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September 23, 1952

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REMOTE MECHANICAL OPERATING METHODS VS.
RUBBER GLOVE OPERATING METHODS FOR THE 234-5 PROCESS

The attached document has been reviewed by the former RDA-DC-9
Working Committee and by J. M. Smith of Radiological Sciences.

We believe that the information set forth is in general agreement
with all concerned and is ready for presentation to the RDS-13
Development Committee for review.

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REMOTE MECHANICAL OPERATING METHODS VS.
RUBBER GLOVE OPERATING METHODS FOR THE 234-5 PROCESS

September 23, 1952

Prepared by: W. P. Ingalls, Process Engineering Unit
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Engineering Department

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REMOTE MECHANICAL OPERATING METHODS VS.
RUBBER GLOVE OPERATING METHODS FOR THE 234-5 PROCESS

Introduction

The present RMA Line has now progressed through the run-in period and is engaged in actual production. Considerable new data and experiences are available for use in an evaluation of the basis used for design of the equipment in regard to contamination control and the safety of operating and maintenance personnel.

Research and development funds have been allocated to the improvement of the 234-5 process equipment. Thus it is desirable that an up-to-date basis be established for use as criteria for the design development of these improvements. A committee for RDS-13 (formerly RDA-DC-9), composed of W. P. Ingalls, J. B. Work and W. A. Brown, has discussed this problem with the operating, maintenance, technical, radiological sciences and design personnel who have had experience with the process line and has included herein a recommendation for the adoption of an approach as to whether remote control or hand operations shall be utilized in the design of new equipment. (See Appendix "A" for definitions and explanations.)

Conclusions

It is concluded that remote control operation of all plutonium purification and fabrication equipment is ultimately desirable. However, until reliable, tested, remote-control equipment is available, the remote control requirement may have to be compromised on some steps of the process to allow non-remote or rubber glove operation in order to obtain equipment with sufficient operating reliability.

Recommendations

It is recommended that in the selection of the type of operation to be applied to new or modified equipment for any process step, that remote control equipment be utilized wherever practicable. However, it is felt that only by reaching a compromise between the characteristics of the process step under consideration and the possibility of obtaining reliable equipment for the operation, can an installation be obtained that will prove to be both desirable and operable.

- As insurance against obtaining equipment that may be less reliable than desired, it is suggested that no binding commitments be made for the operation of a new installation until it has been proven out, either by operation of similar equipment in the past, or by testing of prototypes, and conversely, that if commitments for production operation of the equipment have been made, that the equipment selected be of a design that has already been proven out by actual production, even if the desired "remoteness" of operation has to be compromised.

Discussion

In 1948-1949, the RG Line was installed in order to meet the earliest practicable date for a plutonium fabrication facility at Hanford Works with the understanding that it did not meet all of the desires for personnel safety that could be obtained with a longer, more studied program. The RM Lines were fabricated on the basis of maximum operating personnel safety, and included remote control from behind a solid barrier for most operations. During start-up of the RMA Line, the equipment for several operating steps proved to be too unreliable for satisfactory operation, and manual operation from Zone 3 through rubber gloves has been substituted by the Manufacturing Department in order to accomplish production as required. In addition, the final shape machining process step has been adopted and is utilizing manual operation through rubber gloves.

It is obvious that no precise policy has been followed as to whether remote operation, or rubber-glove operation, shall be utilized.

In order to analyze the different possible methods of operating equipment it has been necessary to assign a definition to each method, and to list and define the principal characteristics of an installation that might effect the choice of the type of operation utilized. These are listed and explained in Appendix "A".

In a discussion of the various types of operation in regard to their suitability as analyzed for the characteristics listed in Appendix "A", it is necessary that the characteristics be integrated as to their importance for the specific operation being considered. For instance, the cost of equipment must always be one of the foremost items, but if a cheaper installation has no flexibility, it may become obsolete in a short time. Similarly, an expensive, flexible, installation may become intolerable because it is not a reliable operating mechanism.

Experience with production-line equipment has shown that after a suitable machine has been developed for "push-button" operation in a production line, the machine will usually pay for itself in reduced operating time, higher capacities, standardized product, and safety to personnel; however, the machine is usually developed in a series of small steps over a number of years as techniques and materials are improved. It is believed that the same progress should be made with the 234-5 Building process. The sudden jump from the elemental hand-operated RG Line, to the complexity of an entirely remote RMA Line is a tremendous step and although equipment has been installed that is capable of performing nearly all of the operations in a remote manner, the additional characteristics of reliability, flexibility and ease of maintenance are not entirely satisfactory in all cases, and require additional development.

