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REMOTE HANDLING AT LAMPF*

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Introduction

Experimental area "A" at the Clinton P. Anderson Meson Physics Facility (LAMPF) encompasses a large area. Presently there are four experimental target cells along the main proton beam line that have become highly radioactive, thus dictating that all maintenance be performed remotely. Figure 1 is a layout of experimental area "A."

The Monitor remote handling system was developed[1,2] to perform *in situ* maintenance at any location within area "A." Due to the complexity of experimental systems and confined space, conventional remote handling methods based upon "hot cell" and/or "hot bay" concepts are not workable. Contrary to conventional remote handling which require special tooling for each specifically planned operation, the Monitor concept is aimed at providing a totally flexible system capable of remotely performing general mechanical and electrical maintenance operations using standard tools.

The Monitor System

A Monitor system consists of a pair of slave manipulators mounted on the boom of a portable hydraulic crane positioned at the work location. Figure 2 is a view of the slave unit.

Operations are conducted from a master control station, installed in a trailer, positioned at a safe distance from the radioactive work area. Viewing is accomplished only by closed circuit television. Figure 3 is a view inside the master control station.

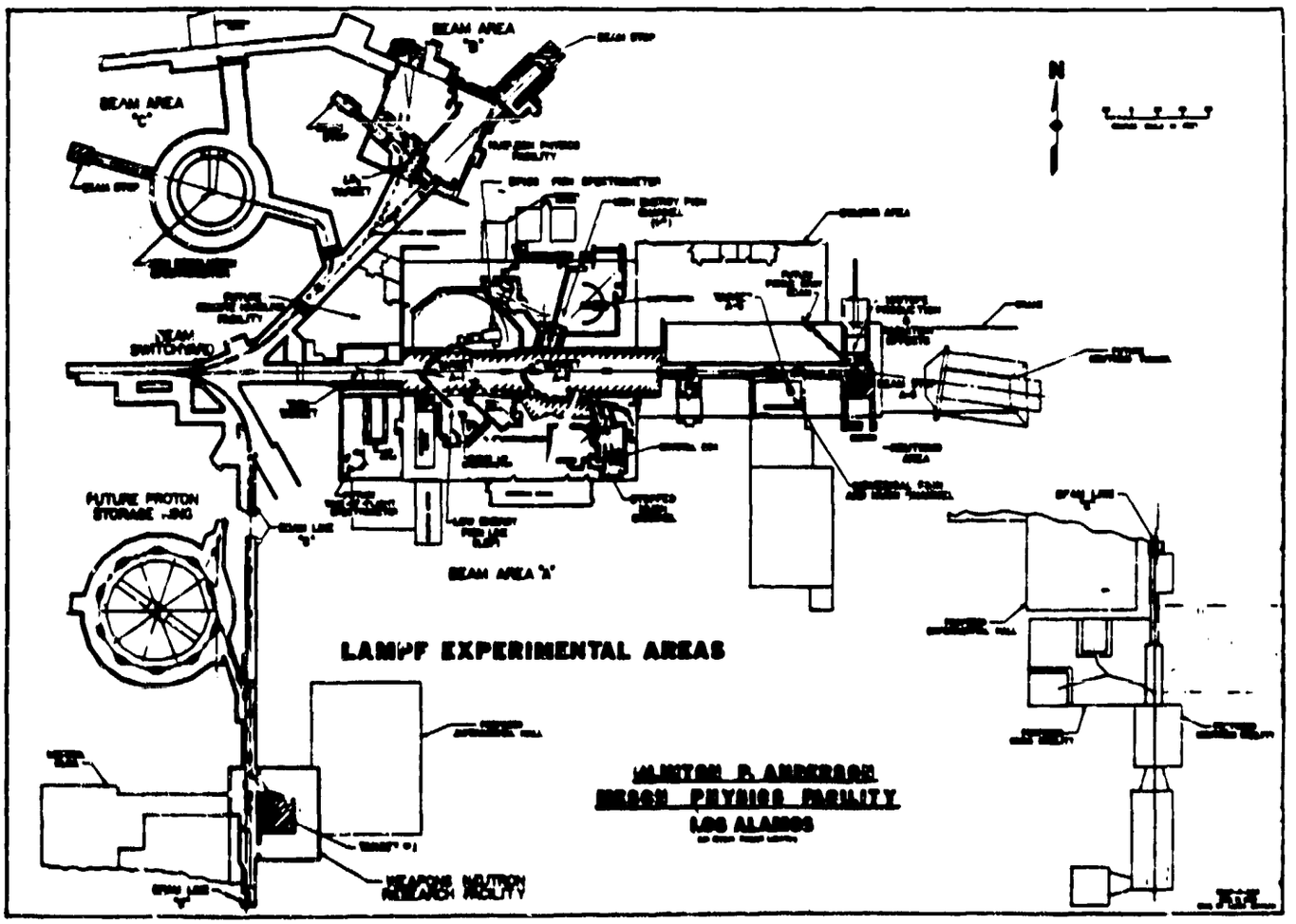

Fig. 1. Area A

*Work supported by the US Department of Energy.

