

SAFETY CATCHERS PROTECT SHUTTER OPERATION ON SPALLATION NEUTRON SOURCE AT OAK RIDGE

Application Note

At Oak Ridge National Laboratory (ORNL) in Tennessee, a unique solution was needed to maintain position integrity on a series of massive shutters, used to control the flow of neutrons of the Spallation Neutron Source (SNS). This neutron delivery system consists of eighteen 30T and 50T shutters, raised and lowered vertically, 20" and 30" respectively, by stainless steel hydraulic cylinders. The cylinders operate on tap water, at 2200 psi, that is continuously filtered and sterilized. The shutters lower by gravity, controlled by metered outflow controls. This operation can occur four times every hour, for approximately 5000 hours annually. The SNS is currently utilized for advanced R&D and materials development in various markets, including semiconductor, medicine and materials engineering. It will be the most intense and powerful pulsed neutron beam source in the world, when it achieves full power of 1.4MW.

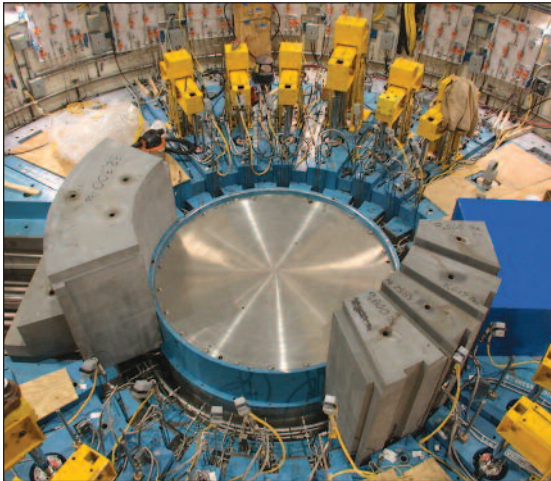


Figure 1. One of the shutter rooms on the SNS (Spallation Neutron Source) at Oak Ridge National Laboratory. Overall, a series of 30T and 50T shutters is utilized for neutron control function. Each shutter has two Sitema Safety Catchers in place.

As ORNL engineer Ken Chipley explained, "We investigated a number of solutions to solve the shutter operation challenge, working with Dave Vesco and his team at TPG Application Technology in Knoxville, a company that specializes in the engineering of remote operation and robotic systems used in radioactive and other hazardous areas. After reviewing several options for the shutter operation integrity, we decided on safety catchers for the drive rods." Each shutter drive cylinder is equipped with two Sitema Safety Catchers, supplied by Advanced Machine & Engineering Co. (AME) in Rockford, Illinois. Sitema Safety Catchers are typically utilized for equipment and personnel protection on hydraulic and pneumatic presses, as well as materials handling equipment, molding machines, automotive assembly transfer lines, even people movers and amusement park rides. In this application, the safety catchers were needed to prevent gravity fall of the shutters,

in the event of hydraulic pressure loss, cylinder failure, control valve failure or other system malfunctions.

Two specially designed hydraulic release stainless steel safety catchers are employed on each of the shutters, which raise and lower via a central hydraulic lift cylinder with twin drive rods in parallel, connected by a bridge cross beam mechanism, also manufactured by AME for this application. In the "up" or closed position, the shutter is suspended by the drive rods.

The safety catchers release with high-pressure (2200 psi) tap water, run through stainless steel hydraulic tubing, controlled by a central high-pressure pump and flow controls. Spring-loaded bases and prox switches to monitor the release and catch positions are also onboard the catchers. Because the safety catchers are recessed in solid steel shield blocks in their installation, all the hydraulic porting was specially engineered for topside access to enable easier installation and maintenance. Seals and elastomeric materials used on these safety catchers needed to be suitable for radiation exposure. All functionality test results and materials certifications were supplied to the strict requirements of ORNL.

Describing the operation of the safety catchers, AME's Fluid Power Division Business Development Manager, Ken Davis, explains, "Sitema Safety Catchers develop holding force on the rod by self-intensification, created by the load as the rod is traveling downward. Therefore, release pressure is needed to move the rod downward. Sitema Safety Catchers do not develop holding force, with or without release pressure, when the rod (load) is traveling upward. Proximity switches are used to monitor the 'catch' or 'release' function of the safety catcher. The spring base compensates for radial and angular misalignment."

