THE SOLID TARGET CONTROL SYSTEM FOR THE RFT-30 30 MeV CYCLOTRON IN KAERI

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Abstract

The solid target of the RFT-30 30 MeV cyclotron in KAERI was designed to produce the metallic radioisotopes, such as Zn-62, Cu-67, Ge-68, Pd-103, and In-111. The target control system should provide high reliability to prevent any kind of failure. Moreover, the operating procedures and maintenance cycle should be optimized and well organized to cover the unexpected situations. In this study, a simulation of the control system for the solid target in KAERI was carried out to confirm the operability of the solid target transport system. The receiving and irradiation stations are connected each other through square tube, and the control software was also checked. The developed solid target control system controls vacuum, cooling, and the whole procedures before, during, and after the irradiation.

INTRODUCTION

The accelerator facilities mainly aimed to develop accelerator or to research the accelerator application have been continually increased since 1930, the first era of accelerator [1-4]. The accelerator can be used to investigate not only the basic material science but also the medical applications, biology, radioisotope development, and industrial applications [5-7]. Besides, as the medical instruments developed for the diagnostic and therapeutic applications, the importance of radioisotopes produced by accelerator is getting more significant than ever [8]. Specifically, the I-123, I-124, Tl-201 and Pd-103 are very important in diagnosis and therapy, and the IAEA supports optimizing and standardizing the solid phase cyclotron target technology to increase the radioisotopes production yields, to improve production economics, and to investigate the availability of the radioisotopes [9].

In this study, we have considered the target system for the 30 MeV cyclotron installed in KAERI. Especially, we have investigated the solid target control system to facilitate controlling of the solid phase radioisotope production procedure.

SYSTEM DESCRIPTION

The developed solid target control system controls the whole procedures before, during and after the irradiation including vacuum and cooling. More specifically, transmit and retrieve the solid target from/to the receiving station (RS) to/from the irradiation station (IS). The controller prepares irradiation by fastening the target, starting cooling and forming a vacuum. The system also releases the target, stops cooling and breaks a vacuum after the proton beam irradiation is finished.

System Inputs

- External user control signals: target on, target off, and system stop
- Sensor and switch signals: optic sensors and limit switches
- Indication signals: valves, blower, pump, cooling, air, and bottom/top/back supports

System Outputs

- Control signals: valves open/close, blower, pump, cooling and air on/off, and bottom/top/back supports
- Alarm indications: no target is in the RS or IS, wrong faced target is in the RS, and the 3rd gate valve is open
- External interface signals: target is ready to be irradiated, target is received in the RS

Design Tool

- Hardware: Compact FieldPoint (National Instrument, NI) with 32 digital input/output channels each
- Software: LabVIEW (NI)

The system monitors the status of components, such as valves, blower, pump, cooling and so on, after it outputs control signals to them. This prevents the system fault induced by an error can be occurred in each component.

DESIGN RESULTS

The solid target control system consists of two main processes, such as the target on and target off processes. The 5 states are defined for the target on process and 6 states are also defined independently for the target off stage. The state machine of the solid target control system, which controls whole procedures, was designed with the defined 12 states including ready state.

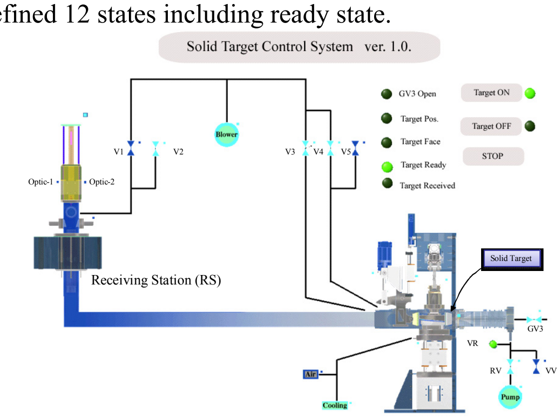

Figure 1: The front panel of the system

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The developed control system is based on the state machine, and can be divided by each state independently. This means that the system can be modularized and encapsulated in state-level, and can be modified or updated without any interference to other states.

In the Figure 1, we have shown that the front panel of the developed solid target control system using the LabVIEW program. The system operates according to the state transition diagram shown in the Figure 2. The pseudo-codes are used to describe the system and the state transition will be occurred only when the designated conditions at the state are satisfied.