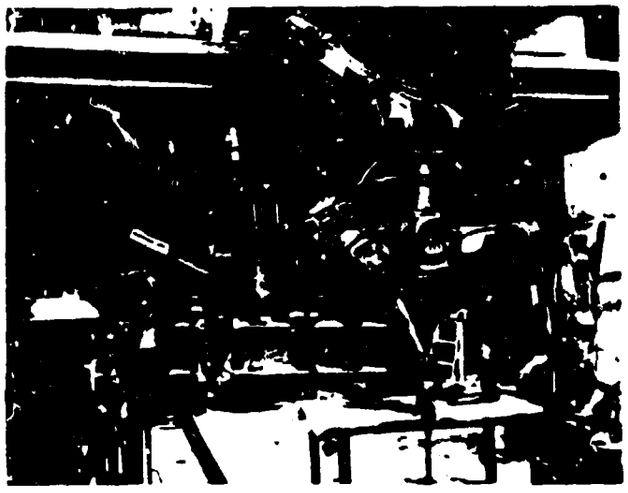

Fig. 2. Monitor Slave Unit

Fig. 3. Monitor Control Room

The Monitor operating crew consists of:

1. The manipulator operator (seated as shown) performs the actual work using master/slave manipulator and various tools as required for the job.

2. The crane operator (not shown) operates remote controls for the hydraulic crane from the console in the right rear, to maintain proper working position for the slave manipulators.

3. The camera operator (not shown) operates the pan, tilt and zoom functions for the television cameras from the center rear console to provide optimum viewing for the manipulator operator. As many as six cameras may be in use at one time.

The prototype Monitor system was first used in 1976 to replace an air cooled beam window in the beam stop area with a newer water cooled version to allow higher beam current. The prototype Monitor used a hydraulic servomanipulator (without force reflection) and an electric manipulator (PAR model 3000.) The operating end of the slave unit is shown in Fig. 4. The master control station consisted of a pair of panel racks and "stick" master located in the experimental hall. This system is shown in Fig. 5.

Since 1976, many ongoing major improvements were made to keep pace with increasing radiation levels and continually increasing complexity of tasks to be performed. The most significant single improvement was the addition of bilateral force reflecting servomanipulators (mfg. to LAMPF specifications by Teleoperator Systems, Inc., Batavia, NY.) Other important improvements were climate controlled trailers for master stations, better control systems, and improved control and viewing console layout.

At the present time, two systems (Monitor I and Monitor II) are fully operational. A third system (Monitor III) is now under construction.

Monitor I and Monitor II were designed to operate primarily within experimental area "A" as they depended upon overhead radio-controlled cranes for mobility and require electrical power from the facility.

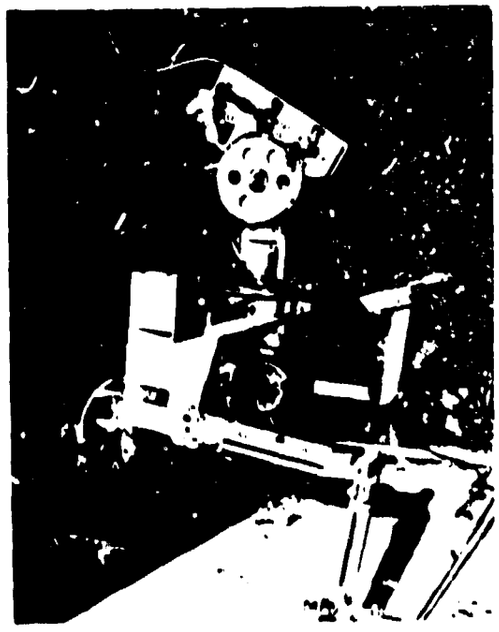

Fig. 4. 1976 Monitor Slave Unit

Fig. 5. 1976 Monitor Controls

Monitor III will be a totally portable system, with its' own power generator, capable of operating at any location accessible by truck.

