A Modular Instrumentation Panel For Monitoring The Status Of Accelerator Cooling Systems At Los Alamos *

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Abstract

A modular instrumentation panel has been designed and built for testing and installation on a linear accelerator at Los Alamos. This type of panel uses a modular approach to the monitoring of water-cooling system parameters. The panel design allows for its installation in various line sizes while using essentially the same design concept. The data taken from this instrumentation panel can be read locally or remotely and are used in several applications, namely, calorimetric measurements and fail-safe systems and alarms. A description of the panel and applications is presented.

Introduction

The concept of a modular instrumentation panel for accelerator water-cooling systems came about because of the complexity of linear accelerators and the water systems that cool them. In an effort to standardize the instrumentation used in the water system and to provide a means of monitoring water system parameters both locally and remotely, the idea of single panel or station was selected. This station would have to be versatile enough to be used in a variety of line sizes and in a broad range of temperature, pressure, and flow applications. This concept was first applied on the design of a beam stop for the GTA-1 linear accelerator. The beamstop was to have a modular panel located nearby that would provide both local and remote readouts of water system information.

This panel was not built because of a change in the scope of the GTA-1 project, it did however provide a design basis from which developed the later version of the water panel presented in this paper.

Functional Requirements

Functionally, the requirements for monitoring the various accelerator water-cooled components and subsystems are similar. The primary concerns are as follows:

(1) To provide a means of determining if cooling water is flowing. If a no-flow condition exists, then a signal must be generated that will not allow the accelerator to start up or that will cut power to a component and disable the accelerator beam.

(2) To provide a means of determining if the cooling water meets the requirements of the various accelerator components in the areas of pressure, temperature, and flow rate. If the requirements are not being met, then the instrumentation must generate a signal that will alert operators and cut power to water-cooled accelerator components.

(3) To provide a means of monitoring the water-cooling system status on various accelerator components both locally at or near the component and remotely at a graphics panel and/or at the computer control center. This monitoring also provides diagnostic information that will allow potential problems in the water-cooling system to be corrected before they become critical and cause accelerator shutdowns.

(4) To determine beam power deposited on the beamstop, additional functional requirements occur in the area of the accelerator beamstop where calorimetric measurements will be made. The following block diagram best illustrates the flow of information from accelerator components to local and remote stations (see Fig. 1). Note that several modular instrumentation panels can be fed into one graphics panel.

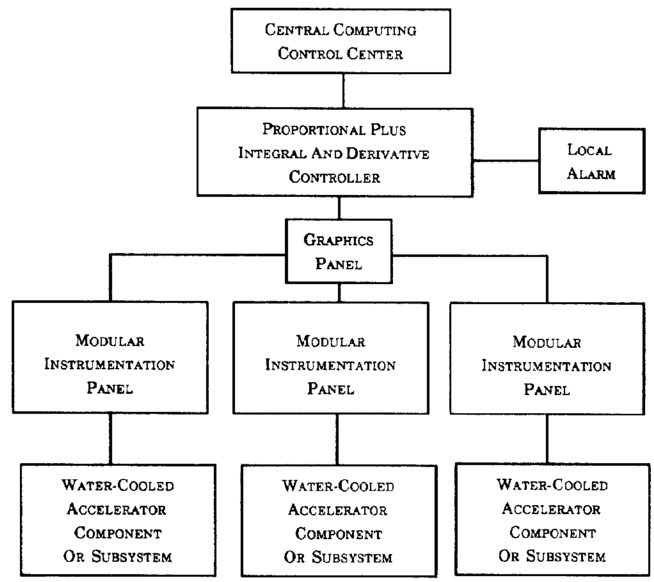

Fig. 1. Diagram showing the flow of information from accelerator components to local and remote stations.

Details of the Modular Instrumentation Panel

The modular instrumentation panel is designed to operate at a maximum working pressure of 150 psi and a maximum operating temperature of 250° F; maximum flow rates vary depending on the line size. However, a nominal flow velocity of 8 fps is generally adhered to. The panel has been designed and detailed for line sizes of 1 1/4-, 2-, 3-, and 4-in. diameters. These sizes are a sampling of the versatility of the panel, other sizes may be built as necessary to meet the size and requirements of the system being monitored. The size range anticipated for the applications on the GTA linear accelerator are from 1- to 2-in. pipe diameters. It is possible that the line size could be reduced to 1/2 in.; however, difficulty in obtaining standard fittings and arrangement of instrumentation may become a problem.

A partially equipped version of the panel has been installed on a 4-in.-diameter copper piping system. The panel was built and installed to monitor cooling water flow, pressure, and temperature to radio-frequency (RF) power sources (klystrons). This system employs only local readout of the monitored parameters.

