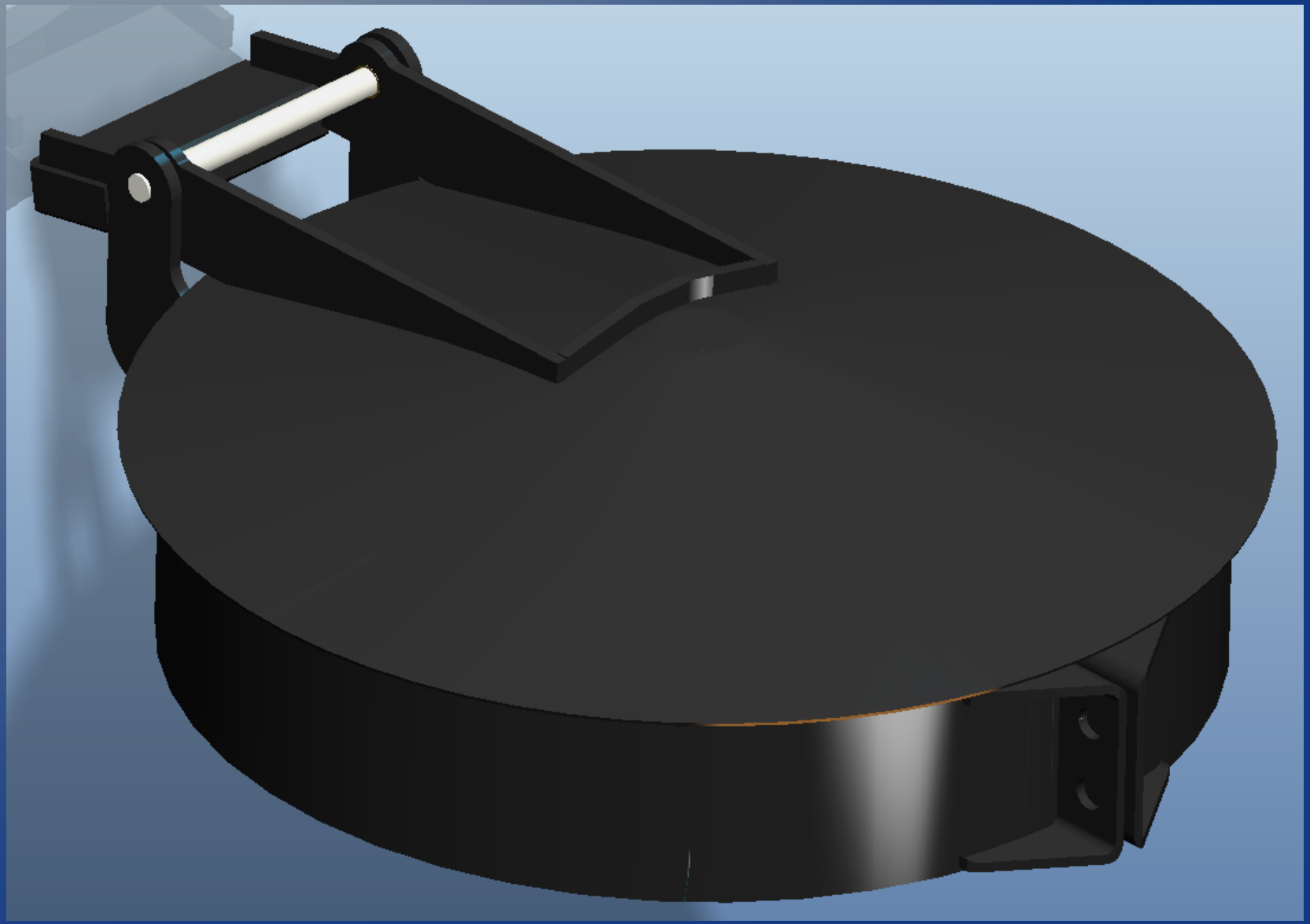
Parker Fabrication Rain Caps

Rain Cap 2.0



Desired Traits in New Rain Cap Design

- From feedback from various customers, the desired improvements to rain cap design were found to be as follows:
  - *Greater resistance to corrosion and or deformation binding that leads to the cap sticking open.*
  - *Able to withstand a larger backfire from engine without deformation that would lead to reduced function or separation from the exhaust stack.*
  - *Cap would open farther in order to not cause back-flow (eddy currents) of exhaust gasses. Gas flow would be vertical.*
  - *Smaller overall size and profile to aid in packaging and shipping*

Extensive finite element analysis has allowed the new design to optimize each individual component's weight and geometry.