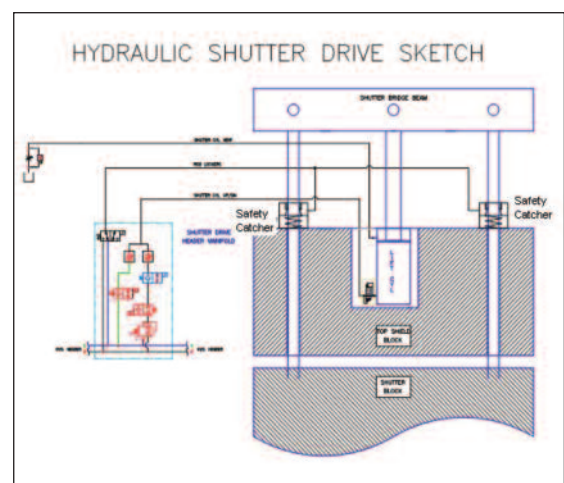


Figure 2. Schematic of hydraulic shutter operation

Should the load begin to drop for any reason when there is no hydraulic release pressure, the self-intensifying blocking mechanism in the safety catcher engages the load and secures it until the load direction is reversed and the pressure is restored. Simply restoring the release pressure will not release the load, Davis notes.

Water is used for this hydraulic system, as it's inert and not susceptible to radiation damage or pose a flammability

hazard. The tap water used here is constantly filtered and sterilized, as it runs through sanitary-grade, Schedule 80 and XXS stainless steel piping. Separate hydraulic control manifolds are present, so that each instrument operates independently. Likewise, each lift cylinder has its own leak detection system.

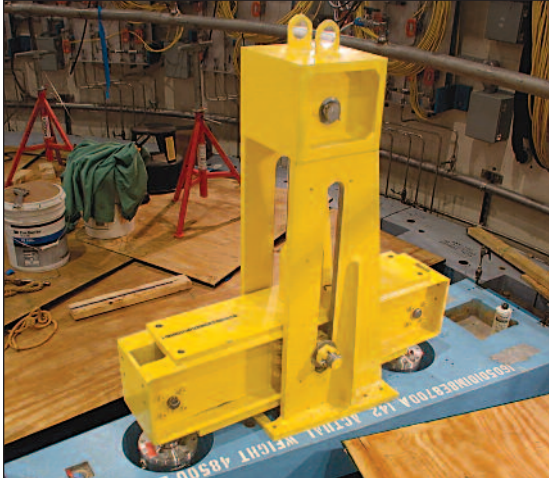


Figure 3. One of the shutter bridge cross beam mechanisms with two (2) Sitema Safety Catchers; shutter in up (closed) position; Advanced Machine & Engineering supplied the 80mm and 100mm drive rods, as well as the shutter bridge cross beam lift mechanisms and lift towers for the application.



Figure 4. View of shutter top with bridge beam removed, showing the lift cylinder (center) and Sitema Safety Catchers (left and right)

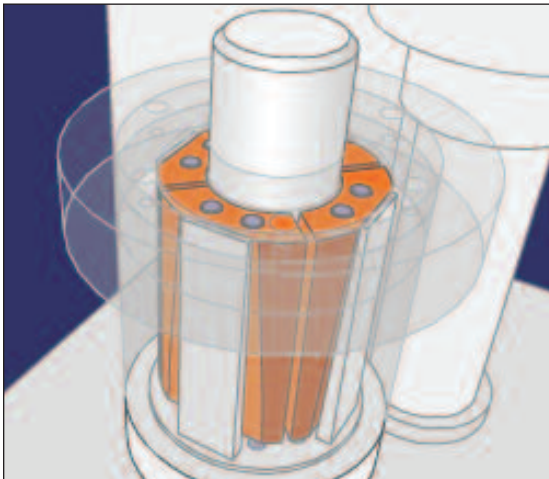


Figure 5. Sitema Safety Catcher cutaway shows basic operation; safety catcher prevents gravity fall or downward motion on loss of hydraulic pressure to maintain shutter in up (closed) position



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