A fully equipped version of the panel using 1 1/4-in. copper tubing has since been built and will be used in testing the Ramped Gradient Drift-Tube Linac (RGDTL) under RF power conditions (see Fig. 2). This complete version of the panel will have the capability of both local and remote readouts of pressure, temperature, and flow (see Fig. 3). All the instrumentation on the panel, except for the flow meter, is designed

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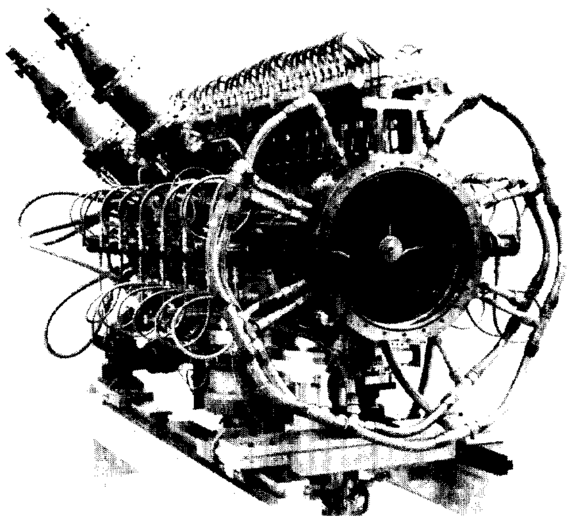

Fig. 2. The 425-MHz ramped gradient drift-tube linac.

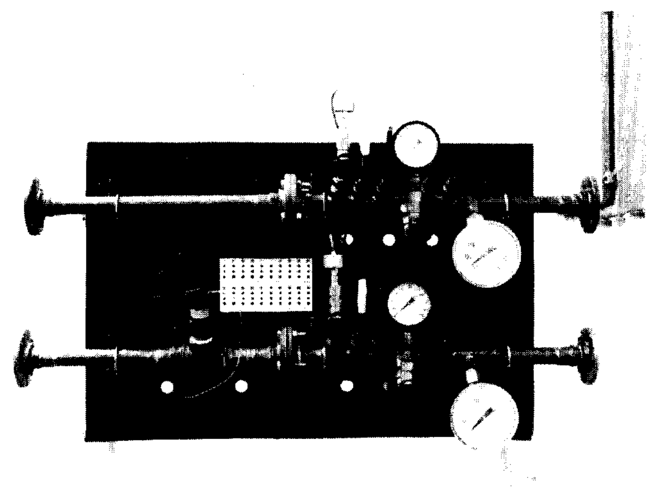

Fig. 3. Test version of the modular instrumentation panel.

to be installed or removed under dynamic conditions. Local instrumentation consists of liquid-filled pressure gauges, dial thermometers, and a digital flow meter. The pressure gauges are attached with valves ahead of them, and the thermometers are inserted into thermowells allowing for removal under operational conditions. These instruments provide a quick visual check on both the supply and return cooling-water status. Remote instrumentation consists of pressure transducers, resistance temperature devices (RTDs), thermocouples, and a digital flow meter. The pressure transducers are attached with valves ahead of them and the RTDs and thermocouples are mounted in self-sealing test plugs to allow for removal while the system is in operation. The panel has also incorporated four spare access ports, two on the supply side and two on the return side; these are equipped with self-sealing test plugs and caps and are installed for contingency purposes. All remote leads are brought to one common panel jack. This is the tie-in point for remote monitoring of the cooling-water system parameters. It is from this panel jack that the signals are fed into a graphics panel (see Fig. 4). Utilizing proportional plus integral and derivative (PID) controllers, the graphics panel has the capability of monitoring and controlling

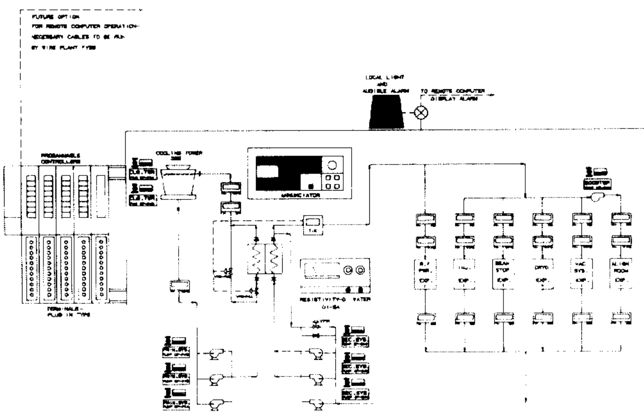

Fig. 4. Graphics panel and PID controller.

the system parameters from a remote location. The graphics panel may also be connected to the accelerator computer control system for additional monitoring. As stated previously, one graphics panel can monitor several instrumentation panels. If there is a problem within the water system being monitored by the graphics panel, then an alarm (both audible and visual) will signify that a problem exists and will identify the location of the problem. The graphics panel has not been built to date and is planned for construction within the near future.