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A COMPUTER-CONTROLLED XYZ RETRIEVER

by

O. K. Roberts

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ABSTRACT

It is the objective of Rocky Flats to reduce radiation exposure to the operating personnel to the lowest practical level. To accomplish this Dow (RF) utilizes the best technology and equipment available in the plutonium manufacturing facilities. This paper describes a horizontal XYZ Retriever with a programmable controller which was recently installed at Rocky Flats to accomplish in-process storage of radioactive materials. The purpose of this paper is to describe the equipment, problems and the effect on the manufacturing environment.

INTRODUCTION

Rocky Flats is in the business of fabricating plutonium into useful parts. Plutonium requires special handling (glove-box atmosphere) because it is flammable, radioactive (hazardous to one's health) and explosive under certain conditions. In looking for ways to make plutonium manufacturing a safer working environment, it was determined that the storage of in-process materials needed improvement. Formerly, all in-process materials remained in the process line throughout the entire manufacturing process. This mobile environment was safe under most conditions; however, the radiation level was higher than it should have been because all in-process material was kept in the conveyor line network. The potential of fire was also higher for the same reason.

A storage system specification was written which required that a means be provided to automatically store and retrieve materials from an enclosed vault rapidly and safely. The storage vault would provide a stable atmosphere for large quantities of in-process material, thus reducing the risk of radiation exposure and fire. Kenway Engineering was awarded a contract to supply a turn-key retriever/storage system. This system (KE-12 XYZ Retriever) was delivered in the late spring of 1971 and became operational during the summer of that same year.

GENERAL DESCRIPTION

The storage vault provides a completely protected environment for the material and operating personnel. It has 10-12 inch concrete walls, ceiling and floors re-enforced with stainless steel inner cover. The windows have double panes approximately 10 inches apart filled with water as a shield against radiation. Each material location has lead coated stainless steel shielding. The maintenance area is located at one end of the vault behind a concrete wall which serves

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to protect maintenance personnel against radiation. The shuttle is located at the opposite end of the vault from the maintenance area. It moves material into and out of a glove box area. The Retriever has 450 storage locations positioned in a 9 x 50 array and housed in a 20' x 80' enclosed vault. There are 419 usable locations with the remaining locations used for maintenance, calibration and shuttle areas.

The automatic controls are located outside the vault near the shuttle. The light panel which informs the operator whether a location is empty or full, the computer (General Automation SPC-12 (16K)), teletype and electronic cabinet are located here. The manual controls are located outside the vault near the maintenance area. These controls serve as an emergency alternative to move material.

The XYZ Retriever has three directions of movement: 2 horizontal (X,Y) and one vertical (Z). The X direction motion is effected by a bridge mounted on tracks which moves along the X axis. The Y direction is effected by a carriage which moves on the bridge along the Y axis. A hoist mounted on the carriage effects the vertical motion along the Z axis. A typical retriever transaction moves to a specified (X,Y) coordinate, reaches down (Z), picks up a container, moves to another specified (X,Y) coordinate and deposits the container (Z). The movements within the vault are monitored by a closed-circuit television system with the camera attached to the carriage.

The KE-12 stored program controls the Retriever motion, remembers carrier status and security information, and provides syntactical input and output via ASR-33 teletype. It also has a self-testing mode of operation whereby it continually checks for operator errors, fail-safe conditions, emergency shutdown and restart. It does not retain material serial numbers, part types or physical properties of the material located inside the vault.

The stored program accepts 11 basic commands:

1. COMPUTER/LOCAL

These commands initialize the SPC-12 program for input data from the ASR-33 or from another computer. At the present time, the retriever is a stand alone system and can be operated only from the ASR-33 in the local mode.

2. DELIVER/STORE/TRANSFER

These commands provide capability to deliver a storage container from within the storage vault to the shuttle car: to store a container (placed on the shuttle car) inside the storage vault: and to transfer containers within the storage vault.

3. ZONE

This command allows the assignment of security codes to be affixed to any location within the vault thereby limiting access to those persons with knowledge of the security code.

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4. LOAD/DUMP

With these two commands, paper tape may be conveniently entered or created without resorting to the programmer's console. This allows the operator who normally does not have a knowledge of computer operations to load the object program or data from the teletype.

