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LA-UR -82-1394

CONF-820609--32

LA-UR--82-1394

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TITLE HISTORY OF REMOTE HANDLING AT LAMPF

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SUBMITTED TO American Nuclear Society, 1982 Annual Meeting, Los Angeles, CA June 6-11, 1982

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HISTORY OF REMOTE HANDLING AT LAMPF

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ABSTRACT

A portable remote-handling system (Monitor)[1-5] has been developed for performing remote maintenance on radioactive experimental facilities at the Clinton P. Anderson Meson Physics Facility (LAMPF). This system has been continually improved since its implementation in 1976. The present system has performed highly sophisticated tasks in improving and maintaining the LAMPF experimental facility. Unlike conventional hot-cell remote-handling technology, the Monitor system is portable and highly flexible, thereby allowing quick response to unforeseen tasks with minimal planning and/or special tooling. In addition to performing routine maintenance and repairs, the Monitor system is capable of performing major revisions and improvements to current facilities, keeping pace with new experimental requirements.

INTRODUCTION

The Clinton P. Anderson Meson Physics Facility (LAMPF) is a linear accelerator, presently operating at a current of ~675 μA at 800 MeV. The experimental target cells are spread over a large area covering ~7000 m^2. Activity levels within the target cells range from ~200 R/h to >100 000 R/h. Typical components in a target cell range from highly sophisticated beam diagnostic devices weighing a few kilograms to large electromagnets weighing up to 15 metric tons. All components within the vicinity of a target are water cooled, thus requiring elaborate piping systems. Figure 1 shows a typical target cell with top layers of radiation shielding removed to show components.

Due to the wide dispersion of work areas and the large size of radioactive components at LAMPF, conventional hot-cell remote-handling technique could not be used -- instead it was necessary to develop a portable remote-handling system capable of performing in situ maintenance.

Fig. 1. Typical target cell with top shielding layers removed.

EVOLUTION OF REMOTE-HANDLING SYSTEM AT LAMPF

Merrimac

The originally proposed remote-handling system for LAMPF was the Merrimac. It was a self-powered portable hot cell positioned over the target cell. Viewing was through lead-glass hot-cell windows mounted horizontally. The prime manipulator was a programmed and remote systems model 3000, which could be augmented by a modified canal-type manipulator. The Merrimac concept was initiated with the early planning and conceptual design of the experimental areas. As physics requirements became firm and detail design of beam-line components progressed, it became apparent that the Merrimac system lacked the flexibility and dexterity required. A

