This document consists of 16 pages.
No. 65 of 100 copies, Series A.

[redacted]

REPORT OF COMMITTEE

LIQUID PROCESS WASTE DISPOSAL AND RECLAMATION

J. J. Grebe	Dow Chemical Company
L. A. Matheson	Dow Chemical Company
M. M. Haring	Monsanto Chemical Company
F. C. Mead, Jr.	Monsanto Chemical Company
W. A. Rodger	Argonne National Laboratory
S. Lawroski, Chairman	Argonne National Laboratory

[redacted]

October 7, 1948

[redacted]

[redacted]

DISCLAIMER

DISCLAIMER

[redacted]

UNCLASSIFIED

WASTE DISPOSAL

Outside Distribution	Copy Number
Argonne National Laboratory	1-9
Atomic Energy Commission, Washington	10-11
Brookhaven National Laboratory	12-19
Bureau of Ships	20
Carbide & Carbon Chemicals Corporation (K-25 Plant)	21-22
General Electric Company, Richland	23-29
Hanford Operations Office	30
Kellex Corporation	31-32
Knolls Atomic Power Laboratory	33-36
Los Alamos	37-42
Mound Laboratory	43-50
National Bureau of Standards	51-52
Naval Radiological Defense Laboratory	53-54
New York Operations Office	55
Oak Ridge National Laboratory	56-63
Patent Advisor, Washington	64
Technical Information Division, OROO	65-79
University of California, Radiation Laboratory	80-83
University of Rochester	84-85
Argonne National Laboratory, Inventory Unit	86-100

[redacted]

UNCLASSIFIED

[redacted]

REPORT OF COMMITTEE

LIQUID PROCESS WASTE RECLAMATION AND DISPOSAL

October 7, 1948

At the direction of the Division of Engineering, Atomic Energy Commission, a committee consisting of:

J. J. Grebe	Dow Chemical Company
L. A. Matheson	Dow Chemical Company
M. M. Haring	Monsanto Chemical Company
F. C. Mead, Jr.	Monsanto Chemical Company
S. Lawroski, Chairman	Argonne National Laboratory
W. A. Rodger, Alternate	Argonne National Laboratory

was set up to make a survey of liquid waste disposal and reclamation problems within the Atomic Energy Commission and to make recommendations for a program designed to improve present practices. The following members of the Engineering Division of the Atomic Energy Commission regularly met with the Committee:

J. H. Hayner
E. W. Hribar
H. Noble

I Statement of Problem.

A. The use and processing of radioactive materials produces solid, liquid, and gaseous wastes of extremely variable compositions.

B. These must be ultimately disposed of into air, water, or the earth at such levels of radioactivity and under such conditions that damage to living organisms can never occur.

C. Some contain large quantities of uranium which should be recovered. Others contain potentially valuable fission products.

D. Fluid wastes, in particular, contain large amounts of indifferent salts some of which may be recoverable economically.

II Assignment of Responsibility.

Since gaseous wastes and metal recovery have been assigned to others, this committee has limited its consideration to the remaining liquid problems although it must be recognized that both of these exceptions as well as laboratory operations will themselves produce liquid waste.

III Committee Meetings.

Meetings of the committee were held as follows:

30 June 1948	Argonne National Laboratory
12-13 July 1948	Knolls Atomic Power Laboratory
9-12 August 1948	Hanford Works
23-25 August 1948	Oak Ridge National Laboratory
30 Sept - 1 Oct 1948	Mound Laboratory

IV Survey Observations.

A. Argonne National Laboratory.

The meeting at Argonne was largely one of organization. The objectives of the committee were set forth by R. S. Warner, Director, and J. H. Hayner of the Engineering Division, USAEC, and plans for committee activities were made.

Most of the Argonne National Laboratory liquid wastes come from the Redox semi-works and run the whole gamut of those to be expected from eventual Redox operations although containing reduced amounts of activity. No attempt is made to process these wastes. They are routinely put into shielded containers and are shipped to Oak Ridge National Laboratory where they are put into the burial tanks used there. This procedure is highly unsatisfactory from the standpoints of cost, safety, and convenience and is regarded as a stop-gap measure only. Facilities for processing and storing wastes are planned for the new laboratory site in Du Page County, but the development of these facilities is just beginning.

B. Knolls Atomic Power Laboratory.

The Knolls problems are nearly all non-existent as yet. Plans are being made for handling wastes from the Knolls laboratories and semi-works in such a way that "no activity is discharged to nature" (Mohawk River.)