In the meantime, it is felt that the equipment should be operated in one of the listed operating classes whereby more of the necessary characteristics of the operation are satisfactorily fulfilled. In other words, for

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certain of the RM Line equipment, it appears to be necessary to sacrifice some of the health hazard safety aspects in order to obtain a line that can be readily maintained and is more adaptable to process development and changes. It should not be construed that this compromise is a desirable state, but that it is a more or less temporary consideration until the time that the mechanical equipment can be developed that will give satisfactory, reliable, remote operation.

Again, the temporary state may last for an extended period of time in some cases, depending upon the degree of risk involved to the personnel operating the equipment, and upon the cost of new equipment required to replace the present equipment. Unless a considerable risk is involved, the economic justification for replacing an expensive piece of equipment is rather difficult, especially when that piece of equipment is producing satisfactorily.

Thus, the following policy rules are suggested to be used as a basis for choosing the type of operation for a process step in the 234-5 Building:

1. Analyze the process step in regard to its characteristics as listed in Appendix "A", and determine which of these apply with the greatest importance.
2. Select the class of operation which will fulfill the required characteristics the best. For equipment performing a repeated production step, this choice should usually be remote control operation.
3. Examine a proposed design for the equipment to be used for its applicability to the type operation selected. If the equipment has not already been proven to be satisfactory for this type of operation, it should go through an exhaustive mock-up and test program so that no doubt remains as to its suitability and reliability. If the development program will take too long, go back and choose a type of operation that calls for equipment that has previously been proven satisfactory.

The above rules are based on the acceptance of the fact that entirely remote operation is ultimately desirable, but that mechanical limitations in the equipment available preclude its use in all cases. All installations should be as near to being remote as the mechanical equipment will allow.

An approach similar to the one outlined herein has been utilized in connection with the machining step in RMA. Machining was originally performed, prior to pressing, by hand in the RG Line. Specifications for the RMA Line called for remote machining from behind a barrier. GEL provided equipment for this operation.

Prior to production operation of the equipment, the operation of machining to final shape was developed, eliminating the pressing operation. The equipment as developed was hand operated through rubber gloves, and was proven out in the RG Line. The GEL equipment in the RMA Line was examined for

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adaptation to the final shape machining operation, but was found to be too inflexible for modification to the new step. Thus the manually operated equipment was installed in place of the remote equipment. It was the most advanced design available that had been proven reliable, time was not available for further development, and no extreme compromise in health protection was made by performing this step by rubber-glove operation. Other operations, such as the loading and firing of crucibles in Task III, require more stringent health protection measures and their degree of remote control could not be relaxed to the extent of this example. It is now in order to develop improved equipment for machining that will provide more "remoteness" of operation for replacement of the existing equipment when replacement becomes necessary or economically justifiable, or for a new installation.

It should be noted that a tendency will exist toward the installation of replacement equipment or new installations identical to existing equipment because of familiarity with the old installation. This tendency should be avoided in favor of the approach outlined herein. Thus identical installations should occur only as the result of an analysis of the factors affecting the installation or should be the result of non-technical factors such as a limited time for completion.

Although it would be possible to list herein the various operating steps in the process and designate the probable class of operation that could be satisfactorily installed for each step at this time, it is felt that this listing would be of an influencing nature for future installations and would ~~tend to establish~~ an ultimatum for the operation of the steps. This should be avoided in favor of the use of the overall approach to each design as outlined. The process, operating steps, product requirements, schedules, etc., are changeable, and it is only by analyzing all of the factors applicable at one time and applying the proper general approach that all conditions can satisfactorily be met.

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APPENDIX "A"

Definitions and Explanations

In order to identify the types of operations that have or may be utilized, the following list has been prepared to classify each type:

- A. Remote Mechanical (RM) Operation
- B. Non-Remote Mechanical (Mechanical Aid) Operation behind Barrier
- C. Non-Remote Mechanical (Mechanical Aid) Operation from Zone 3
- D. Rubber Glove Operation
 - 1. Servicing by plastic bag technique.
 - 2. Servicing by air locks.

The above classifications are described as follows:

A. Remote Mechanical Operation

This type consists of a line wherein the entire operation of the equipment is performed by operators located behind a solid barrier. Only maintenance and servicing, where materials or samples are inserted or removed from the line, are performed in the same room where the equipment hoods are located. This is sometimes referred to as "push-button" operation. RMA and RMB were designed and fabricated on this basis. Inasmuch as servicing and maintenance work is performed through rubber or plastic gloves on all sides of the hoods, a separate barrier from the hood walls has been installed in order to have an unpierced bulkhead between the hoods and the operators.

