

Decontamination System

Mechanization and Automation of DHRUVA Cut-end Rod Handling System

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Cut-end Rod Handling System in operation

ABSTRACT

Continued efforts are being made to upgrade the existing mechanical handling systems with automation features. Decontamination & recycle of the cut end of the fuel rods of research reactor is utmost important to ensure the minimum inventory of the components. For recycling operations, an automated Rod Handling System has been designed and deployed which is a major advancement over existing handling system. The system handles 5.7 m long cut-end rod in balanced condition and moves to different work stations for decontamination, cutting and dismantling operations. Deployment of the system has resulted in improved safety, reliability and reduction in collective dose with enhanced plant throughput.

KEYWORDS: *Mechanization, Automation, Man-rem consumption, Plant throughput.*

Introduction

Heavy Equipment Decontamination (HED) System in Decontamination Centre (DC) of WMD is mandated to decontaminate Dhruva cut-end rods leading to eventual recycling of the rods. The cut-end rod is a 5.7 m long composite Al-SS assembly weighing 70 kg. At HED, the rod is decontaminated and dismantled into three sections viz. Al shield (for recycle to AFD), Al cut piece (for disposal) and SS Plug (for recycle to AFD). The Al shield and SS plug are decontaminated using various DC baths before its recycle. For all these operations, an automated Rod Handling System has been deployed which is a major advancement over existing handling system. Since Dhruva, AFD and DC do not have any buffer storage capacity for these rods, HED system operations are continuous in nature and must be operated in tandem with Dhruva and AFD operations.

Earlier, a mechanical gripper system with limited long travel was installed in the facility for handling the cut end rods. However, due to the ventilation duct, crossing through the facility, the rod box was not accessible with the old mechanical gripper system. All the operations were then carried out manually, resulting in higher man-rem consumption and safety issues. The old system was unserviceable due to ageing effects. Therefore, it was necessary to design a new system to overcome the limitations of the old system and with provision of improved automation features.

System Design Features

The system is a custom designed special purpose electromechanical manipulator with four degrees of freedom. Out of these four degrees of freedom, three are in cartesian

framework i.e. long travel (X) of 20 meter, cross travel of trolley (Y) of 6 meter, and vertical elbow hoist motion (Z) of 1.4 meter. Spatial positioning of the end gripper is achieved by actuation of the X, Y and Z movements. At the end of the elbow (Z), rotation of gripper assembly is provided. Payload capacity of the system in all positions is 70 kg. The 3-D schematic of the system is given in Fig.1.

The system is operated through a Programmable Logic Controller (PLC) based Supervisory Control and Data Acquisition (SCADA) Control Terminal. A radio operated push button pendant as an overriding operation feature has also been provided. Materials having high strength to weight ratio have been employed for structures like rails & CT girder for construction of the equipment.

The system can handle cut end rod having 60 mm diameter and unbalanced weight due to SS Plug at one end. The system is capable of picking the active cut end rod from the rod box in a horizontal balanced condition. The rod is then rotated through $\pm 90^\circ$ depending on the plug position and moved it to the decontamination tank for lowering into it. The system is equipped with two Pan/Tilt/Zoom cameras to view the entire work volume during active operation from control room. Built-in safety features like triplex hoisting chain, hoist chain tension sensors, redundant hoist breaking system,

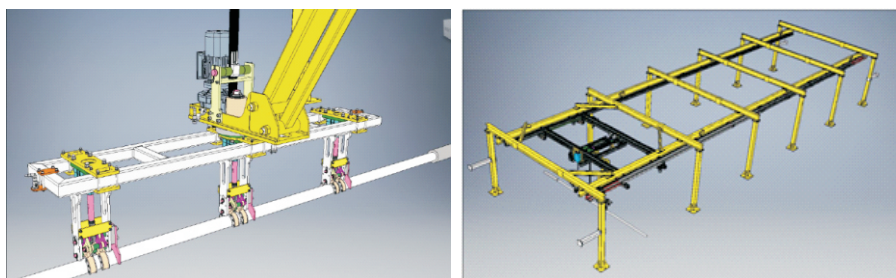


Fig.1: 3-D model of the Cut-end Rod Handling System.

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Fig.2: Cut-end Rod Handling System in operation.

provision for emergency release of load, proximity switches and LASER sensors for accurate detection of workstation positions & cut end rods are incorporated in the system. The system has three modes of operation viz. Auto Mode, Manual Mode & Bypass Mode. All routine operations are carried out in Auto Mode from the control room with minimum human intervention. Fig.2 shows actual cut-end rod handling system in operation at HED.

Installation, Testing & Commissioning

The system design mandate was the reduction of man-rem expenditure by incorporating automation features for decontamination of Dhruva cut end of fuel rod. Detailed planning was carried out for installation, testing and commissioning of the system so as not to affect Dhruva and AFD operations. A three-month time interval was available to complete the installation and testing requirements. Exhaustive and full-scale testing was carried out at manufacturing site prior to its installation to minimize time to restart facility operations. The old existing handling system, weighing 3.5 Te was dismantled. Relocation of process

equipment was carried out for smooth operational flow & reduction in cycle time. The complete integration of system, testing & commissioning were carried out over a period of 3 months. After conducting multiple demonstration trials, the system has been deployed for regular active use. Till date, 180 Nos. of rods (12600 kg) have been processed successfully. The system has resulted in improved safety, reliability and reduction in collective dose with enhanced plant throughput.

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