Purpose
In the early 1990s, UCAR fabricated a snowfall simulator that they have used to test deicing fluids for aircraft, among other applications. Ice cores are actuated by a stepper motor turning a lead screw and travel along a linear guide rail feeding it into an auger bit. This bit shaves the ice core, creating conditions that simulate snowfall. When one ice core has been exhausted, the motor controlling the carriage must be actuated in reverse back to reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, releasing system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes. The purpose of this project is to retrofit the simulator with a quick release system that allows for the user to manually unlock the carriage and quickly pull it back into the reloading position, which can take upwards of three minutes.

Preliminary Design
Customer requirements were determined, which led the rest of the design process. It was determined that the most important factors of the design is that it can be integrated directly onto the existing equipment, and uses the least amount of user input.

The existing front end of the simulator was removed and inspected Notebook sketching of the possible design. This shows the geometry decisions to overcome space constraints.

Analysis
The design was verified to ensure that the connecting rod between the clamp and the lead screw would not fail due to the supplied torque from the motor. We first visualize the force against the threaded connection as:

\[ F = \frac{2T}{d \cos \alpha} \quad \frac{2(160 \text{oz-in}) \cos(85^\circ)}{3/8 \text{in} \sin(85^\circ)} = 4.84 \text{lbf} \]

The force applied onto the threads, inducing a bending stress is:

Using Mohr’s Circle:

\[ \sigma = \frac{P}{A} = \frac{M c}{I} \]

\[ \tau = \frac{Q}{A} = \frac{T r}{J} \]

Principal Stresses:

\[ \sigma_1 = 1.93 \text{ksi} \]

\[ \sigma_2 = 0.77 \text{ksi} \]

Finite Element Analysis was used to validate the hand calculations, resulting in predictions that are within 22.6% of each other. There is an expected factor of safety of 36 for this system. Failure due to static loading, as predicted by Tresca standards are also shown below, within which the stress states exist well inside.

Most affected zone:

Max stress = 1.5 ksi

References