Monitors I and II have served well in maintaining existing experimental equipment within area "A"; however, Monitor III will be needed to accomplish planned major rebuilding of target cells A1 and A6, particularly from the standpoint of removal and disposal of radioactive structural components. Figure 6 is a sketch of the Monitor III system. In addition to maintenance and construction, Monitor III will be used in transport and disposal of radioactive materials removed from the facility.

Major Accomplishments

Since 1976, the Monitor system has developed and expanded to keep pace with maintenance requirements and improvements to experimental area "A." The original Monitor system was limited to performing relatively simple tasks, while the present systems have evolved to the point where it is possible to remotely perform tasks previously possible only by direct "hands on" methods. Some of the more complex tasks now performed by Monitor on a routine basis include "in place" fabrication of piping systems, soldering, brazing and grinding.

The most significant accomplishment to date for Monitor was the total rebuilding of LAMPF target cell A2. This involved the replacement of the target chamber, upstream collimator, three large magnets, profile monitor, and a myriad of piping and electrical systems. Weights of the components replaced ranged from a few kilograms to 25 metric tons. Since most of the components replaced were newly designed, the existing piping and electrical systems had to be totally replaced to suit the geometry of the new components. The new target chamber had to perfectly match four existing vacuum flanges from the main beam line, two secondary beam lines and target insertion port. This was accomplished by positioning an alignment fixture with adjustable flanges in the target cell and mating the flanges to the existing ports.

