestion of radioactive materials has not presented a serious problem. Fortunately, many of the materials handled are very poorly absorbed from the gastrointestinal tract. It was important, however, to minimize the possibility of ingestion by prohibiting smoking, eating and drinking in work areas, and by keeping the hands clean. The absorption of radioactive materials through breaks in the skin must be prevented. Experience has shown that work clothing should be provided to all workers handling radioactive materials. Disposal of unwanted radioactive substances has been, and continues to be a major problem. Appendices are added on general rules and procedures concerning activity hazards, definition of terms, description of equipment, and references to techniques and procedures.

15. "Certain Considerations in the Application of Isotopes to Medical Problems" Stetten, DeWitt, Jr. <u>Bulletin of the New York Academy of Medicine</u> 24, May 1948; p. 300-307

The properties and availability of stable and radioactive isotopes are briefly considered. Methods of handling, hazards, and waste disposal in so far as radioactive isotopes are concerned are also discussed.

16. "The Impact of Radioactivity on Chemical Laboratory Techniques and Design" Tompkins, Paul C., and Henri A. Levy (ORNL) AECD-1835 (n.d.) Declassified (Apr. 15, 1948) 7 p.

    Discussion of the features of chemical laboratories and laboratory practices peculiarly related to the full and safe use of radioactive materials; present design and technique is tailored to the chemical properties of materials.

17. "Laboratory Handling of Radioactive Material; Protection of Personnel and Equipment" Tompkins, Paul C. United States Naval Medical Bulletin, March-April, 1948. Supplement, p. 164-175 (See also MDDC-1527)

    Both personnel and equipment must be protected from an undesirable high intensity of external radiation and from adverse results due to radioactive contamination. Radiation protection is provided by a combination of distance and massive shielding between the source and the operator or instrument. Contamination control is provided by the development of aseptic technique. To accomplish the latter, steps must be taken to keep active material confined to the interior of the equipment and provision must be made for the detection, removal, and subsequent disposal of any active material that gets outside the equipment. Techniques which have been developed to accomplish the above in such operations as sampling, preparation of experimental solutions, evaporation, filtration, and injection of radioactive materials are described and illustrated.

18. "Radioactive Decontamination Properties of Laboratory Surfaces; II Paints, Plastics and Floor Materials." (ORNL-382) Tompkins, Paul C., and Oscar M. Bizzell, Clyde D. Watson (ORNL) AECU-552 (n.d.) Unclassified 33 p.

    Determination of the susceptibility of various paints, plastics and floor materials to contamination and their subsequent ease of decontamination by simple empirical tests; the probable usefulness of these materials in radioactive laboratories and attendant facilities are further indicated by chemical resistance tests with common laboratory reagents.

19. "Management and Treatment of Exposed Personnel" Wirth, John E. (University of Chicago Metallurgical Laboratory) MDDC-1728; Jan. 30, 1947 Declassified (2-12-48) 17 p.

    The prevention of exposures to quantities of radiation which may be harmful to personnel; recommended procedure for washing contaminated hands and for immediate care of wounds likely to be contaminated with Pu.

20. "Radiological Defense; Vol. III." Armed Forces Special Weapons Project NP-1609 (n.d.) Unclassified; 140 p.

    Compilation of lectures presented in Washington, D. C., during 1947, 1948, and 1949 in a joint course on "Medical Aspects of Nuclear Energy"; the papers deal primarily with radiation injuries and protection of personnel; papers on the handling and use of radioactive isotopes in clinical medicine are included; bibliography.

21. "Army Doctors Say Mass Hysteria Need Not Follow Atomic Bomb Explosion"
Military Surgeon 102-6, p. 501-503, June 1948

Army doctors, who are conducting continous study of the problem of atomic bomb explosions, state that although the population would be faced with the greatest emergency of its history, the entire population would not be wiped out, and measures to help the survivors could be made. Many lives may be saved by a widespread knowledge of therapeutic measures among physicians and a general understanding of preventive measure. Four known kinds of radiation can be expected within the immediate area of the blast. The gamma radiation is similar to the X-ray and is lethal to a distance of a mile of the blast. Neutron beams passing through matter such as blood, bone, or flesh produce ionization of the atoms which make up body cells. Beta rays and alpha particles cause superficial damage. (TDD)

22. "Radiological Safety Regulations" Navy Department Bureau of Medicine and Surgery; December 1947 (NP-522) 95 p.

These regulations, established by the Bureau of Medicine and Surgery, are designed to meet the requirements of the overall Radiological Safety Program of the Navy, particularly in connection with the utilization of atomic energy. The following subjects are covered: radiological hazards, tolerances, personnel requirements, medical examinations, photographic dosimetry, protection of personnel, general radiological safety regulations, special regulations for ships and material contaminated by atomic bomb tests, storage, handling and shipment of radioactive materials, miscellaneous radiological reports required by the Bureau of Medicine and Surgery, first aid, and safety indoctrination. Appendexes include AEC and ICC regulations.

23. "Clinical and Pathological Observations on the Effects of the Atomic Bomb" (Atomic Bomb Investigation Groups, Manhattan District) NP-1202 n.d. Unclassified; 12 p.

Presents nine cases showing the pathology of skin burns caused by the exploding bomb at Nagasaki.

24. "Rules and Procedures concerning Radioactive Substances and Associated Hazards" U. S. Atomic Energy Commission, Clinton Laboratories, (PBL 92135) 30 p.

The presently accepted rules and procedures which are considered necessary for the safe conduct of operations at the plant site are made available in this report. Topics covered are tolerance; radiation monitoring; protective clothing and devices; eating and smoking rules; contamination of persons; contamination of areas; storage handling and disposal of radioactive materials; and summary of enforcement responsibilities.

25. "Rules and Procedures for Radiological Safety; Final Report" Naval Radiological Defense Laboratory; AD-190(n) April 1949; Unclassified. 43 p.

This manual consists of two parts: Section I gives general rules and procedures concerning radiological hazards; Section II contains a glossary of terms and specific information on various procedures pertaining to handling radioactive materials.

26. "Medical and Health Physics Quarterly Report; April, May, and June 1950" University of California Radiation Laboratory; AECD-2928; July 26, 1950. Decl. Sept. 5, 1950; 83 p.