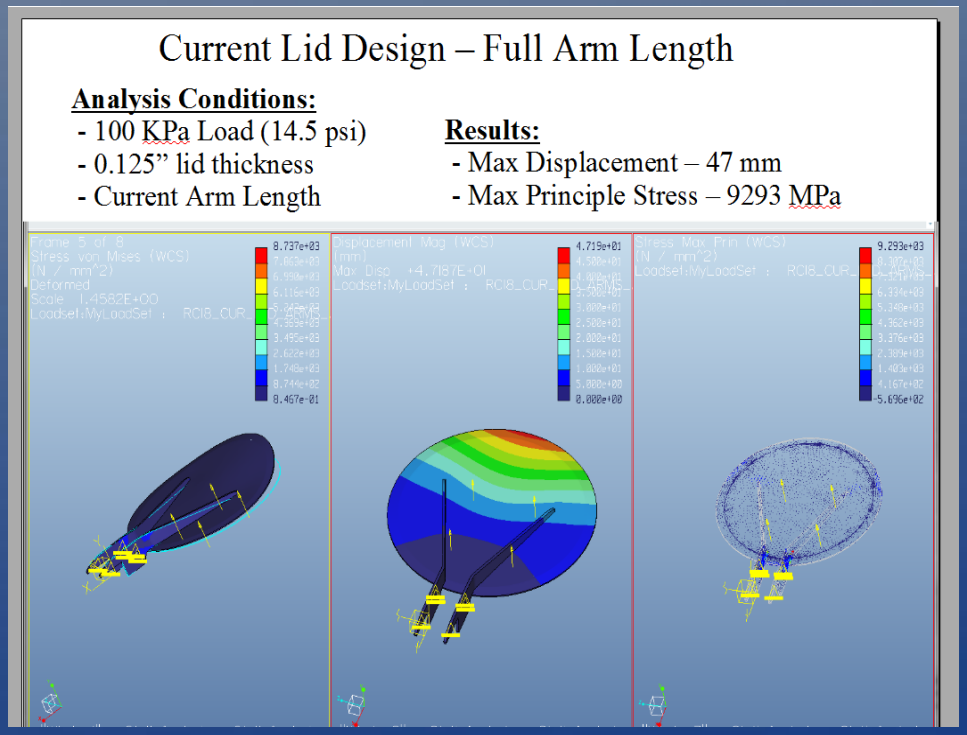
The optimization lowered the overall weight and minimized the dynamic weight (inertia) of the lid when in motion while actually increasing the strength of the complete assembly.

- ***48 % Average reduction in overall weight***
- ***42 % Average reduction in rotating inertia***
- ***All principle stress values under material yield points***

Current Lid Design – Full Arm Length

Analysis Conditions:
- 100 KPa Load (14.5 psi)
- 0.125" lid thickness
- Current Arm Length