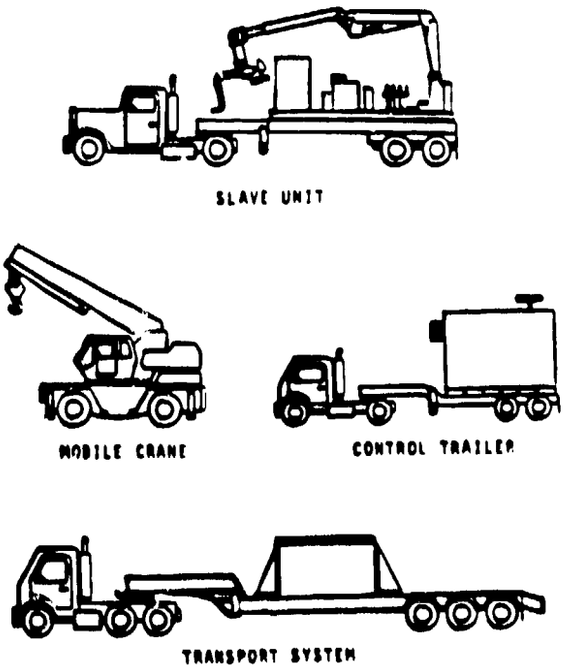

Fig. 6. Monitor III

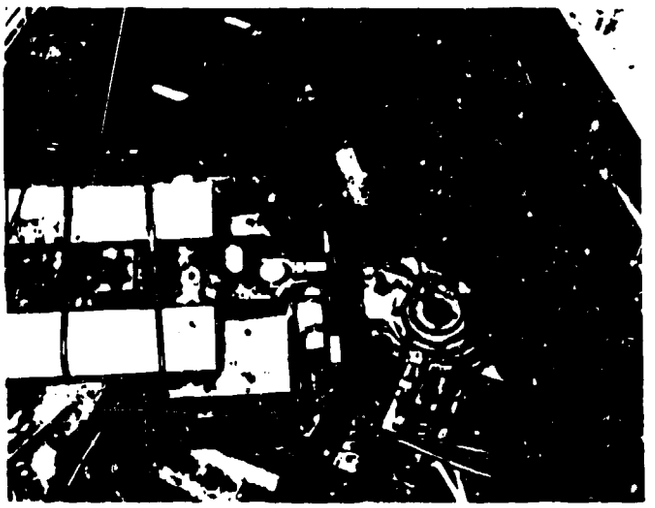

Fig. 7. Target Cell A-2, 1976

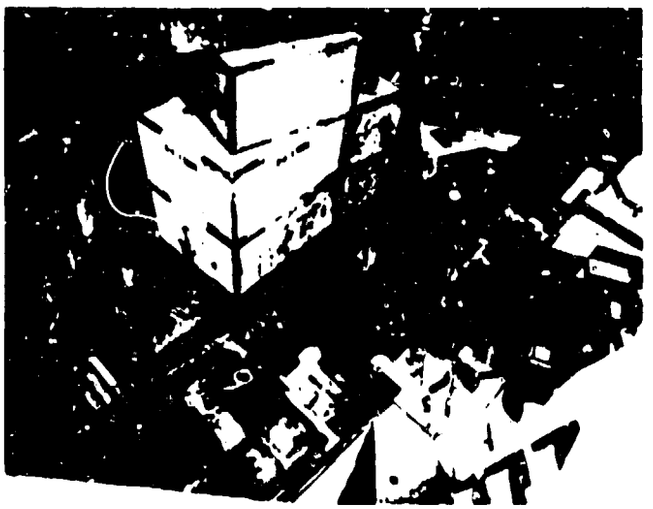

Fig. 8. Target Cell A-2 with all Components Removed

After the adjustable flanges were mated, they were remotely tack welded to preserve alignment during removal from the cell. The fixture was then removed, decontaminated, and placed on a large metal table. An external jig was then adjusted to match the flanges on the alignment fixture, then the jig was used for construction of the new target chamber. Figure 7 is a partial view of target cell A as built in 1976. Figure 8 is a view of the same cell with all the components removed. Figure 9 is the new target chamber just before installation. Figure 10 is a view of the partially reconstructed target cell.

Conclusions

The Monitor system has been totally successful in maintaining LAMPF experimental area "A." In addition to performing planned improvements to the facility during scheduled down times, it has performed emergency repairs with minimal loss of operating time. The useful work output of the Monitor systems has risen by a factor of four since 1976, with a less than 20% increase in operating personnel.

In its present state of development the system is capable of performing any foreseen task; however, in order to satisfactorily meet the future programmatic needs to LAMPF, operating efficiency must continue to improve at the same rate or greater, than experienced between 1976 and 1983.

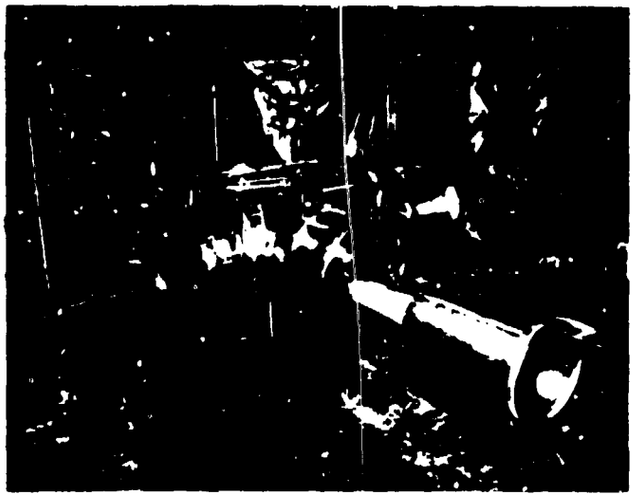

Fig. 9. New A-2 Target Box

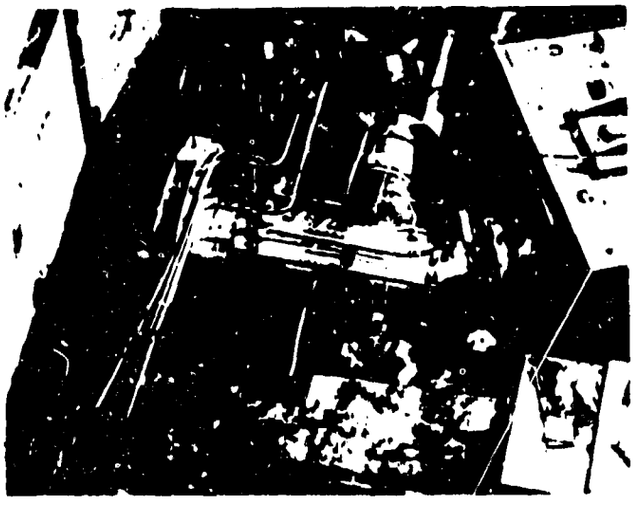

Fig. 10. Target Cell A-2, 90% Complete 1983

References

1. J. E. Lambert and D. L. Grisham, "History of Remote Handling at LAMPF", Proceedings of the 30th Conference on Remote Systems Technology, American Nuclear Society.

2. D. L. Grisham and J. L. Lambert, "Monitor 1983", Proceedings of 1983 Particle Accelerator Conference Volume NS-30, Number 4, p 2267.