Separate abstracts have been prepared on the following sections of this report: The Metabolic Properties of Plutonium and Allied Materials, sect. 1; Biological Studies of Radiation Effects, sect. 2; Health Chemistry and Physics, sect. 3.

27. "Benign Tumors, Nevi, and Precanceroses" Laymon, Carl W. Minnesota Med. 33, 908-9, 915; September 1950

Descriptions and treatments of warts, fibromas, pigmented moles, nevi, keratoses, and precancerous lesions including radiodermatitis are given. First-degree radiation burns are characterized by erythema with slight burning and itching which disappears after a few days or weeks. In second-degree radiodermatitis there is edema, intense erythema, and vesiculation followed in a few days by exudation and erosion and crusting. There is a loss of hair which may be permanent. Months later there may be atrophy and telangiectasia with excessive dryness of the skin followed by pigmentation, the formation of keratoses, and later malignant and ulceration with extremely slow healing which may take months. In chronic radiodermatitis the skin is dry, thin, smooth, shiny, and sensitive to trauma. There may be hyper- or hypopigmentation. As the dermatitis progresses, telangiectasis, keratoses, and intense atrophy may develop. Ulceration which frequently develops into carcinoma is not uncommon. Other disorders which may be complicated by malignant change include ulcers following burns or varicosities, lupus erythematosus, and lupus vulgaris.

28. "The Role of the Doctor in Atomic Defense" Warren, Shields; Chicago Med. Soc. Bull. 52. June 10, 1950; p. 1051-3

The text of a speech presented before the Annual Clinical Conference of the Chicago Medical Society is given. It is a review of the general problems of a medical nature which will arise in the event of an atomic detonation in the air, on the ground, or under water. The need for all medical personnel to familiarize themselves with the events and emergency treatments, including rapid diagnosis, is emphasized.

29. "Public Health Aspects of Atomic Energy (Concluded)" Morton, Roy J.
Mississippi Doctor 28; June 1950; p. 51-54

The problems of radioactive waste disposal with a minimum objective of insuring that the radioactive isotopes released into drainage systems, atmosphere, or soil must be incapable of sufficient concentration to be harmful to plant or animal life, are discussed, and some of the measures taken by the Atomic Energy Commission to insure this are presented. Air contamination measurements, dust filter systems, decontamination, and reclamation of some products and storage of decaying materials beyond a danger time are discussed. A short history of the waste disposal unit which was set up to evaluate hazards, to study the factors that influence the extent and significance of the hazards, and to aid in the development of effective and economical measures for prevention and control of hazards is given; the study program is described in more detail comprising three main branches: survey studies consisting of field sampling and evaluation; process studies consisting of laboratory and pilot plant studies on wastes; corollary studies consisting of the improvement of instrumentation and laboratory techniques as well as cooperating efforts with geological, meteorological, and ecological study programs.

30. "Some Medical Aspects of Atomic Warfare" Lumbie, A. *J. Roy. Army Med. Corps* 94; May 1950; p. 246-58

Mechanical, thermal, and radiation injuries caused by an atomic bomb explosion are discussed. After exposure to acute total body irradiation, lymphocytes, erythroblasts, germinal epithelium of the testis, myeloblasts, the epithelium lining the base of the gastrointestinal crypts, the germinal cells of the ovary, the basal layer of the skin, and the connective tissue are likely to be injured; bone, liver, pancreas, kidney, nerve, brain, and muscle are less susceptible to the ionizing effects. The acute and moderate radiation syndromes are described in detail, and the histological appearance of the different organs and cells are outlined. The collection and treatment of the atomic casualties, decontamination, hygiene, and other closely related topics are discussed in their relation to the atomic bomb. 54 references.

31. "Lessons from Operation Crossroads" Erickson, C. A. *Chicago Med. School Quart.* 11; April 1950; p. 91-5

A description is presented of the effects of the air and underwater explosions of the atomic bomb at Bikini. The tests showed the Navy, according to the author, that: ships at anchor and ships in tactical formation must be widely spaced; and design changes on ships should be effected to reduce damage above water, especially to the superstructure, and to provide greater protection to the personnel; the adequacy of theoretical safety measures was investigated. Under a separate heading the phenomena accompanying an atomic blast are described. Typical effects upon a city are outlined, including the zones of damage and the effects to personnel within the respective zones; blast, burn, and primary radiation effects are included, and the danger of radioactive cloud emission is also considered.

32. "Medical Aspects of the Atomic Bomb" McConnel, J. R. Ordnance; March-April 1950; p. 905-10

Atomic casualties, which are produced as a result of blast, heat, and ionizing radiation, are discussed. The relative value of these agents determined by a scale of biological significance will vary primarily with the type of detonation, namely, in the air, on or near the ground, and under water. With an air detonation, the ranges of the blast and thermal effects are distributed over the greatest possible area. In the ground detonation the ranges of blast, heat, and ionizing radiation are less than the air-detonation values. The heat and initial ionizing radiation produced as a result of an underwater detonation are largely contained within the surrounding water. It is stated that the danger from radiation has been highly overrated.

33. " 'A' Bomb Burns" Clarkson, Patrick Guy's Hosp. Gaz. 64; March 11, 1950 p. 80-84

The first part of a discussion on atomic-bomb burns is presented, in which the physics of nuclear fissions, the pattern of disaster (types of effects), and acute diffuse ionizing radiation illness are described in separate sections. In the nuclear-fission section the atom and nucleus, ionization and the roentgen unit of dosage, types of ionizing radiation (α, β, neutron particle, and radiation), and nuclear fission and fusion are briefly discussed, and the chain of events occurring when an atomic bomb explodes is outlined. In the disaster section the main patterns of above-ground explosions, surface explosions, and underwater explosions are presented, and the main properties of radiation, thermal, and blast effects are included. In the acute ionizing radiation section it is mentioned that doses of 400 to 600 r of whole-body radiation are usually 50% fatal, while those exceeding 600 r are usually totally fatal; the main phenomena (hemorragic symptoms) appear after a variable latent period and are followed by bacterial invasion. Some late effects are leukemia, bone sarcoma, and, possibly, mutations. Possible types of therapy are discussed and consist in prophylaxis by preliminary bleeding, administration of phenylhydrazine and desoxycorticosterone, and increasing resistance by preliminary x-rays.