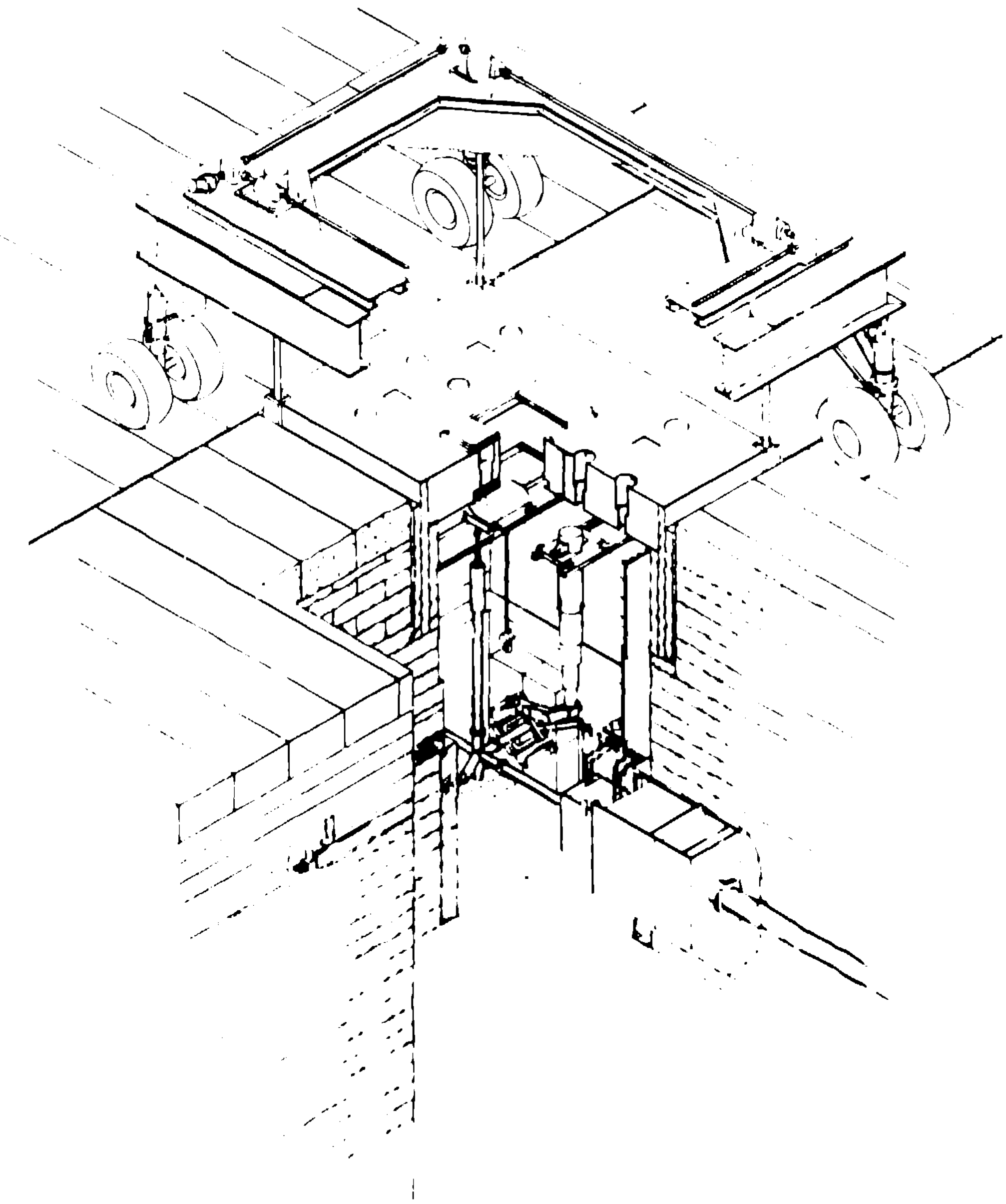

Fig. 2. Conceptual drawing of Merrimac remote-handling system.

conceptual drawing of the prototype Merrimac is shown in Fig. 2.

Monitor Prototype

As detailed design of target cells, experimental requirements, and operating conditions were defined, new technology in remote-handling became imperative. The Monitor concept was conceived by the LAMPF Group MP-7 staff and R. A. Horne of CERN. The following list of operating requirements led to the Monitor design.

- Remote operating with video viewing with the operating station up to 100 m away from the work area.

• Ability to work in extremely close spaces -- up to 10 m below floor level.

• Ability to handle standard mechanical and electrical fittings with minimal special provision for remote handling.

• Completely portable system.

The prototype Monitor system utilized a surplus hydraulic servomanipulator (obtained from the U.S. Navy) and a modified electromechanical manipulator mounted on a portable hydraulic crane. The master station consisted of a set of standard electrical racks to house the video Monitors and manipulator controls.

Monitor I

The prototype Monitor was commissioned as Monitor I in 1976. The first real task was to remove and replace a beam-line window at the A-6 target cell. The equipment performed extremely well; however, the more dexterous operations took considerable time due to the lack of force reflection in the hydraulic manipulator as well as limited experience in these operations. The hydraulic manipulator was replaced with an electrical bilateral force-reflecting manipulator that was custom built to LAMPF specifications by TeleOperator Systems, Inc., Batavia, New York, in 1976, thereby greatly increasing operational capability of Monitor.

