7 Equipment Protection System

The beamlines at NSLS-II are expected to handle x-ray beams with very high power and power densities. Therefore, care must be taken to design the beamline with components that can handle these power loads. Any component that has to handle these high levels of power has to be monitored. The beamline Equipment Protection System provides a means of monitoring the components which, when jeopardized, can cause component failure. The EPS has the responsibility to act on alarm conditions by mitigating the situation that has caused the alarms. The system baseline is configured with the infrastructure to support all monitoring of cooling flows and six fully populated front ends. The baseline EPS will support all future expansion in terms of wiring, I/O and control logic. Excluded from the base line is the beamline control and monitor portion of the system, and its cost is captured in the individual beamline budget.

7.1 Functionality

Every beamline EPS will monitor and interlock the devices in the front end and the beamline.

All front ends at NSLS-II are expected to have two safety shutters, one photon shutter, and a few masks. In addition, the front end will also have vacuum inline valves to provide vacuum isolation. The front end is also expected to have a fast valve to provide a conductance limitation during a vacuum accident. Most beamlines will also have an x-ray exit window as part of the front end. These x-ray windows will provide a vacuum isolation but will transmit the x-ray beam. Certain beamlines, such as the soft x-ray beamlines, are expected to share the storage ring vacuum with the front end providing the interface. In such cases, the fast valve, along with the rest of the inline vacuum valves, provides the isolation needed in case of accidents.

Due to the large power loads, all components in the front end that intercept the beam will have water cooling. These components are typically the fixed mask, photon shutter, and exit windows. The water flow will be monitored by flow meters and the signals will be fed to the EPS. All vacuum valves will be pneumatically operated. All vacuum valves will be operated by the EPS and have their positions monitored.

Most beamlines are expected to have some beam conditioning optics upstream of their monochromator. The beam conditioning optics will see the large power of the beam and as such will be interlocked by the EPS. Beamlines are also expected to have vacuum valves, which will also be controlled by the EPS.

It is expected that the beamline portion of the EPS system will be customized to suit the condition of the specific beamlines.

7.2 Design Specification

The design of the EPS is expected to be robust. The system will be based on programmable logic controllers (PLCs), which provide excellent customization capability and also extensive diagnostics.. The hardware used will be the same as used in the beamline Personnel Protection System and the Accelerator Personnel Protection System (for both topics, see Chapter 8).

Each beamline will have its own EPS system, with the sole function being to provide protection from damage of equipment due to synchrotron radiation. As such, the EPS will consist of only one PLC per beamline. The EPS system will consist of three parts: front-end EPS, beamline-specific EPS, and command/ control of PPS components such as shutters and station doors. The front-end portion of the EPS is expected to be similar on most beamlines, while the beamline portion of the EPS will be customized to each beamline. Similarly, for the command/control of PPS components, the front-end shutters will be identical in all beamlines; however, additional shutters on the beamline will be beamline specific.

All front-end components that intercept the synchrotron beam will have water cooling of the components. The water flow of the components will be monitored by the EPS via flow meters. The EPS will be in alarm state if the flow drops below a specified setpoint. Depending on the location of the component it monitors, it will command the photon shutter to close and – for cases where the flow is upstream of the photon shutter – it will request the stored beam to be dumped.

All vacuum valves in the front end will also be controlled by the EPS. Setpoints from vacuum controllers that are provided to the EPS will be used to determine when it is permissible to allow opening of the valves. The EPS will determine when it is necessary to close a valve, and will do so if it senses a vacuum alarm based on the vacuum setpoint to the system.

For specific beamlines, the EPS will be customized based on the user requirements for that beamline. Besides monitoring the water flow and controlling the vacuum valves, the EPS system may be used on beamlines to monitor other variables, such as temperature, position, and so forth.

The EPS will be used to control the actuation of the shutters. It will monitor the status of the PPS for each shutter and, when a permit is available, it will accept requests to open the shutters. The EPS will be responsible for sequencing the shutters in cases that involve a combination of photon shutters and safety shutters. All station doors that are automated will also be operated by the EPS.

7.3 Interface

The EPS will have human Interfaces (HMI) located at the main location of the hardware, which is expected to be located directly above the front end on top of the storage ring tunnel. In addition, there will be a minimum of one HMI per beamline at the beamline stations.

The EPS provides the command and control functionality for the beamline PPS. It receives the status information of the PPS and, based on that, can operate the shutters. The PPS, in addition, can request the shutter to close and the EPS will then command the shutter to close. In the event the shutter does not close within a specified time, as determined by the PPS, the PPS will initiate an emergency shutdown (ESD) situation.

The EPS will have an EPICS interface to the control system. The EPICS interface will provide both the main control room and the beamlines a complete overview of the status of each beamline. The data from the EPICS interface will also be logged and archived by the central computing systems.

The EPICS interface to the EPS will be both read and write. The write functionality will be controlled by the EPICS Channel Access Security. This is essential, to isolate the possibility of accidental control of the wrong beamline EPS via the control system.