34. "Atomic Warfare and Animals" Wilkins, J. H. Bio-Chem. Rev. 21; March 1950; p. 3-5

The four main effects of an atomic bomb explosion---flash, blast, fission products, and radiations---are discussed in this general article on atomic radiation. Symptoms of radiation sickness in dogs are outlined, and such methods of treatment as warmth, intravenous injections of plasma and/or saline, demulcents, sulfa drugs, penicillin, protamine, toluidine blue, and rutin are described. Methods to be used following the explosion, including decontamination procedures, are presented.

35. "Destructive Aspects of Atomic Explosion" DeCoursey, Elbert;
<u>S. Dakota J. Med. Pharm.</u> 3; March 1950 (See also NSA 1-241) p. 71-3

A general discussion is presented on the symptoms and pathology of ionizing radiations, such as those seen after the atomic explosions at Nagasaki and Hiroshima. The severity of the radiation effects varied inversely as the distance from the radiation source. Leukopenia, nausea, vomiting, diarrhea, fever, hemorrhages, thrombocytopenia, and other symptoms are classified as to time of appearance and relation to the severity of the patient's condition. The ionizing radiation affected mainly the lymphoid and hematopoietic tissues, skin, genital organs, and gastrointestinal tract, as seen in about 200 autopsies in Japan. Even as few as 3 days after irradiation there was atrophy of the lymphoid elements in the lymph nodes, spleen, and gastrointestinal tract. In the bone marrow of dying victims there was an absence of the hematopoietic cells except for foci of young erythroid elements, but at the end of the first week some evidence of regeneration was present. Baldness was the surest sign of ionization, occurring in the fourth or fifth week; the testes showed prominent changes, having almost all their sex cells destroyed; the ovaries showed minimal changes. Spectacular hemorrhages appeared in the kidneys and intestines, and those of the pharynx and intestine often resulted in death. In conclusion, the author notes that the effects on tissue of α and β particles, γ rays, x-rays, and fast or slow neutrons are similar qualitatively.

36. "Diseases of the Hands and Nails" Curtis, Arthur C., and Lewis W. Kirkman
<u>Oral Surg. Oral Med. Oral Pathol</u> 3; March 1950; p. 289-355

This article discusses in detail and under separate headings the symptoms and treatment of a variety of diseases of the hands and nails (virus, pyogenic bacteria, fungus, moniliasis, tinea, blastomycosis, sporotrichosis, syphilis, scabies, tuberculosis, psoriasis, tularemia, carcinoma, eczematoid eruptions, allergy and occupational dermatoses, and also special diseases of the nails). Among the conditions discussed is radiodermatitis. The authors point out that the only significant difference between the skin reaction following exposure to x-rays and that following radium is a superficial ulceration of the epidermis frequently seen with the latter, and due to the emitted alpha and beta particle (filtered radium applications not exhibiting this phenomenon.) The manifestations of the chronic and acute forms of radiodermatitis are outlined; treatment is surgical if the burns are severe and adequate drainage, proper immobilization, and skin grafting at an early date are considered to be very important.

37. "Radiobiological Additivity of Various Ionizing Radiations" Zirkle, Raymond E.
<u>Am. J. Roentgenol. Radium Therapy</u> 63; February 1950; p. 170-175

A discussion is presented on the problem of additivity of various types of ionizing radiations. A summary is included which outlines the degree of additivity found in various experiments by the author and others through combinations of α, β, γ, fast-neutron and x-rays on the mouse, bean roots, Drosophila eggs, Drosphila pupea and the human skin. It is concluded from the analysis of these studies that incomplete additivity of two types of radiation indicates some difference in the mechanism of action of the radiations.

(37. cont.)
complete additivity indicates that the mechanisms of action of the radiations [illegible] in their most essential feature, the promotion of the same [illegible] (one of a succession of unknown relevant events leading to the production of the known biological effect), but are not necessarily alike otherwise. It is concluded that it is probably wise to assume that additivity of fast neutrons and γ rays is the complete type.

38. "The Clinical Pathologist in an Atomic Age" Warren, Shields; Am. J. Clin. Path. 20; January 1950; p. 1-2

A general discussion is presented on the role of the clinical pathologist in an atomic era. The available methods for the estimation of the degree of radiation injury done to the human body are briefly mentioned, and the need for an accurate, simple, and quick means of estimation is stressed; with threshold doses of radiation, individual variations in the response to ionizing radiation may be extraordinarily wide and creates decreasing uniform accuracy. From the standpoint of internal radiation, the most satisfactory method of determination of the degree of radiation received is to determine the amount of radioactive material present in the body or its excretions. The author concludes that since atomic energy is increasingly important to present-day life, there is an increasing responsibility on the part of doctors to learn about this new force, to give thought to its use in peaceful channels and to be prepared, in case it should be used against us, to protect and aid the community.

39. "Radiobiological Research" Jacklitsch, J. J., Jr.; Mech. Eng. 72, 17-8 January 1950

This article reports the study of the long-term effects of atomic bomb radiation at Bikini. Radioactivity is declining but still is detectable throughout the coral reef that circles the lagoon. External radiation is not dangerous except, perhaps at the bottom of the lagoon some 200 ft. under the surface. Though radioactive material probably exists to be ultimately dangerous to rats, crabs, and fish if they take the substance into their bodies, or to men if they were to eat for some time the fish from the lagoon or the coconuts from the island's palm trees.

40. "Radioactive Effects of Atomic Explosions" Gazzaniga, G. E. Scienza e lavoro 5 (in Italian) 1950; p. 16-19

A short note on mechanical, thermal, and radioactive effects of atomic bomb explosions.

41. "Atomic Defense---A Constructive Approach" Wolfe, Richard D. Military Engr. 41; Nov.-Dec., 1949; p. 417-20

The effects of the explosion of an atomic bomb are discussed and means of minimizing or reducing the effects are considered. The blasting and contamination effects produced by such an explosion are treated and the research now underway on the defensive aspect of nuclear energy warfare is outlined briefly.