A concerted laboratory effort was found here. Experiments have been done on carrier precipitation, ion exchange, and evaporation as a means of reducing the volume of waste from laboratory and semi-plant sources. Although it is not necessarily believed to be the ultimate solution, evaporation has been chosen as the method which will require the least development. An evaporation waste plant has been designed and will be constructed in conjunction with the Separations Plant Research Unit (SPRU). Some of the more active wastes will be stored until experience is gained with the evaporation equipment, but the ultimate aim is to reduce the total active waste output to residual solids. The problems here seem to be under fairly satisfactory control.

C. Hanford Works.

The magnitude of Hanford's waste problems cannot be taken lightly. There are now 23 million gallons of assorted wastes being stored. This not only represents a hazard, but is extremely costly. It is calculated that storage and handling costs range from 23-34¢/gal. This now approximates $3,000,000 per year.

[redacted]

The wastes from the present $BiPO_4$ process are treated as follows:

1. Metal Waste from the extraction step, contains the uranium and most of the fission products. This type of waste represents almost half of the stored waste and contains a total of approximately 3 Kg of Pu and 50 million curies of activity. It is neutralized before storage with caustic soda and soda ash. There are two groups (Kellex and C&CCC) now working on the recovery of the uranium from these wastes.

2. First Decontamination Cycle Wastes. Each decontamination cycle produces two wastes, one strongly acid (about 10M HNO_3) solution of the by-product $BiPO_4$ precipitate in relatively small volume, and the other a large volume of 1M acid from product centrifugation. Both are neutralized with NaOH and sent to the same storage tanks. Also added to these tanks are the alkaline coating removal solutions. These wastes are considered too active tod discharge to ground through "cribs" and are being stored indefinitely.

3. Second Decontamination Cycle Wastes. These wastes are chemically similar to those from the first decontamination cycle. They contain sufficiently little activity that after storage for a year or more during which time settling out of active sludge and decay further reduce the level, the supernatant may be discarded to ground via "cribs" which are discussed in the next section.

[redacted]

[redacted]

4. <u>Crib Wastes.</u> All drainings, scrubbings, and wastes from the concentration processes along with the decantations from the second decontamination cycle wastes are discarded to the ground via cribs. Cribs are porous wooden structures buried some 20-30 feet. The liquid filters into the ground. It has been determined that both plutonium and fission products are adsorbed on the sand rather close to the cribs, plutonium the more so. Penetration of activity has not exceeded approximately 100 feet down and 300 feet laterally from any crib.

Tolerances on liquids to be sent to these cribs have been set by the Health Instrument Division. They are:

Pu	4 micrograms per liter
β	5 microcuries per liter
γ	50 microcuries per liter

There is considerable controversy as to whether or not this operation constitutes a hazard. Good arguments can be presented on both sides. It appears that the operation may be carried on without danger for some years, but it is a solution indigenous to Hanford.

The proposed Redox process (which it is expected will replace the $BiPO_4$ process) as presently conceived will produce about the same quantities of wastes as the present process. They are listed on the following page.

[redacted]

BiPO$_4$ Process			
Waste Designation	Gal/year	Activity	
		Pu microgram/liter	β * microcuries/liter
Metal Waste	2,150,000	100	100 - 200
First Cycle			
By Product Prec. Solution	200,000	1.8×10^3	10
Product Centrifugate	1,500,000	46	
Second Cycle			
By Product Prec. Solution	80,000	1.2×10^3	2×10^{-3}
Product Centrifugate	1,200,000	65	

* Only figures available are taken from supernatant of neutralized waste after standing.

Redox Process				
Waste Designation	Compositions (%)		Gal/year	γ c/gal
	HNO_3	$Al(NO_3)_3$		
IAW	3.4	23	550,000	66
2AW	2.3	38	200,000	0.1
IDW	4.4	23	540,000	0.1
3AW	2.3	38	230,000	8×10^{-4}
IFW	4.4	23	540,000	2×10^{-3}
Coating Wastes	--	--	200,000	--
Organic Recovery (Still Heels and Washes)			2,100,000	--
Total			7,000,000	

In addition, cooling water from the piles which normally contains predominantly short lived activities, is held up in retention basins to allow a decay period before discharge to the Columbia River. In the basins algae concentrate the activities which may present problems later. The flows involved approximate 50,000,000 gal/day/pile.

D. Oak Ridge National Laboratory.

Current wastes at Oak Ridge National Laboratory come from (1) the operation of the separations Pilot Plant where wastes similar to those of the Redox process are produced, (2) the production of various isotopes, (3) laboratory investigations, (4) the operation of the pile, (5) receipts from other Atomic Energy Commission sites.

Uranium bearing wastes are neutralized with NaOH and Na_2CO_3 and stored in burial tanks of 170,000 gallon capacity. A program was recently completed in which the metal was all precipitated with excess NaOH, allowed to settle and the supernatant decanted to the rest of the waste system. A two-fold volume reduction was realized.

