GENERAL ELECTRIC
COMPANY

RECEIVED

UNCLASSIFIED

AUG 26 1955

HW-38052

Page 1

300 AREA
CLASSIFIED FILES

C. 37
1

DO NOT CIRCULATE!
REFERENCE COPY ONLY.

CONTAMINATED EQUIPMENT RENOVATION SHOP

A PRELIMINARY STUDY

Prepared By

H. R. Hughes

August 25, 1955

Process Engineering Sub-Section
Design Section - Engineering Department
Hanford Atomic Products Operation
General Electric Company

This document has been read and approved by appropriate
members of the Design Section.

Head, & Services Design & Development Unit

Manager, Process Engineering Sub-Section

MASTER

DISTRIBUTION RESTRICTED TO U.S. GOVT

DISTRIBUTION

1. R. H. Beaton
2. R. S. Bell
3. C. R. Bergdahl
4. J. L. Boyd
5. H. A. Carlberg
6. G. K. Carpenter
7. A. B. Carson
8. W. J. DOWIS
9. J. B. Fecht
10. J. M. Fox, Jr.
11. O. H. Greager
12. A. B. Greninger
13. W. M. Harty
14. H. R. Hughes
15. E. M. Johnston
16. E. G. Jones
17. R. L. Junkins
18. J. E. Kaveckis
19. A. R. Keene
20. C. E. Kent
21. W. H. Koontz
22. W. K. MacCready
23. W. M. Mathis
24. J. S. McMahon
25. P. R. McMurray
26. H. M. Parker
27. O. H. Pilkey
28. E. L. Reed
29. M. F. Rice
30. R. B. Richards
31. C. A. Rohrmann
32. H. P. Shaw
33. O. V. Smiset
34. J. H. Warren
35. F. W. Woodfield
36. Extra Copy
37. 300 Files
38. Yellow Files

CONTAMINATED EQUIPMENT RENOVATION SHOP
A PRELIMINARY STUDY

PURPOSE AND SCOPE OF THIS STUDY

The intent of this study is to establish more completely the justifications for constructing a decontamination plant as outlined in Budget Item B 5720, "Contaminated Equipment Renovation Shop", FY 1957, Plant and Equipment Projects.

In particular, the economic incentives have been explored. The question or idea has been investigated of assigning a dollar value to engineering information which might be obtained from examining contaminated equipment which has failed from unknown causes. Heretofore it has not been possible to examine such equipment because suitable decontamination facilities have not been available. An effort has been made to uncover all possible uses for the proposed facility in order that the estimated capital and operating costs might be evaluated in terms of all the functions which the proposed plant might perform.

Information concerning the effectiveness of the decontamination procedures proposed for use in the new plant has been studied to determine if there is a sound basis for the projected design. Transportation of contaminated equipment is included in this phase of the study.

There is currently a great deal of interest in the use of ultrasonic methods and equipment for decontamination work here at HAPQ. For the purposes of this report the ultrasonic method is considered to be but one of several cleaning techniques which are available. The present limitations of the ultrasonic method have been investigated but no attempt is made here to assess its ultimate capability.

Operating records and other data supplied by plant engineering personnel in the Manufacturing Department form the basis for the financial analysis in this report. Their assistance in this respect is acknowledged.

CONCLUSIONS

Repairing contaminated process equipment is but one of a number of useful functions which this proposed plant could perform. Its value as an engineering and operating research unit may ultimately exceed that of its usefulness in repairing contaminated process equipment. In preparing a project justification this multiple purpose aspect of the proposed facility should be emphasized.

The Atomic Energy Commission in a report entitled "Major Activities in the Atomic Energy Programs", July - December 1954, page 36, cited the need for improvement in the method of performing decontamination work and stated that work in this field has great potential for reducing the construction and operating costs of radio-chemical separations plants. It is estimated that if this proposed plant is constructed at HAPO an annual saving in replacement equipment costs in the amount of \$500,000 can be realized.

While there is as great a need for improved methods of performing decontamination work at HAPO as elsewhere the important limiting factor is more a lack of facilities than a lack of "know-how".