42. "Mechanical and Thermal Injury from the Atomic Bomb" Pearse, Herman E., and J. Thomas Payne New Engl. J. Med. 241 (see also NSA 3-1320) Oct. 27, 1949; p. 647-53

A description is given of the incidence and varieties of traumatic and thermal injury from the atomic bomb and the results of the clinical production of flash burns. The components of the atomic bomb flash were: a temperature of over 4,000°C; transmission largely by radiation; a spectrum high in ultraviolet, infrared and in visible light and brilliancy; and, a duration of less than a second. Shadow burning, the production of keloids, contracture and ulceration are described and correlated with the distance from the radiation source, the degree of protection afforded by clothing and other shelter, and the incidence of radiation sickness and traumatic injuries. The flash produced by magnesium was used to produce a flash burn similar in characteristics to the atomic radiation burns; extremely high intensity of radiation, short duration (0.1 sec) and other criteria were satisfied. It was noted that clinically there was an abrupt and diagrammatic demarcation between the burned and normal skin; the normal, basophilic cells changed on a straight line into acidophilic, burned cells. In the dermis the demarcation was at the burn border in the crypts and hair follicles. The method of healing of this type of burn was unusual; the burn consisted of a coagulative, fixed type of necrosis in the epidermis and dermis, with eschar formation and subsequent sequestration, rather than the organization seen in the noncoagulative, necrotic tissue of the moderate temperature burn. With a flash burn of moderate severity the epithelium grew out from normal borders and hair follicles and the healing was rapid; with widespread radiation injury and destruction of the epithelium in the crypts and hair follicles, delayed repair due to the lack of epithilial islands occurred. Prevention of infection and adequate shelter and diet are suggested as methods of treating these burns. 11 references.

43. "Radiodermatitis and Necrosis" Cronin, Thomas D., and Raymond O. Brauer Surgery 26; October 1949; p. 665-72

A description is presented concerning the pathology and treatment of radiation necrosis and dermatitis. The pathology in chronic radiodermatitis consists of hypertrophy of the epithelium and atrophy of the corium, with the loss of the sebaceous glands, hair follicles and sweat glands; there is a marked obliterative endarteritis affecting all vessels and seriously reducing the blood supply to the area. Pain is the outstanding feature of all deep burns, and usually does not appear until a late stage. Therapy usually consists of the removal of the diseased area by electrodessication and coagulation, by excision, or by amputation. Occasionally palliative treatment is deemed advisable and consists of the application of moist dressings of saline or boric solutions, soothing ointments or fresh leaves of the Aloe vera plant; the palliative therapy is particularly indicated for the symptomatic relief of early or mild radio-dermatitis, in cases of acute ulceration, and where surgery is refused. The various techniques of skin grafting to replace the damaged areas are briefly outlined, and it is noted that a pedicle graft carrying its own blood supply must be used in all cases where the radiation damage extends to the deeper areas and structures. 12 references.

UNCLASSIFIED

44. "Beta Ray Burns of Human Skin" Knowlton, Norman P. Jr., Edgar Leifer, John R. Hogness, Louis H. Hempelmann, Loren F. Blaney, Dan C. Gill, William R. Oakes, and Charles L. Shafer; J. Am. Med. Assoc. 141 Sept. 24, 1949; p. 239-40

Four cases of β-ray burns of the hands are reported, and the methods of treatment are presented. Estimates indicate that the men received 5,000-10,000 rep (roentgen equivalent physical) to the outer surface of the skin. The β-ray dosages were approximately 500-1,000 rep at 3 mm below the surface and 30-100 rep at a depth of 6 mm. Since there was little evidence that whole body irradiation exceeded 15 r of γ rays in any case, it is assumed that the whole body exposure had little effect on the radiation effects on the hands. The clinical response to the irradiation consisted of four phases: a tingling and itching at the time of exposure, followed closely by a slight erythema and edema, lasting two to three days; a latent, asymptomatic period of three to five days; a secondary erythema, soon followed by vesicle and bulla formation, the vesicles drying and desquamating within three weeks, leaving a new layer of epithelium; and, a chronic phase characterized by atrophic epithelium and loss of secondary epidermal structure. The only significant hematologic findings were a neutrophilia, an increased sedimentation rate, and increase in the number of refarctive granules in the cytoplasm and a low grade of reticulocytosis. The treatment was local and consisted of routine burn therapy with accessory chilling, surgical debridement and skin grafting. Rutin, a high protein diet, multiple vitamins and parenteral penicillin were also given. The results are incomplete at this time.

45. "The Problem of Plantar Radiodermatitis" Montgomery, A. H., R. H. Montgomery, and D. C. Montgomery N. Y. State J. Med. 49; July 15, 1949; p. 1664-7

The problem of plantar radio-dermatitis and its treatment is presented. The treatment may either be surgical or conservative with a view toward healing the area and preventing ulcer formations by means of soothing or stimulating remedies. Reconstructive surgery is advised for all cases with ulceration in an area of 0.4 cm or more.

46. "How Much Radioactive Substance is a Man Permitted to Take without Harmful Results?" Rave, Walter. Naturw. Rundschau 2 (in German) July 1949; p. 326-8

This article discusses the general problems connected with contamination by radioactive elements; the half-lives and destructive powers of several radioactive isotopes such as Sr^{89}, Sr^{90}, I^{131}, Te^{127}, and Y^{90} are listed along with the specific areas in which they concentrate upon introduction into the body. The need for care in avoiding contamination by these substances is stressed; it is pointed out that once contamination occurs there is little that can be done to influence or ameliorate the destructive course of the radiations released upon the body.

UNCLASSIFIED

47. "Preliminary Observations on the Biological Effects of Radiation on the Life Cycle of Trichinella Spiralis" Alicata, Joseph E., and George W. Burr. Science 109; June 10, 1949; p. 595-6

Six experiments to determine the effects of different periods of irradiation of the encysted trichinae larvae in meat are described. The method used in these experiments consisted in preparing small cellophane wrappings each enclosing about 1 g of trichinous rat meat and placing the packets between two tubes containing radioactive cobalt in a refrigerator at 4°C so as to deliver 2000 r to the meat over each 24 hr. period. The rays emitted were largely γ-rays. After the meat was irradiated for a period of time, the contents of each of two wrappings was fed to two white rats. One of the animals was then killed and autopsied at 5 days and the other at 30 days after infection. The irradiation produced no lethal effect on the larvae and no change in their power to mature, but did produce an increased and variable effect on the reproductive cells of the adult female worms, and in the form of the body wall of the parasite. Irradiations for 4 days produced sterility in 12-36% of the female worms; for 5 days, sterility in 45-100%; and for 6 days, sterility in 50-100% of the female parasites. These results show that γ-radiation at the dose, intensity, and temperature applied is not lethal to trichinae larvae encysted in meat, but under proper dosage renders the female worms sterile and unable to complete their life cycle. Further experiments are in progress.

