International Collaboration on Advanced Neutron Sources (ICANS XXIII)

Contribution ID: **36** Type: **Oral Presentation**

Spallation Neutron Source (SNS) 2 MW Target Life Analysis

Monday 14 October 2019 10:45 (25 minutes)

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory has a Proton Power Upgrade (PPU) program underway to update the proton beam energy from 1.0 to 1.3 GeV and the power on target from 1.4MW to 2MW at the First Target Station (FTS). A critical requirement of this program is the design and operation of a 2MW target with a life of 1250 hours (4 targets per year), however, less targets per year is desirable. The approximately 40% increase in power translates to a similar increase in the pressure pulse created from the proton energy deposition into the target. The FTS target is composed of a 316L stainless-steel target mercury vessel (with liquid mercury flowing though it) and a water shroud that surrounds the mercury vessel, which is primarily for secondary containment of the mercury. The two primary failure modes for the target are erosion and/or local failure from cavitation damage and high-cycle fatigue (HCF) damage in the mercury vessel.
Several design and manufacturing techniques are used to mitigate these failure modes in the mercury vessel, such as local geometry optimization, near mirror-finish surfaces, and Kolsterising® (a manufacturing technique for increasing surface hardness of stainless steel). Nevertheless, a reduction of the loading itself is needed to achieve the 2MW target design life (or better) and this is currently aided by gas injection for 1.4 MW targets. Gas injection introduces small helium bubbles into the mercury flow to reduce the pressure pulse induced by the proton beam and to reduce cavitation. All these techniques help to improve the fatigue life of the target mercury vessel.
To assess the fatigue life of the mercury vessel, a reasonably realistic simulation of the pulse effect on the target is required. This is achieved through an explicit transient-dynamic simulation that includes the initial pressure mapped from the pulse energy deposition and a tensile failure condition to represent the cavitation behavior in the mercury. The resulting stress history is then used to perform global analysis of the parent material fatigue life or a local weld joint analysis. In this presentation, an iterative design-analysis process is described to optimize local geometry in the front of the target, as well as a sub-modeling technique used for a more intricate gas injection bubbler design, which is subjected to more pulse load than in previous targets. Furthermore, the limitations of this process are discussed along with development plans to improve target life analysis for PPU and future target designs at SNS.

Author: MACH, Justin (ORNL)

Presenter: MACH, Justin (ORNL)

Session Classification: Target

Track Classification: Target/Moderator