It is probable that the presently budgeted funds in the amount of \$2,000,000 will not be sufficient to construct the kind of plant which will be required.

The project is sufficiently promising that the work should be carried further. It is recommended that design scoping proceed with the view to developing designs to the point where firm estimates of construction costs can be made.

DISCUSSION

1. Economics

It is a characteristic of new manufacturing plants that in the first few months of operation inherent faults in the design and fabrication of process equipment result in a number of equipment failures and modifications. HAPO experience supports this thesis. After an initial period of malfunctioning the failure or shutdown rate falls to a minimum for a considerable period before again rising because of normal wear and obsolescence.

The best available record of contaminated process equipment failures is the property disposal or burial records. From an examination of these records Table 1 has been prepared, showing an estimate of the salvage value of equipment which might have been saved if a properly equipped decontamination shop had been available during the period of record indicated.

While this estimate of one million dollars saving in replacement equipment costs is derived from factual data certain extenuating circumstances make it inadvisable to use this figure for amortization of the construction costs. The records from which the savings estimated here were deduced include the startup periods for Redox and TBP. In the case of the T Plant the record reflects an accelerated disposal of equipment items which had failed several years prior to the time at which they were buried. While the burial records may accurately reflect the items of equipment buried over a five year period much of the equipment actually failed over a 10

year period. This is particularly true of the T Plant.

Our estimate of annual savings must be related to an annual rate of equipment failure. The burial records do not accurately reflect the time at which failure occurs. There are a number of reasons why failed equipment may be held many months before being buried. Inasmuch as the period in which the equipment actually failed is approximately double that indicated for the older plants in Table 1, and this longer period covers both startup and long term operating experience, it is concluded that a sound figure to use for amortization of the investment would be one half that shown in Table 1 or \$500,000 annually. It is believed that this estimate of \$500,000 annual saving in replacement equipment costs can be reasonably defended.

The dollar value of an engineering examination of failed equipment could not be established with any real basis in fact. It is impossible to determine with exactness that future designs will duplicate existing installations or to what extent spare parts now on hand would be modified to prevent future failures of the same kind. Quite obviously the information obtained would be of value in designing new plants but the benefits obtained must be placed in the same category with those derived from applied research and engineering developments generally.

It is estimated that this plant would require a permanent full time operating crew of five people including the supervisor. It is apparent

that if the plant is established it will take over certain functions now performed by others and it will also eliminate some of the expense now incurred in burial operations. While there is no precedent it appears that with all overheads included operating costs would be of the order of \$100,000 annually. It also appears that this estimated operating cost will not bring about a net increase in the same amount in the total manufacturing costs because there should be offsetting reductions. The need is sensed but no satisfactory basis can be found as yet to establish a dollar value for the functions which this plant might perform in addition to that of its original purpose. These additional functions are discussed in the following section but for cost purposes they must be classed as intangible.

2. Additional Functions

One of the more interesting things brought out in this study is that there is an important, if not urgent need to improve the state of the art in decontamination work. It is a fair statement to say that at this time there is no generally accepted method for accomplishing this work. It appears that there is an equal if not better justification for this proposed plant as an engineering development works for applied research in decontamination work than there is for the originally conceived purpose. The proposed plant would have a unique advantage as an engineering development works in that a substantial part of its operating cost could be liquidated to manufacturing costs for the decontamination work performed.

There is a need for an expertly trained and properly equipped decontamination crew which can operate on a plantwide basis in the manner of a fire department to cope with emergency situations. At present when accidents occur a special crew is assembled to handle the problem and for a number of reasons this procedure is not satisfactory.

This facility could serve as a training school in decontamination work and become a prototype for industry generally. With the advent of atomic power plants (within limitations) this facility could provide one of the engineering services which will be required by offsite installations. Included in this category of installations will be atomic engines and mobile power plants. Vital parts or components of these power plants, in the event of their failure, might be salvaged through the medium of the services which this facility could perform. Of timely interest in this matter is the recently authorized study¹ of the General Dynamics Corporation, which will investigate decontamination services, waste disposal and related problems with the object of developing the commercial possibilities in this work.