It is realized that one step further in the way of health protection could be realized by performing all service and maintenance work by remote mechanical means also; however, since these tasks are so varied and intermittent, and are under planned regulation, they are assumed to be acceptable as manual supplements under the term of remote operation. The original RMA design began on the basis of remote sampling and servicing, but these requirements were relaxed early in the design period.

B. Non-Remote Mechanical (Mechanical Aid) Operation behind a Barrier

This classification includes the utilization of direct hand manipulation of operating shafts or rods by operating personnel, the shafts extending through a solid barrier and being sealed with stuffing boxes or bellows seals. The operating area, in this type, contains no access to hoods through gloves or plastic bags. These are all in a Zone 3 area

behind the barrier. For this type, the barrier may be the solid front wall of a process hood.

C. Non-Remote Mechanical (Mechanical Aid) Operation from Zone 3

This classification is the same as B except that the operation may be from any side of the hood, within the Zone 3 area, and within the same area that contains rubber gloves or plastic bags in the hood walls.

D. Rubber Glove Operation

1. Rubber Glove Operation with Servicing by Plastic Bag Technique

This classification assumes rubber glove operation for a hood with the operator either within or separated from the servicing area.

2. Rubber Glove Operation with Servicing through Air Locks

The RG Line was originally installed with these characteristics, although the operations were performed through gloves from a separate area formed by the front walls of the hoods.

It is realized that the same hood may utilize several of the above classifications, or modifications thereto, but the overall classification of each hood should be based on the type of operation built into the hood that affords the least protection for personnel. Thus, if any one operation in a hood is performed through rubber gloves, the hood should be classified as a rubber glove operation regardless of how many other remote operations are performed. Maintenance may be considered separately in that it is done under special protective conditions.

In analyzing the above types of installation it is necessary that consideration be given to the advantages and disadvantages of each classification in regard to the following characteristics:

1. Costs

- a. First cost including development of equipment.
- b. Operating costs.
- c. Probable maintenance costs.

2. Operability

3. Reliability

4. Ease of maintenance

5. Flexibility.

6. Contamination control

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7. Personnel contamination risk
8. Personnel safety for other than contamination risks

A brief discussion of the above characteristics is given below to clarify the interpretations of them as used in analyzing the various methods of operation:

1. Costs - The first cost of the equipment must include any development work done in the design or building of the equipment. It follows, therefore, that items already proven to be satisfactory should be cheaper than newly developed items of the same magnitude.

The operating and maintenance costs of equipment depend largely upon other characteristics listed, but must be considered in economic comparisons.

2. Operability - The simplicity of the operation, effect on the operator, such as mental strain, special clothing, etc., and the caliber of operator required are taken into consideration.
3. Reliability - This characteristic consists of the evaluation of how reliable and dependable the operation and equipment are. As a general rule, mechanisms will perform a task identically for each repetition, where human hands will not; however, machines that are consistently breaking down or developing defects are not as reliable as manual operation. An available method of emergency operation improves reliability.
4. Ease of Maintenance - It should be conceded that all mechanisms will require maintenance eventually, and that arrangements providing for ready accessibility, easy contamination control, and simple replacement of parts, are desirable.
5. Flexibility - Experience has shown that it is desirable to install equipment that can be easily modified to accommodate process changes and changes in operating techniques. Large, complicated mechanisms, and permanent structural arrangements do not lend themselves to changes.
6. Contamination Control - This classification evaluates the probable ease with which contamination is confined within a hood, or within a small area, both during normal operation and in case of any possible emergency or accident that may arise. It also includes the ease with which any contamination is cleaned up.
7. Personnel Contamination Risk - Any risk of contamination to personnel should be considered as a compromise. Complete separation of personnel from the operations is the goal to reach in all cases. Every risk taken in this respect must be a calculated risk, accepted only because other characteristics of the operation so dictate.

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It is suggested that the evaluation of the personnel contamination risk include an estimate of the number of hours of work under regulated conditions that will be necessary by all personnel involved with the applicable process step. The time spent for SWP maintenance of remotely operated apparatus may be so great in comparison to that required for SWP operation of a rubber glove hood for the same process step, that it may be profitable to install the rubber glove equipment until reliable remote equipment is developed.

8. Personnel Safety Other Than Contamination Risk - Explosion hazards, risk of contacting toxic gases, cuts, bruises, etc., are usually considered of secondary importance to contamination but they must not be overlooked. A combination of a gas explosion and contamination is possible.

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