DOSE RATES PRODUCED FROM A LOSS-OF-COOLANT ACCIDENT AT THE OSTR

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GENERAL OVERVIEW

- TRIGA® reactors are small non-power reactors that make excellent research tools, which is why you can find many of them, including the Oregon State TRIGA® Reactor (OSTR), on college campuses.
- Operational nuclear reactors have unique challenges and associated risks which require robust safety systems and detailed Safety Analysis Reports (SARs).
- The potential accident to be considered is a loss-of-coolant accident (LOCA), where the inventory of water that surrounds the OSTR core is lost.
- The water not only plays an important role by keeping the reactor core from overheating, but it also attenuates most of the radiation. Were this water to be lost, gamma radiation would stream upwards from the reactor and through the roof.
- With an uncovered core, gamma radiation can scatter back down to the ground at preferential scattering angles through interactions with the oxygen atoms in air.
- Known as Skyshine, this phenomenon leads to higher exposure rates in a narrow belt at some distance away than would normally be expected which is illustrated by the red line in the graphic to the right.
- The NRC requires off-site emergency planning in cases where the doses to general public exceed 1 rem.
- This project examined whether Skyshine is a significant contributor to off-site dose to the general public during a LOCA.

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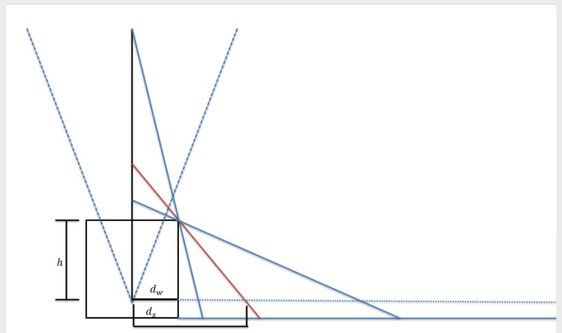
METHODOLOGY

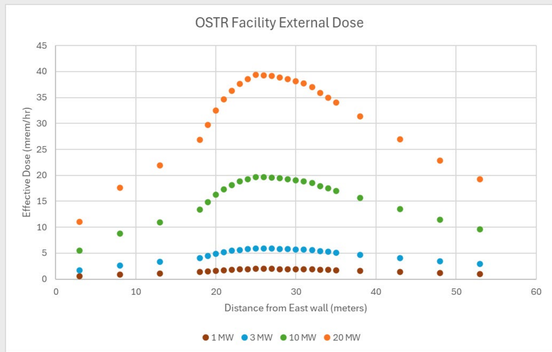
- Monte Carlo N-Particle (MCNP®) was selected as the analysis tool. It is a computer code which is used to look at the transport of radiation and is ideal for examining the Skyshine phenomenon.
- The burnup calculation simulated one year of continuous operation of the OSTR to get a realistic distribution of radionuclides after nuclear fission and decay. From the burnup calculation a list of radionuclides and their respective activities was generated which was converted into a source term to be used in the second part of the model.
- This source term is used to create a representative gamma ray spectrum for the radioactive products. MCNP® simulates the paths these gammas take and can measure the energy deposited by the gammas at our regions of interest (i.e., where Skyshine occurs).
- This energy deposition can then be converted to dose rates which are then compared against the 1 rem off-site emergency planning requirement.
- The reactor water inventory is assumed to instantly disappear, which is inline with our conservative approach to this LOCA scenario.
- The length of the accident was chosen to be 67 hours, as it represents the length of a worst case scenario where the LOCA begins at 5 pm on a Friday and operators do not return to the facility until 8am Monday, where it then takes 4 hours to recover the core with water and end the accident.



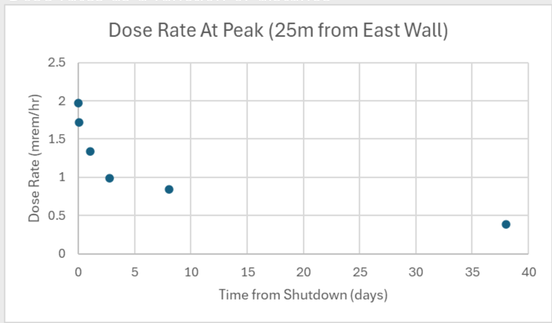
Graphic representation of Skyshine phenomenon

CALCULATIONS AND RESULTS

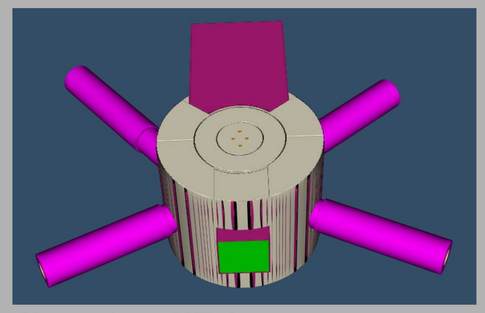
- Results of the MCNP calculations had acceptable values of error for point detector tallies.
- Shown in the graph below, the highest dose rate created by the Skyshine phenomenon is located 25 meters from the east wall of the reactor building. This corresponds to a point in the Radiation Center parking lot.
- The peak dose rate for 1MW operating power is calculated to be 1.97 mrem/hr immediately after shutdown. This rate will decrease as the fission products in the core decay.
- Dose rates at higher powers are linearly proportional, because the fission product activity is assumed to be linearly proportional to power.
- The dose received by Skyshine was calculated by integrating the dose as a function of time between the initiation and end of the accident (hour 0 to hour 67). The integrated dose is 5.5 mrem for 1 MW operating power.



Dose rates as a function of distance



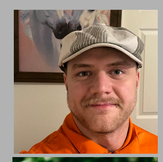
Dose rates at peak location as a function of time


3D rendering of OSTR Core

CONCLUSIONS

- The total dose received in this period for 1 MW operating power is 5.5 mrem.
- As 5.5 mrem is significantly below 1 rem, off-site emergency planning is not required as a result of Skyshine.
- The reactor power that corresponds with Skyshine producing 1 rem is approximately 178 MW. Therefore, Skyshine is likely not a significant contributor to off-site dose at the current license limit of 1.1 MW, nor at any practical increase of power (e.g., <5 MW).
- Therefore, dose received from Skyshine during a LOCA should not be a limiting factor for determining reactor power.

MEET THE TEAM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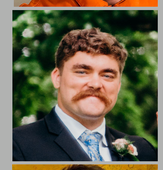
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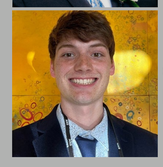
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