48. "The Clinical Syndrome of Irradiations by the Atomic Explosion" Genaud, P. E. Presse. Med. 57 (in French) May 21, 1949; p. 443-4

A summary of the pathological effects of an atomic explosion on such organs of the body as the digestive tract, the blood-forming organs, the epidermis, and the sexual glands of the human male and female is presented. The clinical characteristics of acute, subacute, and hyperacute radiations are included, and the immediate and remote results are outlined. Further investigations are being carried out on plants, humans, and the Drosophila, but it is observed that no precise statement can be made concerning the permanent effects of such radiations.

49. "Anti-histamine ointments for skin protection in Radiation Therapy" Mains, M. P. Radiology 52; April 1949; p. 579-581

Some anti-histamine ointments, beneficial in combating radio-dermatitis caused by the release of histamine and histamine-like substances during tissue damage, are discussed. The author advocates the use of Aquaphor as a base for both Benadryl and Pyribenzamine in 5% strength. Using 200 kv at 50 cm target distance with 0.5 mm Cu and 1.0 mm Al filters, 1,000 r in air formerly produced marked skin reactions. Doses as high as 2,400 r in air produce less reaction when the anti-histamine ointments are applied to the treated skin. Examples are given of the beneficial and protective effects of oral and local anti-histamines in specific cases treated by the author.

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50. "On the 'Atomic Disease'" Levent, R. Gaz. Hopitaux 122 (in French) Mar. 5, 1949; p. 114-5

This is a general survey of data so far acquired on the pathological effects of atomic bomb explosions. The sources used are: Negre and Bolot, Presse Med. (1943), Jan. 15 and 29; Lacassagne (paper read at Academie Nationale de Medecine on Feb. 17, 1948); and Cronkite and Chapman, Military Surgeon (1949) Jan. A distinction is made between effects of explosions in air, in water, and under soil. Another is based upon the distance from the explosion center. A classification is attempted of various patho-anatomical and clinical pictures of the diseases, mostly fatal, caused by intense irradiation. The preliminary character of our present knowledge in this field, and the complete ignorance of protective and curative measures are emphasized.

51. "The Use of Radioactive Isotopes in Clinical Medicine" Bowers, John Z. Delaware State Med. J., V. 21; (1949) February; p. 25-27

The results of exposure to an atomic bomb explosion and the therapeutic effects of radioactive isotopes are briefly described. Two and one-half pages of discussion follow.

52. "The Medical Aspects of the Atomic Bomb" Looney, W. B. Virginia Med. Monthly V. 76 (1949) February; p. 73-75

This review is based on the material in the course on Medical Aspects of Radioactivity given by the Medical Department, U. S. Navy, and the American College of Physicians at the Naval Medical Research Center, Bethesda, Md., from February 16, 1948.

53. "Radiological and Salinity Relationships in the Water at Bikini Atoll" Ford, William L. Trans. Amer. Geophysical Union V. 30 (1949) February p. 46-53

The circulation in Bikini Lagoon during the post-Baker Day period is deduced from the distribution of salinity and radioactivity. The use of the distribution of radioactivity as a method of determining the circulation is compared with other methods. The presence of radioactivity in the waters of the lagoon as a result of the explosion presented a unique opportunity to obtain a partial evaluation of the radioactive tracer technique in problems of hydrography. Figures showing a circulation scheme and the distribution of salinity and radioactivity are presented for the third, fourth, and fifth day after the underwater explosion. The circulation at this time was found to be abnormal due mainly to the unusual weather conditions. It has therefore been discussed with particular reference to the areas of concentration of the radioactive material in view of the possible bearing on studies of the effect of radiological contamination on marine flora and fauna at Bikini. The use of radioactivity in tracing water motions at Bikini gave results which were in general agreement with those obtained by other methods.

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54. "Atomic Energy in Medicine" Bowers, John Z. Diplomate v. 21 (1949) February; p. 39-42

The activities of the Division of Biology and Medicine of the Atomic Energy Commission are presented briefly along with a more detailed account of the effects on human beings of an atomic explosion.

55. "Histological and Histochemical Study of the Skin of the Guinea Pig Treated with X-rays" Frederic, J. Arch. Biol. (Liege) 60 (in French) 1949 p. 79-101

A study was made of morphological changes produced by X-rays in the epidermis, and, in particular, in the histological elements containing substances with -SH groups (sulfhydrils). The skin of the paws of 32 guinea pigs was irradiated with 5000, 2000, and 1500 r. The histological and histochemical evolution is shown on 9 microphotographs.

56. "The Active Ion Transport through the Isolated Frog Skin in the Light of Tracer Studies" Ussing, Hans H. Acta. Physio. Scand. V. 17 (1949) p. 1-36

Experiments using radiosodium to determine the amount of flow of sodium and chloride ions in both directions through an isolated frog skin, as a function of a number of factors, were made. The technique used was described. The factors determining the flow were the outside salt concentration and outside and inside pH, under normal conditions. The theoretical basis for the use of tracers to determine the active transport of an ion species through a membrane was considered. The results showed that influx of Na^+ ions was much greater than the outflux, and depended on the pH of the inside solution. The Cl^- influx was less variable, but acted similarly to the Na^+ ions. 27 references; 10 tables; 11 figures.

57. "Experimental Study of the Air Ionization Produced by a Certain Radioactivity of the Soil; its Effect on Human Health" Cody, P. Bull. Soc. Sci. Bretagne 23 (in French) (1949) p. 69-76

With the aid of ionization chamber or a photographic plate, placed in the neighborhood of the soil, radiations can be detected that are localized in certain spots of the soil surface (0.5 to 2 m in diameter) and show diurnal and seasonal variations. They are probably particles emitted as a result of radioactive processes in the soil. Various physiological and pathological effects due to the "telluric radiation" are mentioned. No critically conceived and methodically made observations are presented.

