BEGINNINGS OF REMOTE HANDLING AT THE RAL SPALLATION NEUTRON SOURCE

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Summary

Expenditure of funds and resources for remote maintenance systems traditionally are delayed until late in an accelerator's development. However, simple remote-surveillance equipment can be included early in facility planning to set the stage for future remote-handling needs and to identify appropriate personnel. Some basic equipment developed in the UK at the Spallation Neutron Source (SNS) that serves this function and that has been used to monitor beam loss during commissioning is described. A photograph of this equipment, positioned over the extractor septum magnet, is shown in Fig. 1. This method can serve as a pattern approach to the problem of initiating remote-handling activities in other facilities.

Introduction

Remote maintenance hardware is extremely expensive and complex. Rarely is funding provided early in a project for procuring or developing such hardware. However, many of the basic ingredients for remote handling can be provided, using inexpensive equipment in the form of articulated booms mounted on existing cranes with which to make useful measurements during machine commissioning. This equipment includes the following capabilities:

- Closed-circuit television (CCTV), including use of pan-tilt-zoom functions
- Remote control of mechanical actuators encompassing several degrees of freedom

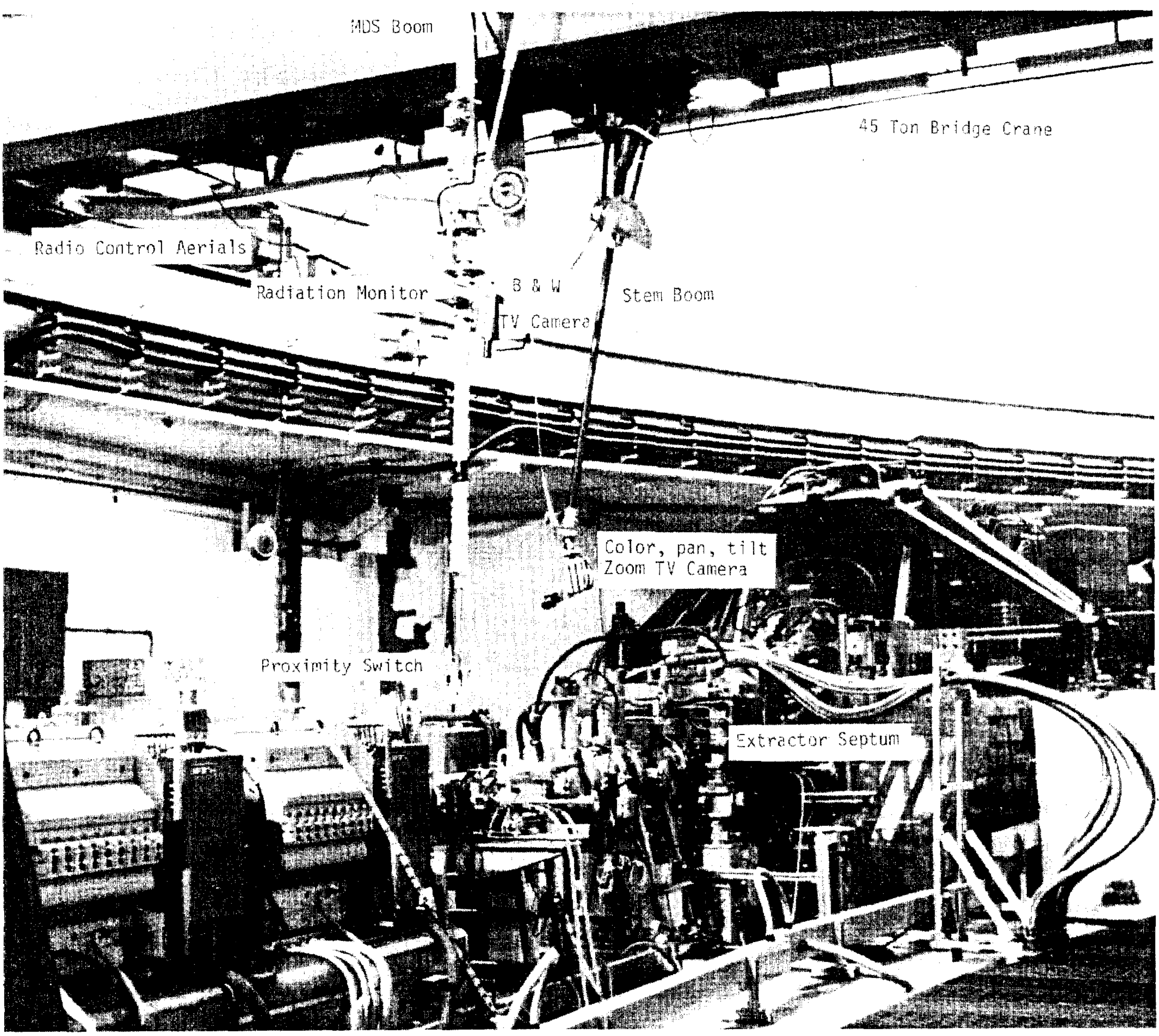

Fig. 1. Maintenance diagnostic system over SNS extractor region.

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- Remote switching of floodlights, instruments, etc.
- Use of color TV and sound
- Use of radio control to operate cranes, booms
- Paying out signal cables
- Gives practice in precision positioning using multiple TV cameras and monitors
- Allows integration with the machine commissioning teams to provide useful measurements early on

Equipment with the above capabilities is referred to as a Maintenance Diagnostic System (MDS). The familiarity gained with MDS equipment can be invaluable when the time comes to procure master slave servomanipulator equipment for on-line remote maintenance.

SNS MDS System Description