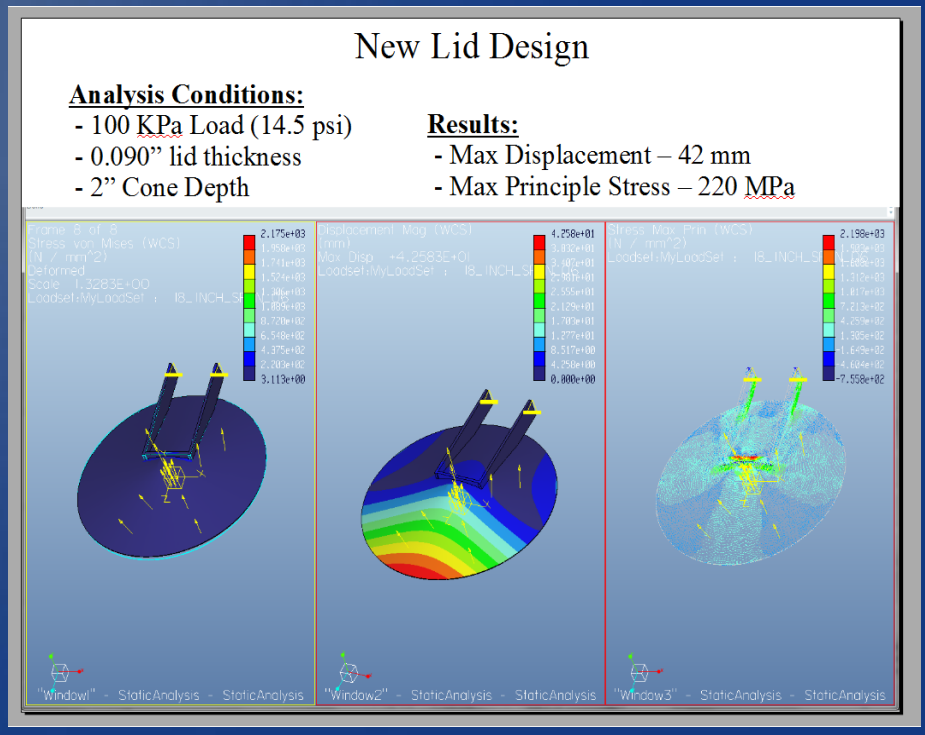
Results:
- Max Displacement – 47 mm
- Max Principle Stress – 9293 MPa



New Lid Design

Analysis Conditions:
- 100 KPa Load (14.5 psi)
- 0.090" lid thickness
- 2" Cone Depth

Results:
- Max Displacement – 42 mm
- Max Principle Stress – 220 MPa



Improved Resistance to Deformation / Separation due to Backfire

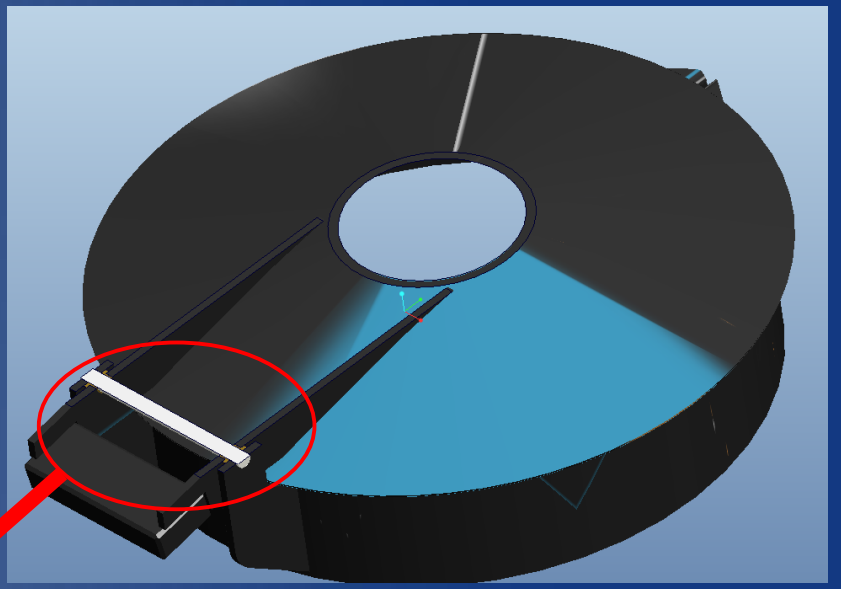
The reduction in rotating weight / inertia, greater opening angle, and the improved conical lid geometry assist in preventing deformation and/or separation during a backfire event.

