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Design of a Nitrogen Cooled Target Shield Pile for the LBNF Beamline

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The Long Baseline Neutrino Facility (LBNF) will utilize a beamline at Fermilab to produce a neutrino beam aimed at the Sanford Underground Research Facility in South Dakota. A primary proton beam will interact with a target to produce mesons, which will be focused by magnetic horns before decaying into neutrinos. The target and horns are contained in a chamber, which is surrounded by a shield pile made of steel, concrete, marble, and borated high-density polyethylene to protect workers and surrounding groundwater from irradiation. The shielding is cooled by nitrogen gas which is pumped through the entirety of the chamber. The nitrogen also prevents corrosion and the production of unwanted radioactive isotopes. The chamber is kept at a positive pressure to prevent the infiltration of air into the chamber. The sealing system of the chamber is composed of a leak-tight stainless steel barrier around the target chamber, a modular hatch cover system to allow access to the chamber for maintenance, sealed feedthroughs which allow cooling water, power, and instrumentation to reach the target and horns inside, and a fill/purge system. The shielding closest to the beamline components is also cooled using water-cooled panels. We discuss here the current design of the shield pile, and the cooling and sealing systems which support it, as well as the expected challenges and plans for improvement.

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