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Jet Flow Target Module Design, Analysis, and Testing

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The Spallation Neutron Source at the Oak Ridge National Laboratory produces neutrons by striking a target containing mercury with a pulsed proton beam. Examination of used targets shows that the innermost surface of the vessel where the proton beam strikes has a significant amount of damage due to mercury cavitation. The target also has an outer thin window flow channel which does not show significant cavitation damage. This lack of damage has two possible causes; the flow condition of the mercury and the thin width of the flow channel. Previous testing as LANSCE has also shown a link between flow condition and cavitation damage.
The target vessel design was modified to improve the flow condition on the inner surface of the vessel. A new design has been developed which diverts some of the bulk mercury flow into a wall jet which sweeps over the inner surface. Numerical simulations were used to develop a target design which balanced the jet flow and bulk mercury flow and provided a stable wall jet. The final design produces a flow condition across the inner surface of the target wall which mimics the near-wall velocity distribution in the channel where no significant damage has been found.
A test apparatus using water flowing in an acrylic vessel has been used to verify the predicted flow. Water allows for visual tracking of bubbles introduced into the flow. High speed videography of these bubbles has shown that the jet flow velocity agrees within 10% of the values predicted by simulation.

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