All non-uranium active wastes are discharged to a retention basin via a series of 170,000 gallon buried settling tanks. The system is operated to discharge β activity into the Tennessee Valley water system at concentrations no greater than ~ 1 microcurie per liter as set by the Health Physics Department.

The Health Physics Department has conducted surveys of the White Oak Creek basin and finds activity slowly building up in the muds.

Considerable work has been done here also on scavenging, ion exchange, and evaporation which may be applicable to waste treatment. This is now being extended for direct application to the problem.

E. Mound Laboratory.

A flocculation and carrier-sand filter method has been developed and put through the pilot plant stage to handle the particular active waste produced there. A full scale plant is expected to be operating by October, 1948. This process will reduce the volume of the waste approximately one million fold and the discharge to the river will not exceed 1 count/ml/min.

V Over-all Impressions of the Status of the Problem.

A. Waste disposal problems are less attractive than fundamental research to the majority of research workers.

B. Where attempts have been made along these lines, the working group has often been subject to the necessities of production. As a consequence, the study has rarely been completed.

C. There is a possible temptation to a contractor to accomplish this work in a manner just necessary to meet the contractual obligations. Consequently, solutions of the problem are temporary, local in character, and potentially hazardous after a period of time.

D. No systematic study or general solution to the problem has appeared.

E. Until recently, waste disposal had only a relatively low priority at most of the sites.

F. Management has failed to recognize that the problem of waste disposal is comprehensive and involves the entire technology of pile operation.

VI <u>General Recommendations.</u>

As a matter of policy, fission products carried by liquid wastes should be concentrated and disposed of under controlled conditions in lieu of dilution and free disposal.

A. In view of the foregoing, it seems vital that the Atomic Energy Commission establish a long range work program for studies in liquid waste disposal. The scope of the program should include:

1. Fundamental research in the chemistry of waste disposal.
2. Developing methods through the pilot plant stage.
3. Assisting the various sites in setting up full-scale plants.
4. Separating and packaging radioisotopes and valuable reagents.

B. The program could be carried on by one or more new contractors or by certain present contractors with supplementary contracts. Consideration of all additional liquid waste disposal problems could be assigned to these contractors.

C. To expedite the foregoing programs, means should be established to interchange and disseminate information and reports throughout the project, so that all interested in this field have up-to-date data and thoughts as they are obtained. Conferences, or sections of an information meeting, could well be devoted to this problem.

D. A means be established to review periodically and coordinate the foregoing program. This should later be extended to include review of the adequacy of technology to be finally adopted.

E. Waste disposal should be given a good priority and allocation, since it is a limiting factor in the full development of the Atomic Energy Commission program.

F. Every consideration should be given to cooperative efforts between the Atomic Energy Commission, contractors, U. S. Public Health Service, geological, oceanographical, meteorological, and water supply agencies. These should be on a national and/or an area basis similar to that now being set up in Tennessee in connection with the Oak Ridge National Laboratory.

G. The Commission should encourage every site to critically examine their present practices with a view to reducing the volume of currently produced waste even if only by a few percent.

H. Future contracts should embody a requirement to handle the waste disposal problems involved in a satisfactory manner.

VII <u>General Considerations.</u>

A. Whatever method or methods are proposed should be general, i.e., dependent on the physical and chemical properties of the waste, and not on location, soil, population, etc.

B. Realistic and experimentally based tolerances must be established. However, the ideal to be sought is reduction of contamination to natural background levels.

C. Standard industrial equipment and practices should be adopted wherever possible. Standard techniques and equipment on waste disposal and water treatment, such as flocculators, filters, softeners, and demineralizers should be well investigated because of the availability and possible use in an emergency.

D. The volume to be handled may be very large, so rate of processing is vital. An unusually large design factor of safety should be used.

E. For immediate solution, old and tried methods are to be preferred to new techniques from which the "bugs" have not yet been removed.

F. The cost factor as well as good engineering practices should be carefully considered.

G. In no case may the "dirt be swept under the rug."

H. Extensive dilution in a process is permissible only if it yields highly decontaminated effluent not otherwise obtainable.

I. During research and design of processes, more consideration should be given to possible waste disposal difficulties, but recommendations for a change in an existing process should not be made unless it is vital to or would very greatly facilitate proper waste disposal.

J. There are a multitude of waste liquids, both in the present bismuth phosphate and Redox processes. Independent disposal methods for all of these seem unnecessary or perhaps impossible. It is thought that all these wastes can be broken down into not more than a few subdivisions, such as:

1. Hot wastes containing economically recoverable uranium or plutonium.
2. Essentially metal free hot wastes.
3. Low activity wastes.