The SNS is an 800-MeV, 200-μA proton synchrotron. The beam is injected at 70 MeV, accelerated in the ring to 800 MeV, and extracted by fast kicker magnets to a depleted uranium target. Anticipated beam loss ultimately will produce high radioactivity levels. Modular engineering was intended to aid in the maintenance of SNS, but during construction many short cuts had to be taken that have restricted access to the modules. In the drive to achieve beam on-target before 1985, no real remote-handling design work could be done; therefore, an MDS system was provided.

Two booms are shown. One is a STEM unit, obtained from Roger Horne at CERN, equipped with a pan-tilt-zoom color TV camera. The STEM boom is extendible to 3 m and uses a pair of prestressed steel tapes to form the boom. The tapes are unwound from twin reels by a high-torque gear motor. Thus, the unit is very compact. The unit is mounted on a base that is pivoted by a linear actuator to sweep the boom in the radial plane. The STEM unit provides the articulated "CCTV eyes" for a second boom, called the "MDS boom", mounted on the opposite side of the bridge crane box beam.

Whereas the STEM unit carries two degrees of articulation (also pan, tilt, and zoom functions for its TV eye), the MDS carries three degrees of freedom. It can extend, traverse azimuthally, and traverse radially. The MDS boom is used to position a radiation monitor. It also carries a variable-focus black-and-white TV camera that is positioned (using a reflecting mirror) so that the monitor dial is in its field of view. Accurate positioning of the detector head uses both the MDS and STEM cameras. The detector head is encaged in a "dog-muzzle" contact indicator that uses microswitches to trigger a remote proximity warning.

Both booms carry floodlights; all equipment (that is, floodlights, cameras, instruments, actuator power supplies) can be switched on or off remotely by delivering relay trip voltages from the switch box shown in Fig. 2. This switch box normally is located in the central control room during commissioning runs, and all boom positioning is controlled from there, using three TV monitors. To aid in positioning the crane, the boom is set at mean azimuth and the crane traverses until the numbered placards on the wall appear in the TV field of view.