As operating experience was gained with Monitor I, the need for improvements became very apparent. By this time the facility operation required that Monitor I be operational at all times. The master control station was moved into a closed trailer to provide a proper working atmosphere for the tedious, demanding tasks required.

Monitor II

Monitor II began as a test bed for evaluation of new equipment and for proposed major changes to the Monitor system, without compromising the operation readiness of Monitor I. Some of the major improvements developed through prototyping on Monitor II are:

• hydraulic automatic level drive to maintain level position of the manipulator mounting bracket, regardless of crane boom position,

• improved pan/tilt systems for the various video cameras,

• proportional controls for the crane hydraulic systems,

• improved operating controls and console layout in master control station, and

• integral systems for tool power, air, welding, gases, etc.

Monitor II was commissioned in 1980, providing operational readiness while Monitor I was updated with all the improvements developed on Monitor II.

Current maintenance and beam-line improvements scheduled at LAMPF require operational readiness for both Monitors I and II, as it is now necessary to perform remote operations simultaneously at common and/or separate locations.

Figure 3 shows an overall view of Monitor II, Fig. 4 gives a close-up view, showing the manipulators, shoulder, and automatic level drive, and Fig. 5 shows a view inside the master control station.

Monitor III

Monitor III, shown in a conceptual sketch in Fig. 6, is a third-generation system now in preliminary design. It will be completely self-contained (with a built-in power supply), capable of operating without external power or other services, and can be readily transported to remote locations by special truck or trailer.

The primary mission for Monitor III is to assist in removal and safe disposal of many very large radioactive components that are scheduled for replacement in future shutdowns. Other important functions include:

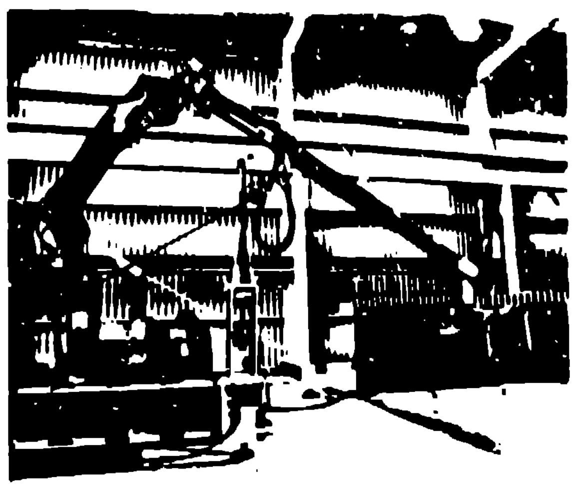

Fig. 3. Overall view of Monitor II.

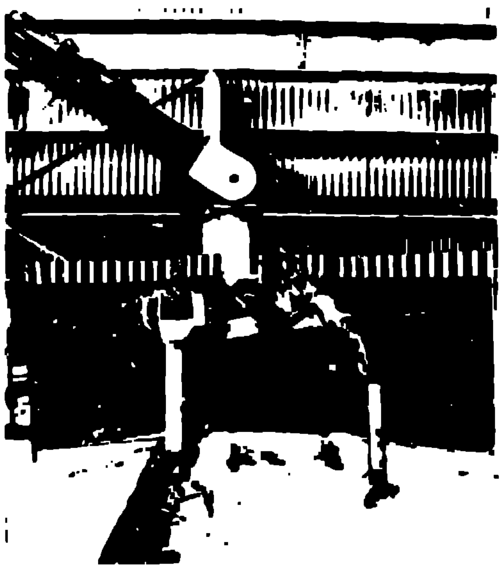

Fig. 4. Close-up view of Monitor II with manipulators.