5. CHANGE

The CHANGE command gives the operator control over the status light panel. With this command, the status table (internal software table) can be changed, reflecting the presence of a full container (light off), the lack of a container or the presence of an empty container (light on). This function is done automatically by the controller when it is operating normally. The CHANGE command is used to update the status table and light panel after error conditions.

6. MAINTENANCE/TEST

These commands are used to verify the operation of the entire system, and to move the Retriever to a specified maintenance area for inspection, preventive maintenance or repairs.

EVALUATION

The Retriever is located in an annex building and connected to the manufacturing building by a conveyor line. This situation developed when the original planning for the plutonium processing facility did not include special in-process storage. The storage system became a part of this facility as an afterthought to the original plans. The Retriever should be more centrally located within the manufacturing line so that parts could be stored and retrieved quicker. Experience has shown that parts are often kept in the conveyor line simply because the time and distance involved in storing them does not warrant the effort.

Delays also occur because there is only one shuttle and one conveyor line to the Retriever. Two shuttles and two conveyor lines could increase accessibility to materials inside the vault and encourage the storage of in-process materials. Under the present system, if the conveyor line or the shuttle became inoperative for an extended period of time the manufacturing effort would be hindered and production schedules would not be met. This problem has not occurred, but it is possible.

Prior to the installation of the XYZ Retriever, all the radioactive material that entered the process line remained either in the conveyor line or at a work station until the manufacturing process was completed. The elapsed processing time could extend from ten days to three months depending on the nature of the part. Obviously, the danger of radiation exposure and fire increases when plutonium is allowed to remain in a mobile environment such as a conveyor line or at a processing work table. With the Retriever, most of the in-process plutonium in a "wait" cycle is removed from the manufacturing environment and placed in the storage vault.

According to the Health Physics Department, the Retriever, better cleanliness standards, the new facility, and changes in production scheduling have all been major factors in the reduction of the average body and hand exposure. Since these major factors went into effect, yearly averages have shown a reduction of body exposure from 2.6 rem to 1.1 rem average per man per year. The hand exposures decreased from 24.6 rem to 7.4 rem average per man per year. This partially demonstrates the effectiveness of the Retriever. The total effectiveness of the Retriever is not easily measured, as in the case of reducing the risk of fire. However, everyone associated with the Retriever agrees that the reduction in the risk of fire is a major justification for the equipment.

MAINTENANCE

In general, the XYZ Retriever is easy to operate and reasonably free of maintenance. A brief discussion of the maintenance problems is included in this section:

1. The speed of the Retriever is determined by software constants in the control program. The speeds were arbitrarily set by Kenway to provide the maximum "safe" speed; however, it was discovered that the maximum speeds were causing excessive wear to the bridge rollers. This problem was easily solved by changing the speed constants in the software.
2. The status light panel is located immediately above the teletype. The light panel is undependable because the light bulbs burn out and the light contacts malfunction occasionally. This problem was corrected by converting the software to allow the operator to print the status of all locations on the teletype (see Fig. 5). The printout not only is accurate but it also provides Production Control with a permanent record.
3. Several times the micro switches on the lifting jaws have been damaged. It is impossible to damage them under normal operation in the automatic mode; however, they could be damaged when an operator is controlling the Retriever in the manual mode. The operators have been warned to use extreme caution when operating the Retriever manually.
4. A few minor software bugs were corrected by Dow personnel.
5. The bridge cable has become the largest, unsolved maintenance problem. The cable is designed to lie in a trough above the Retriever bridge. As the bridge moves, the cable folds or unfolds depending on the direction. This constant folding and unfolding causes the cable to crack and short circuit (see Fig. 6). Three cables have been used, two bonded and one woven, but none of them have offered a permanent solution. A temporary solution to the problem is to replace the cable 2 or 3 times a year.

CONCLUSION

The XYZ Retriever has provided a versatile, reliable and safe in-process storage device, easy to operate and reasonably free of maintenance.

Although certain design changes and other improvements could be made, the XYZ Retriever has fulfilled the purpose of automatically storing and retrieving materials rapidly and safely and at the same time has reduced the risk of radiation exposure and fire which was the main objective.

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KENWAY ENGINEERING
BOUNTIFUL, UTAH

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