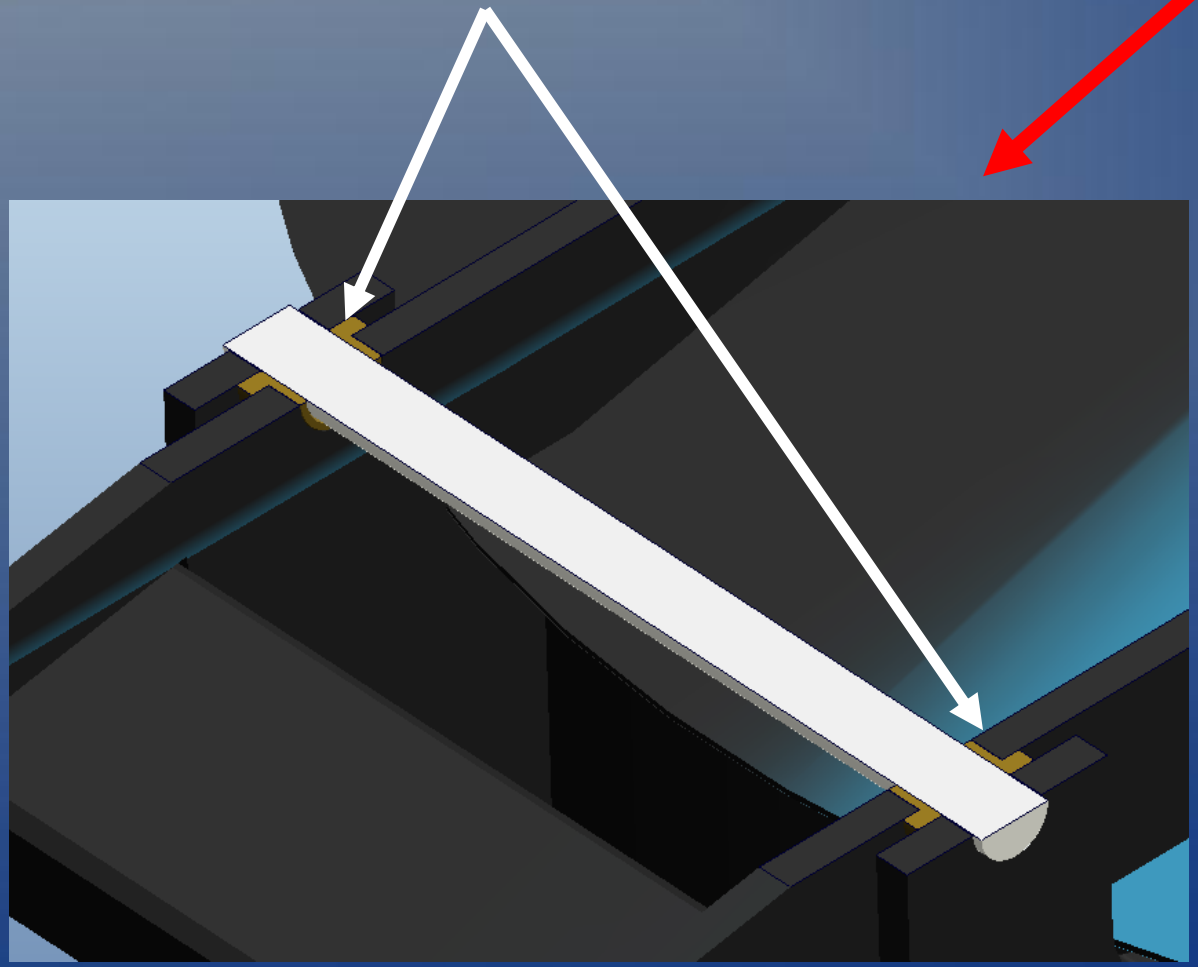
For a given backfire event force, the lower rotating inertia reduces the impact force when the lid reaches the opening stop point. The lower impact force will reduce the chance of lid deformation causing loss of function, or cap separation from the stack.

The larger opening angle also reduces the impact force at the opening stop point during a backfire event. The backfire force has less surface area to act on and a less effective force vector angle.