K. As close contacts as reasonably possible should be maintained with at least one good industrial manufacturing firm in any field or type of equipment being used.

L. Consideration should be given to decontaminating and recycling chemicals, solvents, etc.

M. Consideration should be given to development of continuous monitoring equipment for waste solutions.

VIII Possible Methods of Approach.

The following methods are suggested for experimentation. A number of these methods are being pursued with varying degrees of emphasis at one or more of the sites visited by the Committee; however, experimentation has seldom progressed to the point where process feasibility was proved nor have any of the experiments been identified with a high priority directed toward a general solution of the problem. They are mentioned here as methods of sufficient promise to justify an accelerated effort. A successful process may necessarily involve a combination of these methods.

A. Evaporation. Although fairly well worked out for some problems, this method is worthy of a comprehensive engineering study. Volume reduction is certain for every type of liquid waste. However, its economics may possibly make it undesirable for a permanent method.

B. Carrier Precipitation. This has proved very successful in certain fields and should prove of general application for all elements that can be made to assume the colloidal condition or that are adsorbed by the carrier. This method will probably not be successful for univalent and some bivalent ions. Indicated carriers are, since they occur in the waste, Al, Fe, Cr, and Bi. Bismuth can be precipitated as $Bi(OH)_3$ or BiOCl. CrO_4^{--} can be reduced to Cr^{+++} with Fe^{++}, the Al^{+++}, Fe^{+++}, and Cr^{+++} can then be precipitated as the hydroxides. This method is worthy of a more extensive study covering concentration, pH, temperature variation, etc. Some mechanical method will have to separate the gel from the supernatant.

C. Sand Filtration. Probably useful in its own right due to mechanical action and/or adsorption. This should be tried on sand, both as is and acid treated. A very useful adjunct to carrier precipitation.

D. Ion-Exchangers -- Natural Clays and Synthetic Resins. This is probably most useful for dilute solutions of low salt content and not too extreme activity. This will probably work best on high valence ions and has the advantage that the exhausted resin can be burned to further reduce the volume. A recovery system would be needed to collect any volatile radioactive compounds. This method will probably complement carrier precipitation and be useful in the separation of the radioisotopes. Both Hanford and Oak Ridge have had exceptional results on the selective adsorption of the soils in their areas.

E. Electrodialysis. Separation of high valence metallic gels and radioisotopes may be effected by this method. It is certainly worthy of study.

F. Metallic Displacement or Scrubbing. Depending on the position in the EMF series, highly electronegative elements, i.e., Mg, Zn can be used to throw out certain radioisotopes. This is a direct method which can effect volume reduction and the separation of chemicals and also is a useful complement to carrier precipitation. Both rough and refined studies are strongly indicated. Displacement can be assisted by electrolysis.

G. Differential Volatility. If the halides of the various indifferent and radioactive elements have sufficiently different vapor pressures, fractional distillation or sublimation should be feasible. Confinement of radioactive gases and dry materials is difficult. Nevertheless, it is believed the method has some promise and should be studied.

H. Electrolytic Separation. This will probably be best for the separation of isotopes and will entail considerable fundamental study. This does not seem to be a top priority method.

I. Solvent Extraction. This is worthy of study in conjunction with the separation of isotopes, but is probably of lesser value because it will merely add more liquid to an already bad situation.

J. Biological Processes. Investigation should be made into the use of various organisms such as zooglea for concentrating activity. Work of this nature has been started at Los Alamos.

IX Specific Recommendations for Immediate Work.

The order of priority of work to be started immediately is as follows:

A. The first and immediate problem to be solved is the removal of activity from the crib-type wastes. This should be accomplished by some method which requires a minimum of research work since speed is essential in the solution of this problem.

B. Hot wastes, such as the first and second cycle decontamination wastes ($BiPO_4$) are the next wastes that should be attacked. Since these latter wastes are obtained from the present separation process, they are currently of prime importance insofar as volume reduction of wastes is concerned. These again, as A, demand a high priority on our list.

C. Redox Wastes. Work should be started on the treatment of these wastes at once, so that start up of the production and waste disposal plants may be coincident.

D. The Committee feels obliged to suggest that a future research and development program should give due recognition to the wastes emanating from a waste metal recovery system and from uses of radioisotopes.

X Acknowledgment.

We wish to express our appreciation to the individuals of the installations visited, who met with the Committee for the purpose of considering the problem of liquid waste disposal. It is apparent that they are recognizing the technical problems and in many cases have made valuable progress in certain of the research phases. It is believed that the work so far accomplished will, to a large degree, prove to be a basis for the major portions of an expanded realistic program that should follow.