3. Transportation

The question of the practicability of moving highly contaminated

¹ Electric Light and Power, May 1, 1955

vessels of large size and complex geometry has been considered at some length. It is concluded that immobilization and/or containment of radioactive particles can be accomplished at reasonable cost but that effective all around radiation shielding of the largest pieces of equipment while in transit is unrealistic.

The maximum amount of shielding which could conceivably be incorporated into a specially designed rail car would still require that some distance be maintained between the radiating object and the train crew². The protection provided thus becomes one of degree.

The method already devised of using spacer cars between a locomotive and a rail car loaded with contaminated equipment provides an acceptable, if not a completely satisfactory means for reducing the radiation intensity to a level such that the train crew's safety is assured. A shadow screen constructed of heavy aggregate and mounted on one end of the car carrying the contaminated equipment would greatly assist in reducing the "shine" in the direction of the train crew³. Such a screen would be effective with a nominal thickness of two feet.

Within the limits anticipated the number of spacer cars introduced into the train between the locomotive and the car carrying the hot object does not create a serious problem in operating the train⁴.

^{2, 3} R. L. Junkins

⁴ E. G. Jones

There is now being manufactured by the United States Rubber Company a type of large container which is used for shipping bulk materials. This container is made of wire reinforced rubberized fabric and the container is collapsable for convenient storage. With some changes in design it appears that this container could be adapted for use as a container for large vessels. With the aid of crane equipment a contaminated piece of apparatus could be placed inside of the container for shipment to a decontamination center. Radioactive particles would be effectively contained while the contaminated equipment is in transit. The container itself could be either decontaminated and stored for reuse or disposed of in a burial ground after it had served its purpose.

The problems associated with the movement of large vessels and other similarly sized equipment are present to a lesser degree in moving physically smaller items. In general, the smaller items can be moved at less cost.

From a consideration of transportation costs only, there is no significant advantage to be obtained from locating a central decontamination facility in the 200 Areas over that of locating it in, for example, the 100 Areas. In general, if a piece of contaminated equipment can be safely moved for any distance within the area under consideration, for a small incremental cost it can be moved the maximum distance that may be required. A major cost of transporting contaminated equipment lies in the preparatory work. The advantages of one site over that of another are found in the

other considerations affecting the site and are discussed under site selection.

The foregoing consideration of the transportation problem has been confined to the Hanford reservation. A precedent exists, however, for the transportation of radioactive items between HAPO and other installations. By using similar methods many items of contaminated equipment could be sent to HAPO for decontamination in the proposed plant.

4. Contamination Cleaning Methods

In the present state of the art the effectiveness of cleaning methods will vary from almost 100 percent "clean" to that of only a small reduction in the initial radiation level, much depending upon the nature or form of the contamination.

In general, it has been demonstrated that the degree of decontamination achieved is dependent upon the facilities available to do the work and the time applied. In most cases radiation can be reduced to tolerable levels.

There is no accepted preferred method for doing the work. Techniques now in general use and certain new methods which look promising are outlined below.

An important variation in method should be mentioned. In some cases the nature of the contamination is such that it cannot be removed. If proper lag storage facilities are made available, the contaminated object can be stored for a few months and decontamination accomplished through

natural radioactive decay. Vault storage facilities would thus permit an examination at some later date to determine the cause of failure when the circumstances in a particular case make such an examination desirable.

An approximate procedure for decontamination might consist of the following:

- a. Removal of installed equipment from process work.
- b. Immobilization of particulate matter by spraying or dipping the contaminated object with an air drying easily dissolved protective coating. Alternate methods might include paper wrapping, boxing, or placing in a cask or container of new design.
- c. Transportation to the decontamination plant. The method used here would depend upon the size and weight of the equipment and the intensity of the radiation emanating from the equipment. The railroad would undoubtedly be used for very large and very strongly radioactive equipment.
- d. Rough cleaning of gross contamination including the removal of any temporary coatings. The rough cleaning would be accomplished by hydrodynamic methods. In some instances the initial work may be done under water.
- e. Finish cleaning of spot or highly resistant residual particles. Here the more highly specialized techniques would be required. Such methods might include ultrasonic and/or electrolytic cleaning apparatus, and direct mechanical scraping or brushing.