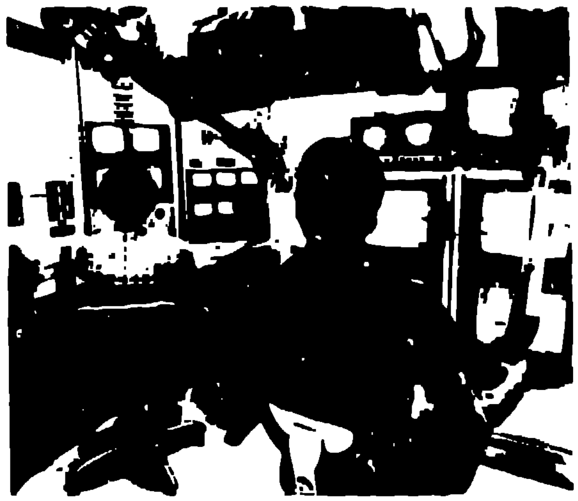

Fig. 5. View inside Monitor master-control station.

- backup for Monitors I and II in situations that require two systems at the same location simultaneously,
- general support of experiments that would otherwise require some radiation exposure to personnel,
- providing a test bed for new equipment, and
- providing emergency readiness for incidents involving radioactive or hazardous material.

ACCOMPLISHMENTS

The remote-handling capabilities at LAMPF have been continually expanded to meet ever-increasing needs. Fortunately, when the facility and the equipment were new the repairs required were relatively simple, and they were easily handled with prototype equipment. After years of operation the repairs are more numerous and complex in nature. The following is a partial list of mechanical skills that are performed routinely and proficiently.

- Welding (MIG, stick, and oxyacetylene).
- Soft soldering (resistance, air-acetylene, and oxyacetylene).
- Silver soldering (air-acetylene and oxyacetylene).
- Metal cutting (saber saw, portable band saw, and abrasive wheels).
- Stud welding (Nelson stud gun).
- Drilling (air and electric portable drills).
- Grinding (air and electric).
- Tapping.
- Field-line removal and replacement.

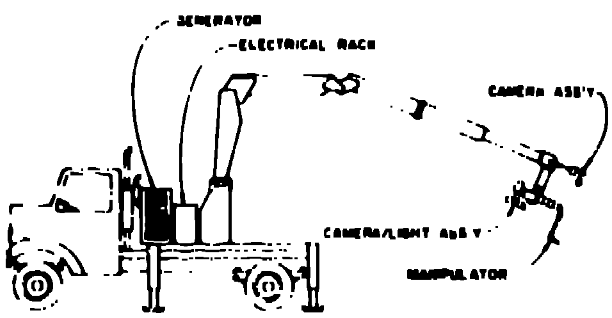

Fig. 6. Conceptual drawing of Monitor III.

FUTURE REQUIREMENTS

As the LAMPF experimental facilities are expanded and existing facilities are modified to meet new experimental requirements, the time available to perform remote-maintenance operations will be reduced. The response and turnaround times for emergency repairs must be reduced to minimize loss of beam time to experiments. To keep pace with future experimental program schedules, the following major improvements will be made.

- New-generation force-reflecting servomanipulators, similar to the present manipulators except more reliable and more easily maintained.
- Medium-duty, low-cost servomanipulators to augment more expensive manipulators (to provide two-hand capability for all Monitor units at reduced cost). It also could be used for high-risk operations such as remote rigging and placement of heavy components.
- Light-duty, small servomanipulators capable of working in extremely confined spaces.
- Computerized positioning system for the Monitor systems.
- Computer-aided design interface software to be used in conjunction with the computerized positioning system.
- Smaller video cameras to be used in conjunction with the small servomanipulators.
- Small remotely controlled vehicle to transport the small manipulator camera system to do remote maintenance in areas not accessible to Monitor.
- Telemetry and/or fiber optic multiplexing systems to eliminate or simplify umbilical connections between master and slave stations.

CONCLUSION

The Monitor system has kept pace with the needs of LAMPF, both in performing repairs and upgrading experimental equipment. However, many future improvements must be made to support future experimental programs at LAMPF. The current Monitor systems are very satisfactory in terms of mechanical skills and dexterity. The major problems affecting future performance are turn-around time and the ability to work in extremely confined spaces.

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