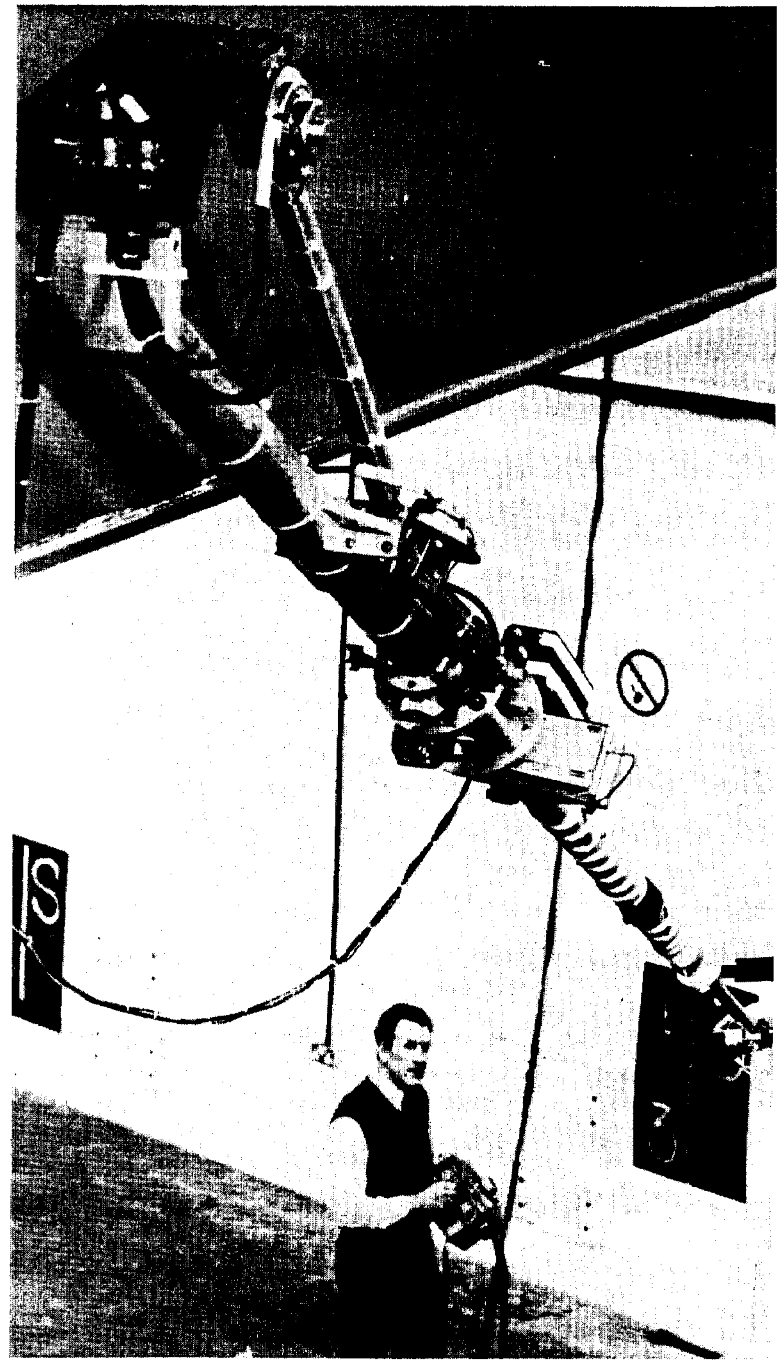

Fig. 2. Control panel for MDS booms.

The crane is radio controlled, and a coaxial line is brought on board to ensure close-coupling from the transmitter to the pickup aerials. In principle, all relay switching functions for the MDS system also could be provided by an upgraded multichannel radio system, but this was not done at SNS. The control cables, including the radio and video coaxial lines, are payed out by the cable drum shown in Fig. 3. This unit uses spring motors to retract the cable and is mounted to the crane so that crane motion simply reels off the cable. The cable is 55 core, including seven 50-Ω coaxial cables, to provide radio and video needs. The extent of the ring that can be covered by the radio-controlled crane is about 270° because of the presence of other "parked" cranes.