58. "Trauma resulting from Atomic Explosions" Parsons, R. P. Amer. J. Surgery V. 76 (1948) Nov.; p. 559-562

For the purpose of generalization, the point of explosion of an atomic bomb may be considered as surrounded by three half-mile wide zones of decreasing injury to men. In the small center circle there will be practically no survivors. They will have perished from direct blast, burns, and radiation. In the next zone there will be many fewer blast injuries, numerous but mostly non-fatal blast burns, and thousands of deaths from radiation as well as thousands of non-fatal radiation victims. In the outer ring (one mile to a mile and one-half) the injuries will be limited mostly to non-fatal flash burns. The nature of the radiation injuries is briefly reviewed.

59. "Nature of Trauma in Atomic Warfare" Brues, Austin M. Amer. J. Surgery V. 76 (1948) Nov. p. 563-565

This is a rather general review of events and injuries suffered at Hiroshima and Nagasaki after the atomic bomb attacks.

60. "Pointers on Atomic Medicine" Hospital Topics and Buyer 26 No. 11, 32 and 34

This short, non-technical resume of the aftermath of an atomic bomb is divided into the following topics: radiant energy, large scale rescue work, public health officers, training doctors in treatment, what symptoms to expect, and effects on victims.

61. "Hydrogen Peroxide and the Indirect Effect of Ionizing Radiations" Alper, Tikvah. Nature V. 162; Oct. 16, 1948; p. 615-616

Experiments undertaken on bacteriophage S 13 in vitro apparently have shown that when the phage is in dilute solution the hydrogen peroxide formed by ionizing radiations will inactivate it. And in experiments on "indirect effect" of ionizing radiations on this phage the ratio of ionic yield for direct action only to ionic yield in dilute solution is of importance for gaining an insight into the "active radical" mechanism. 6 references.

62. "Clinical Reactions and Injuries in Supervoltage Therapy" Jones, Arthur Proc. Roy. Soc. Med. V. 41 (1948) October; p. 703-709

This brief account of the clinical effects of supervoltage radiation and of the injuries which have resulted during the treatment of malignant disease with the million-volt apparatus includes the following: (1) injuries to the skin and subcutaneous tissue, (2) injuries to connective tissue, (3) effects on respiratory tract, esophagus, bladder, bone, eye, and liver, and (4) occurrence of muscle fibrosis.

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63. "What the Fire Service Should Know about the Atomic Bomb" Fire Engineering V. 101 (1948) October; p. 674-6 and 715

The need for better fire and radiation protection against the atomic bomb is emphasized. The various effects of an atomic bomb explosion are also discussed in a general manner.

64, "The Effects of High Energy Radiations on Water and Aqueous Systems" Krenz, F. H. Can. J. Research V. 26B (1948) Sept. (See NRC-1801) p. 647-656

In order to obtain a better idea of the effect that irradiated water has when biological systems are exposed to high energy radiation, the properties of the water were investigated. Evidence was obtained for vibrationally excited "polymers" of water which result in long lived activity. It is concluded that the large "indirect effect" of the water on biological systems may well be due to the properties of the "polymers". A cross section of the dilatometer used in measuring the water expansion upon gamma radiation, expansion curves and curves of lag effect in water and some aqueous solutions are presented. 35 references.

65. "The Effects of X-Rays on the Mitotic Activity of Mouse Epidermis" Knowlton, Norman P., Jr., Louis H. Hempelmann, and Joseph G. Hoffman (AECD-1808) Science 107; June 11, 1948; p. 625

The mitotic index of the skin of the mouse has been studied as a means of measuring the biological effect of X-rays at doses of 35 and 325 r. As little as 35 r of 250 kv X-rays produce a drop in the mitotic index to zero within one to two hours after radiation. The number of mitoses returned to normal within a few hours after radiation. The time required for the number of mitoses to return to normal increases greatly with increased radiation dosage. It is believed that the time required for the mitotic index to return to normal will provide an excellent basis for rating the biological effectiveness of radiation of different types and different energies. With 325 r of X-rays the mitotic index required six days to return to normal and continued to increase to more than twice normal. This is believed to be an over compensation phenomena which may also be used as an index of radiation damage.

66. "Atomic-Bomb Radiation" Mechanical Engineering 70. June 1948; p. 546

The radiation effects produced by an atom bomb are considered. The known kinds of penetrating radiation which can be expected within the immediate area of a blast are: gamma radiation, neutron beams, beta rays and alpha rays. The types of burns, physical damage to persons and food and water are also considered.

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67. "Effects Resulting from Atomic Bomb Explosion" Price, F. L. J. Florida Med. Assoc. V. [illegible] (194[illegible]) May; p. [illegible]

The atomic bomb explosions in Hiroshima and Nagasaki created a blast wave that lasted almost a second in contrast to the few milliseconds of pressure resulting from an ordinary explosion. No estimate of the number of deaths or symptoms caused by blast pressure could be made, but the pressure developed on the ground under the explosion was not sufficient to kill more than those people who were very near the center of damage. In Hiroshima 60% and in Nagasaki 95% of immediated deaths were caused by burns, and 90% of the burns suffered by patients who reached first aid stations were second degree. The radiations which caused injuries were primarily those created within the first second after the explosion; and it is estimated that gamma rays and neutrons caused about 7% of the deaths. The irradiation effects of nausea and vomiting, fever, diarrhea, purpura, ulcerations of the mucous membrane, and leukopenia varied in intensity according to the severity of irradiation. Death followed within 10 days of severe injury, and mortality was 50% for those receiving moderate injury. There was almost complete disappearance of all cells of the myelopoietic and erythropoietic series. Men who had received enough radiation to produce symptoms did not have spermatozoa and most of the spermatogenic tissue was replaced by proliferating cells of Sertoli. The female reproductive system was affected to a much smaller extent. In Nagasaki the estimated radiation intensity at a distance of 1250 meters from the point of explosion was 473 r. It is believed that the mortality rate for all types of injuries could have been reduced if electrolite solutions, plasma, whole blood, and penicillin had been available.

68. "No Place to Hide" Bradly, David Boston, Little, Brown and Co. 1948; 182 p.