The hydrodynamic procedures include the use of plain water, steam, mild solvents and commercial cleaning solutions, acid wipes and dipping in acids, and fluid abrasive solutions including sand blasting.

The hydrodynamic methods are quite effective for the initial removal of gross contamination. Particles which have become so firmly attached that for practical purposes they are an integral part of contaminated equipment are likely to be immune to this treatment.

The size of firmly attached particulate matter may be molecular in order. If so, a satisfactory cleaning procedure must be effective in the realm of molecular dimensions. In this area ultrasonic and electrolytic cleaning methods are effective throughout industry generally and these methods should be adaptable to decontamination work.

Electrolytic cleaning methods are well established in the electroplating and metal refining industries. The electrolytic action can be localized to some extent with the aid of portable electrodes. A gasketed cell containing the electrolytic solution and the cathode terminal might be attached to the side of a large vessel to accomplish the cleaning of a small area.

The possibilities in using ultrasonic equipment and methods for decontamination cleaning have been described in two reports listed below and will not be discussed in detail here. A major problem in the use of ultrasonic methods for general purpose cleaning is the limited area of coverage and the lack of experience with the method in decontamination work. For a

more comprehensive discussion of the ultrasonic application see these reports:

"Decontamination (Cleaning) by Use of Ultrasonics" by J. E. Kaveckis,
11-30-54

"Investigation of Ultrasonic Decontamination", HW-34811, 1-28-55
by R. F. Corlett and J. W. Kolb

Typical examples of ultrasonic cleaning equipment are shown in Fig. 3-A and 3-B. The ultrasonic method looks very promising and a development program should be initiated to prove its real capability. If a decontamination facility is ultimately constructed ultrasonic tools and equipment should be provided for cleaning small objects and for experimental work.

5. Description of the Plant

The following description of a decontamination plant capable of handling large vessels as well as small equipment is purely conceptual. An effort has been made to correlate the ideas developed in interviews with plant engineering personnel into two possible arrangements, shown in Fig. 1 and 2, of plants which would perform the desired functions. Fig. 1 shows a fully inclosed plant with minimum facilities⁵, and Fig. 2 shows a partially outdoor, more complete plant constructed after the manner of one of the newer test facilities at Arco.

The plants shown would include operating galleries, solvent mixing stations, remotely controlled 50 ton cranes, cleaning cells, hot shops, special tools and equipment. Waste cribs and waste storage tanks would

5 Suggested by G. K. Carpenter

be required or alternatively connection to existing cribs or tanks. The facilities for lag storage wherein valuable equipment might be held for several months until radioactivity dies down to safe levels and cleaning cells where equipment may be cleaned under water if necessary are shown in more detail in Fig. 2. All cells would be equipped with drop covers or power operated doors depending upon the frequency with which they might be opened or closed.

The loading and unloading area is designed for use by rail cars and trucks. This same space will also serve as a decontamination cleaning area for these vehicles.

No attempt has been made at this stage to develop detailed designs for the special tools and equipment which would be required for this facility. Some ingenuity will be required in the design work but it will be that of adaptation rather than of completely new ideas. The possible exception to this statement is in the design of ultrasonic equipment for cleaning large objects and surface areas.

The required design of the cleaning cells will of necessity include complete facilities for performing many operations under water. The similarity of this same arrangement to the facilities required for performing many types of experimental work on "hot" objects suggests that such experimental work be included among the useful functions which the decontamination plant might perform. As an example, the experimental work might include

mechanical dejacketing of prototype elements, radiography activities, preparation of sources for special services, food processing and other commercial radiation activities⁶.