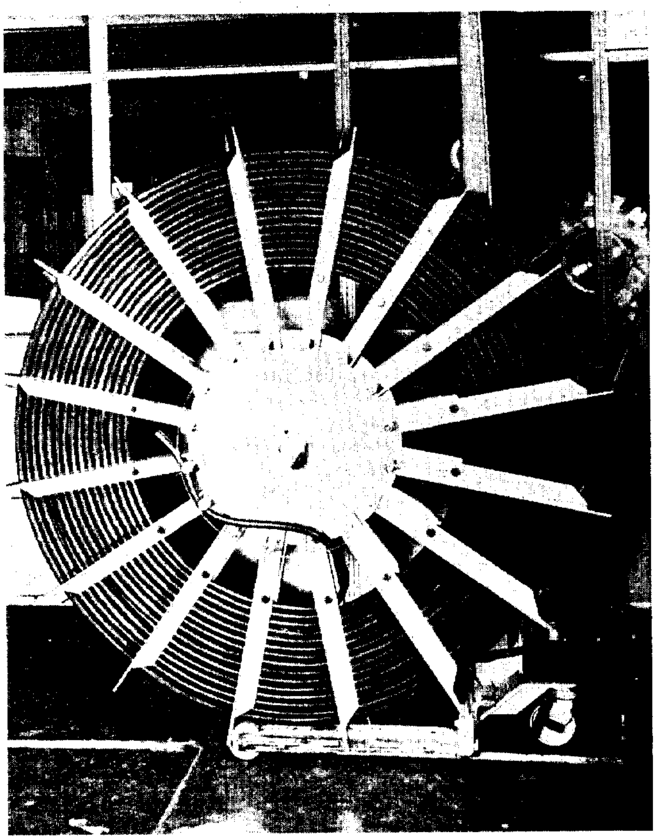

Fig. 3. Spring-motor driven 80-m cable reel.

Future Extension of the MDS System

At the present time, the MDS system is mounted on the bridge crane that services the SNS synchrotron vault. The system has been used to make radiation surveys of the synchrotron during commissioning and has also produced isorad scans. It also is being used to compile a library of video tapes that can aid in hardware recognition and crane positioning. An obvious future extension of this system is to mount a STEM unit on horizontal rails to provide surveillance, trouble-shooting observations, and radiation monitoring down the length of the extracted-proton-beamline tunnel.

It is conceivable that MDS also could aid in simple leak testing by carrying a gas bottle and remotely controlled valve. It could reach into "hot" areas and release a tracer gas into flanges, etc.

Conclusions

The success of the MDS system at SNS points out the value of early excursions into remote operations. SNS now has a budding Remote Operations and Maintenance organization called, appropriately, ROAM. An introduction to basic components has been made: CCTV; multiple-degree-of-freedom; articulated, mechanical booms; remote read-outs; radio control etc., as well as the opportunity to develop and reconfigure this hardware to gain valuable hands-on experience. Extension of this system into other parts of the machine will demonstrate its usefulness to operations and management. When master-slave servomanipulator-system procurement becomes essential, ROAM will be the best qualified organization to lead this effort.

In contrast to man-controlled servomanipulators, SNQ at KFA has proposed a robotic maintenance system to handle a high, anticipated failure rate. The SNQ delivers a 5-MW beam and will become extremely radioactive. To maintain plant availability of over 80%, use of robotics has been proposed. Tests have shown a time savings of three times over conventional, man-controlled servomanipulator systems. Unfortunately, such an approach requires that critical failure components all be designed for robotics--itself a lengthy and costly undertaking. Considering the difficulty in obtaining much management support for remote maintenance early in a project, such restrictions have little chance of being approved. However, this approach has much merit for the extremely powerful machines being proposed today. The accelerator community should be aware of the possibility that an accelerator someday may go on-line without adequate concern for these problems and may have to be operationally curtailed because of inability to maintain it or keep it on-line for economically feasible periods.

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