This is the log of a doctor who was assigned to duty with Operations Crossroads. He was one of the men of the Radiological Safety Section whose duty it was to stand guard with Geiger counters for invisible danger from radioactivity. The account covers the period May 29 - October 10, 1946. The main events recorded are Able Day and Baker Day on Bikini. The author believes that in the indiscriminate use of atomic energy for political coercion the survival of the human race is at stake. He believes also that there is no defense against atomic weapons, there are no satisfactory countermeasures and methods of decontamination, nor are there any satisfactory medical or sanitary safeguards for the people of atomized areas. The appendix is "a layman's guide to the dangers of radioactivity" and contains a section on the fundamentals of atomic physics.

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69. "Atomic Danger from the Radiation Point of View" [illegible], Lucien.
J. Radiol. Electrol. 29 (in French) 1948; p. [illegible]

General information is given on lethal and pathological effects of the atomic bomb, the main sources being American publications on Hiroshima, Nagasaki, and Bikini (no closer data on references are given). The effects are discussed under several headings. Detonation wave: no biological reactions are mentioned. Heat radiation: up to several hundred meters from the center of the explosion, all living beings, if not protected, are destroyed; the burning effects upon the skin are felt up to 3,500 meters. Visible and ultra-violet radiations: no precise facts are known. Neutrons and β-particles: the range of the neutrons is probably about 500 m; that of the β-particles about 10 m; however, owing to the high initial kinetic energy, the ranges may differ considerably from the values given. γ-radiation: to these are due the majority of casualties and of observed biological effects; the energy limit is probably 3-4 Mev; the rate of casualties resulting in death is 20%, at a distance 1,000-1,200 m from the explosion center the mortality is 50%; beyond 1,500 m death is rare. In the zone between 500 and 750 m, persons who were protected from the detonation wave and the heat, but had absorbed penetrating radiations, died within a week (bloody diarrhea, hematemesis; between 750 and 1,000 m, death occurred 3-5 weeks after the explosion (buccal ulcers, leucopenia, cutaneous hemorrhages, alterations of the bone medulla). Among non-mortal cases were temporary male sterility, miscarriages, loss of hair. The last of the explosion effects enumerated here is the remaining radioactivity due to scattered fission products and to induced radioactivity; this was found weak in Hiroshima, but rather dangerously high in New Mexico. The accumulated fission products from the uranium piles may be used as a powerful weapon of war, in the form of dust spread over the enemy's cities.

70. "The Atomic Bomb's Effects on Plants and Soils" Jornlin, Francis M.
Fertilizer Review 23, No. 4, 7-11, 14; No. 5, 7-9, 11-3 (1948)

The possible effects of radioactivity on plants and soils are discussed, together with an investigation of the claims of Mr. Takeo Furuno in Nagasaki that the crop yields after the atomic bombing were accelerated. A description is given of the heat, radiations, and blasts produced by the bombs at Hiroshima and Nagasaki, with respect to their immediate and residual influence on plants, seeds and soil at various distances from the centers of the blasts. Seeds and other organisms below the soil surface received little irradiation; many plant abnormalities were noted in new sproutings soon after the radiations. The soil at 3,930 ft. from the center of the blast showed little radioactivity two months after the bombing, and no activity one year after the bombing. The increased yields in Furuno's fields are believed to be due to large amounts of fertilizer, in the form of potash and $(NH_4)_2SO_4$, that he added to the soil. Carefully controlled research is now in progress to establish more definite facts concerning the biological effects of the bombing.

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71. "Preliminary Report on Japanese Specimens" Brues, A. M., and W. Kisieleski
AECD-2024-K August 1, 1947 (decl. 5-20-48) 2 p.

Specimens of various materials including soil, mica plates, and glass have been collected from the Hiroshima and Nagasaki bombed areas and from the Nishiyama reservoir area which had been mildly contaminated by fission products arising from the atomic bomb explosion. They have been tested for induced radioactivity. Soil specimens collected in the reservoir area sixteen months after the detonation of the atomic bomb still showed significant radioactivity.

72. "The Treatment with 2, 3-Dimercaptopropanol (BAL) of Acute Systemic Uranium Intoxication in Rats" Allen, Roberta P., and William F. Neuman. AECD-2204 (M-1980) May 26, 1947 (decl. 8-11-48) p. 18 (For publication in NNES)

Studies on 2, 3-dimercaptopropanol (British Anti-Lewsite; BAL) which have been carried out in the United States (Waters and Stock, Science 102, p. 601-606, 1945) and in England (Peters, Stocken, and Thompson, Nature 156, p. 616, 1945) have shown that this compound is a very effective antidote for several types of heavy metal poisoning. In each case the heavy metal in question is thought to exert its toxic effects by inhibiting essential -SH enzyme systems. The effectiveness of BAL is attributed to its ability to enter into successful competition for the metallic ion and thus insure excretion of the metal as a non-toxic metallo-organic complex.

Albino rats were systemically poisoned intraperitoneally with 5.0 mg per kg of $HgCl_2$ and successfully treated with Bal as late as 30 minutes after administration. BAL was assayed against the toxic effects of 3 uranium compounds, $UO_2(NO_3)_2 \cdot 6H_2O$, UO_2F_2, and UCl_4, parenterally administered to albino rats with negative results. The negative results were taken as confirmatory evidence for the view that uranium exerts its toxic effects primarily by some other means than a combination with -SH groups.

73. "The Effects of Atomic Bombs on Health and Medical Services in Hiroshima and Nagasaki" United States Strategic Bombing Survey. Mar. 1947; 91 p.

This report briefly outlines the immediate and remote measurable effects of the atomic bombs and the subsequent widespread fires on the health of the civilian population. The investigation includes the different phases of public health following the outline used in the over-all health survey of Japan. This report contains chapters which relate to medical and health facilities and services, nature of air raid casualties, sanitary facilities and services, food supply and nutrition, communicable diseases, and industrial health and hygiene. Included are photographs showing damage done to various medical facilities and injuries sustained by persons within the bombed areas.

UNCLASSIFIED

74. "Radio-Biological Research with Fast Neutrons" Catsch, A., and K. G. Zimmer, O. Peter. Z. Naturforsch V. 2 1-5 (in German) (1947) Jan. Feb.