The successful and expeditious accomplishment of decontamination work in the proposed facility will depend in a large measure upon the efficiency with which the work can be performed. All required equipment should be immediately available⁷. In order that work may proceed with a minimum of delay the facility must be provided with specially equipped rail cars, containers for all apparatus which might be moved to the cleaning plant and any special tools required for loading and unloading operations. Such advance preparations would be particularly effective when the plant is called upon to execute a rush program.

6. Site Selection

The proposed decontamination plant will require waste storage tank facilities for the high level wastes and cribs for low level liquids, the liquids being mostly water and dilute acids. Railroad and highway connections will be needed, electric power in minor amounts, sanitary water in small quantity and at times an appreciable amount of water for the cleaning operations. All of these facilities are most conveniently found in the

6 A. B. Carson

7 J. M. Fox, Jr.

200 Areas either 200-East or 200-West.

If the concept of the proposed plant as an engineering research and training unit in addition to a decontamination plant is accepted, it would be desirable to locate the site at some point along the perimeter fence of one of the 200 Areas where it could be made conveniently accessible to visitors and people having limited security clearances.

For the protection of personnel from radiation while contaminated equipment is being moved or handled out of doors consideration should be given to the advantages of a favorable terrain if such is available.

The form of the radioactive waste would be such that it could be easily pumped to cribs or storage tanks. Within the general area under consideration the site can be independent of considerations for gravity flow to a disposal area.

7. Alternate Facilities

There have been incorporated into the design of the Redox and Purex plants certain facilities for doing decontamination work. These facilities can handle small and medium size equipment. The decontamination cells are serviced by the same cranes which service the production areas. In the case of the Redox plant certain limitations have been placed upon the crane which preclude its use as a dependable means for servicing the decontamination shop⁸. If any appreciable amount of decontamination work were to be

8 Wilbur Koontz

performed in either the Redox or Purex plant the possibility exists that the crane time available would either inconvenience the decontamination work or interfere with production.

There are a number of other limitations which apply to the Redox and Purex decontamination shops. Generally the space allotment is not adequate for anything approaching the requirements for a central facility handling work on a plantwide basis. In order to move contaminated equipment in and out of either of these shops it would have to be moved through the respective process areas in each building. When the equipment to be decontaminated came from other areas, conflicts in the receiving docks and rail facilities could develop into additional interference with manufacturing operations.

The Purex and Redox shops were designed to provide a minor but essential service for and within the buildings of which they are a part. Except in a very limited sense their capabilities cannot be expanded to serve any greater program than that for which they were originally intended⁹.

Excluding the possibilities for converting an unused building to this purpose, all other decontamination facilities now in use on the plant are less suitable for the purpose and subject to more disadvantages than the Redox and Purex facilities.

Consideration has been given to remodeling an existing canyon building

such as the 221-B Building. Present plans for reactivating this building as a production facility would rule this out. There is some doubt that such a building could be remodeled at less cost than constructing a new building specifically for the purpose. More detailed designs must be developed before comparative estimates can be made.

Table 1

ESTIMATED SALVAGE VALUE OF PROCESS EQUIPMENT WHICH
HAS BEEN LOST FOR LACK OF DECONTAMINATION FACILITIES

200 East and 200 West Areas

<u>PLANT</u>	<u>TOTAL PERIOD OF RECORD</u>	<u>ANNUAL RATE</u>
T	18 months	\$ 225,000
REDOX	18 months	273,000
B	6 years	30,000
TBP	3 years	150,000
TOOLS	2 years	8,500
INSTRUMENTATION EQUIPMENT	2 years	<u>75,000</u>
SUMMATION, ANNUAL RATE		\$ 761,500

Arbitrary estimate for Purex plant:

Process equipment exclusive of instrument apparatus	150,000
Instrument apparatus	50,000
Total for Purex	200,000
Total for HAPO	\$ 961,500

It is anticipated that the contribution from the 300 and 100 Areas will be negligible.

FIG. 1

CONCEPTUAL PLAN
PROPOSED DECONTAMINATION PLANT

FIG. 3a

FIG. 3b

TYPICAL ULTRASONIC CLEANING UNITS

DATE

FILMED

5/19/94

END