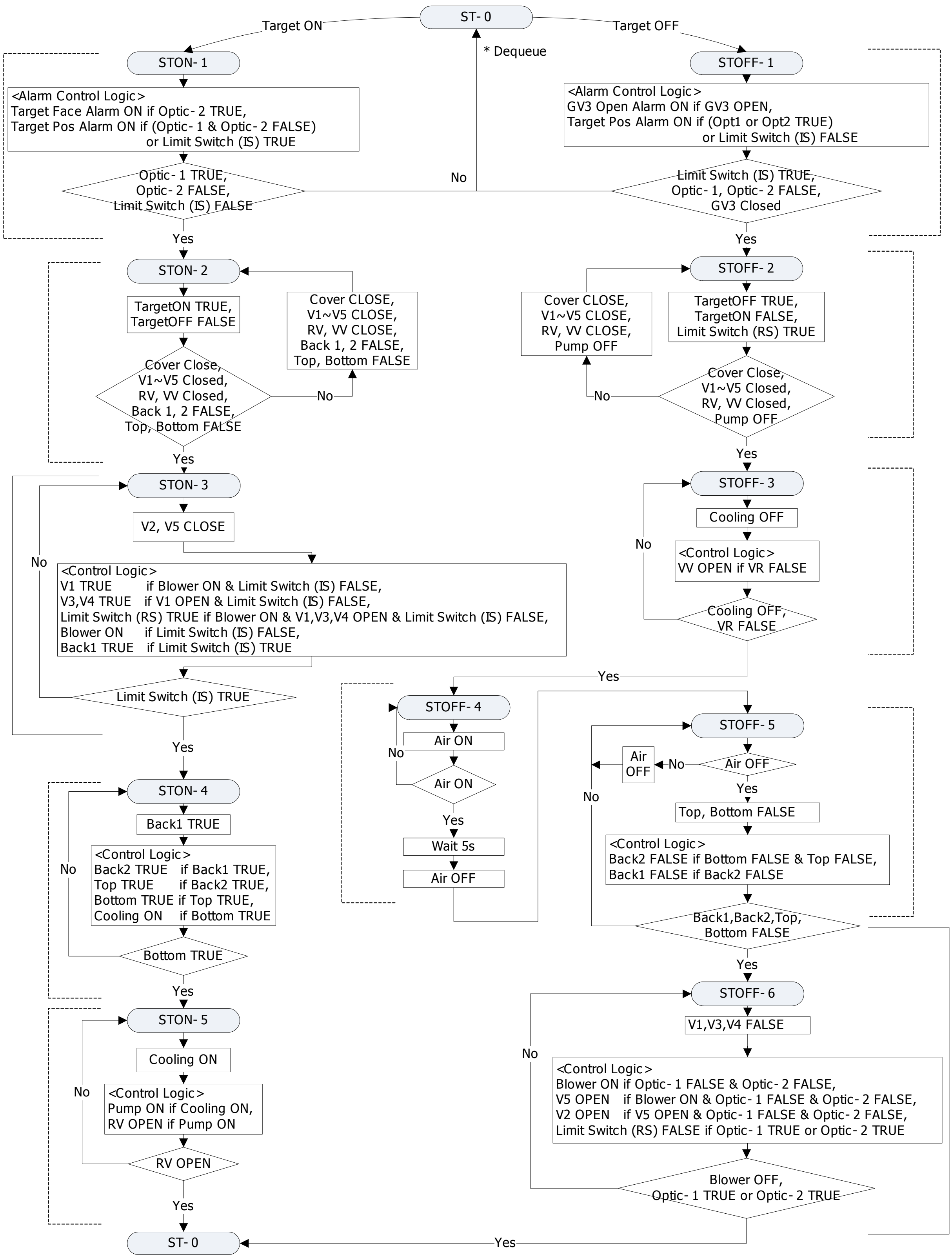

Figure 2: The state transition diagram of the system

CONCLUDING REMARKS

The state transition diagram of the control system with 5-states and 6-states has been designed respectively for the target on and off procedures. The solid target control system with state machine have been developed results in easy to maintain and update. The simulator for the system was also developed and tested under all scenarios. We have also carried out the operability test for the developed system successfully.

As a further study, the communication modules will be developed to provide multi-point access and remote control methodologies.

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