Radiation effects of fast neutrons are characterized by damage to the leukocytes whereas the erythrocytes are to a large extent resistant to radiation damage. The effect of radiation on the blood forming organs damages cells in the process of dividing as well as immature cells. As a result of the damage to the blood forming organs, secondary changes in the blood appear long after the irradiation. The importance of these results in determining the tolerance dose lies in the fact that with neutrons changes in the blood picture are apparent even with very small doses. This is quite different from X-rays. Apparently too in the case of neutrons there is no correlation with radiation intensity nor is there a quick recovery as with X-rays. It is important therefore to study the effects of neutrons, especially the correlation between radiation intensity and damage. It is important too to study the effect on other organs in order to properly protect personnel engaged in nuclear research.

75. "Change in Cutaneous Sensitivity to X-rays during Experimental Hyperglucemia in Rabbits" Baclesse, F., and J. Loiseleur. Comptes Rendus Des Seances de la Societe de Biologie 141 (1947) p. 743-45

Intramuscular injection of a near-lethal dose of glucose 45 minutes previously to X-ray irradiation reduced the sensitivity of the skin to x-rays.

76. "The Effects of Atomic Bombs on Hiroshima and Nagasaki" U. S. Strategic Bombing Survey. June 30, 1946; 53 p.

This report gives a full account of what the atomic bombs did at Hiroshima and Nagasaki together with an explanation of how the bomb achieved these effects, the extent and natures of the damage, the casualties sustained, and the political repercussions from the two attacks. Photographs showing damage done in Hiroshima and Nagasaki are included. Appended are maps of the two cities which show the kinds of damage suffered in various areas.

77. "Local Skin Damage by Deuterons" Schubert, G., and W. Riezler. Naturwissenschaften 33. 1946; p. 285-86

Irradiation of the skin of guinea-pigs with deutrons from a distance of 16 cm from 4 to 90 seconds produces changes in the epithelium and stratum papillare up to a depth of 0.11 mm without any obvious local reaction. These changes are shown by increased staining properties and homogenisation of connective tissue. The various layers are difficult to recognize, although the nuclear structures are still intact. Four weeks later, the outer epithelium is completely regenerated, but there is atrophy of the affected area and the cellular connective tissue extends almost to the surface. The homogenisation of tissue is explained by the destruction of the protein molecules, resulting in local atrophy.

78. "What you should know about the Atomic Bomb (A message from the surgeon general)" Bliss, R. W. Army Medical Department, nd. 50 p.

This pamphlet contains the following series of articles based on lectures delivered during a course in atomic medicine sponsored by the Armed Forces Special Weapons Project: I. Introduction to nuclear physics; II. Biologic effects of nuclear radiation from an atomic explosion; III. Medical effects of atomic explosion; IV. Evaluation of the five atomic explosions; V. Fundamentals of radiation pathology; VI. Pathologic anatomy of radiation effects of atomic explosion; VII. Detection of overexposure to ionizing radiation; VIII. Public health aspects of atomic explosion; IX. Essentials of instrumentation; X. Protection against atomic bombs.

79. "Species of Aloe (other than Aloe vera) in the treatment of Roentgen Dermatitis" Loewenthal, L. J. A.

Two species of the Aloe plant, Aloe arborescens and Aloe mutabilis, are presented as having beneficial results in the treatment of roentgen dermatitis comparable to those of Aloe vera. Two cases of radiation dermatitis treatment are included. 10 ref.

80. "Radiological Defense, Vol. III." Armed Forces Special Weapons Project, Nd. 140 p.

This volume is a series of lectures dealing mainly with problems in handling radioactive materials, the biological effects of radiation, decontamination problems, therapy of radiation illness, and tracer techniques. (auth)

81. "The Radioactivity of the Atomic Bomb from the Medical Point of View" Nakaidzumi, Masanori. Tokyo Imperial University (NP-302) nd. 10 p.

The radiations which hit the human body were the following: neutrons and γ rays in the air (including the primary neutrons and γ rays from atomic bomb and γ rays produced by the reaction between neutrons and nitrogen nuclei in the air), the radioactivities of the tissues of the human body and the soil resulting from the bombardment of neutrons (β and γ rays), and the fission fragments which fell on the ground (β and γ rays), etc. These all acted together, and the significance of each is complicated. Moreover, the scattering of γ rays by the buildings differed very much according to the type of building and its location. So the total dose received by each person may have been different even when at the same distance from the explosion center or in the same building. The radiation intensity does not always decrease according to the inverse square law. Therefore, the factors affecting the total dose of radiation on the human body are very complicated and not easily calculated. In the estimation of total dose by clinical symptoms, epilation is a rather accurate indication. However, the effect of protection by shelter, etc., should be considered and its effect on the appearance of symptoms should be decided statistically. From the incidence of epilation the dose which was given to the human body can be estimated. Assuming the head epilation dose to have been

(31. Cont.)

1000 r within 2 km, where 90% of all patients with epilation were located, it is estimated that the dose directly beneath the explosion center was from 10,000 to 15,000 r. This also assumes explosion center to be 550 meters above the ground and the radiant rays to decay by the inverse square law. Protection from the radiant rays of the atomic bomb afforded by caves, concrete walls, and building structures is discussed.

32. "Clinic of the Atomic Bomb Radiation Sickness" Sassa, Kanshi. Tokyo Imperial University (nd) (AP-303) 30 p.

This is a summarized report on the clinical observations of radiation sickness caused by the atomic bomb explosions in Hiroshima and Nagasaki. Over 10,000 patients were examined. Mechanically caused or heat injuries such as wounds and burns are not included. The etiological factors considered are age, sex, distance from center of explosion, and shelter. General symptoms such as fever and fatigue are described. Observations on the digestive, respiratory, and sex organs, the nervous system, the oral cavity, eyes, skin, blood and urine of victims of radiation sickness are discussed.

33. "The Atomic Bombings of Hiroshima and Nagasaki" U. S. Army Manhattan Engineer District n.d. 45 p.

This report describes the effects of the atomic bombs which were dropped on the Japanese cities of Hiroshima and Nagasaki. It summarized information on damage to structures, injuries to personnel, and moral effect. An eyewitness account of the bombing of Hiroshima by Father J. A. Siemes is included. Maps of the two cities are appended.