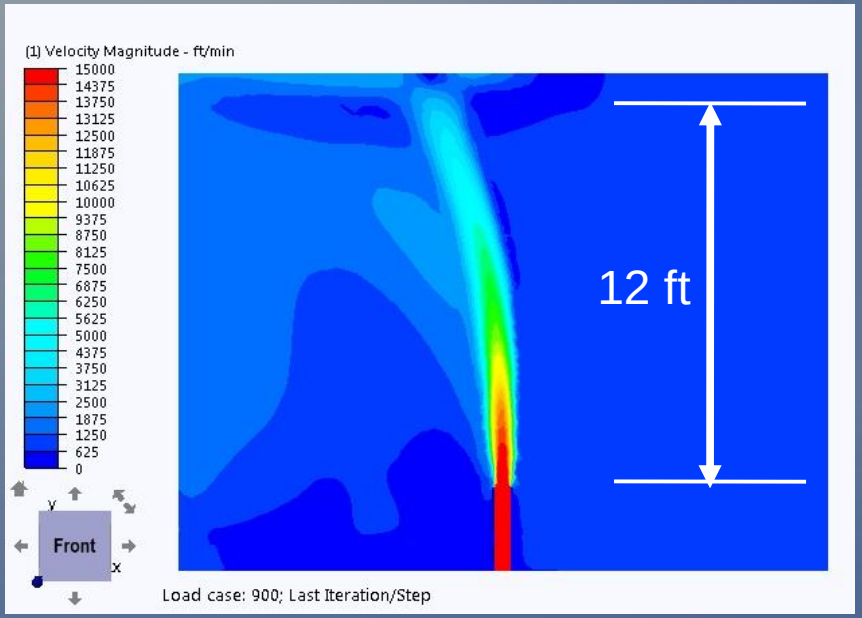
The improved conical shape of the lid over the previous flat style prevents the lid from “bending back” during a backfire event resulting in loss of function and possible engine water damage.

Parker Fabrication Rain Caps use bronze top hat bearings to absorb radial and axial loads along with a stainless steel pivot rod in order to prevent corrosion and ensure continued fluid lid motion.

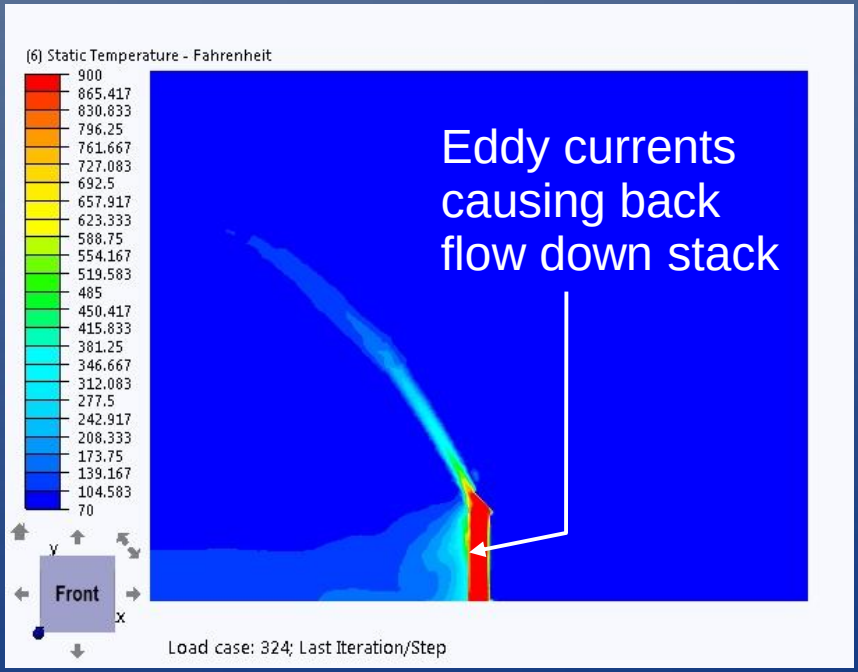




CFD Flow Analysis



The top analysis is a 5 ft long stack without a rain cap in a 10 knot wind from the right. Even in the wind, the exhaust flows straight up. This is the desired effect if the rain cap was present.

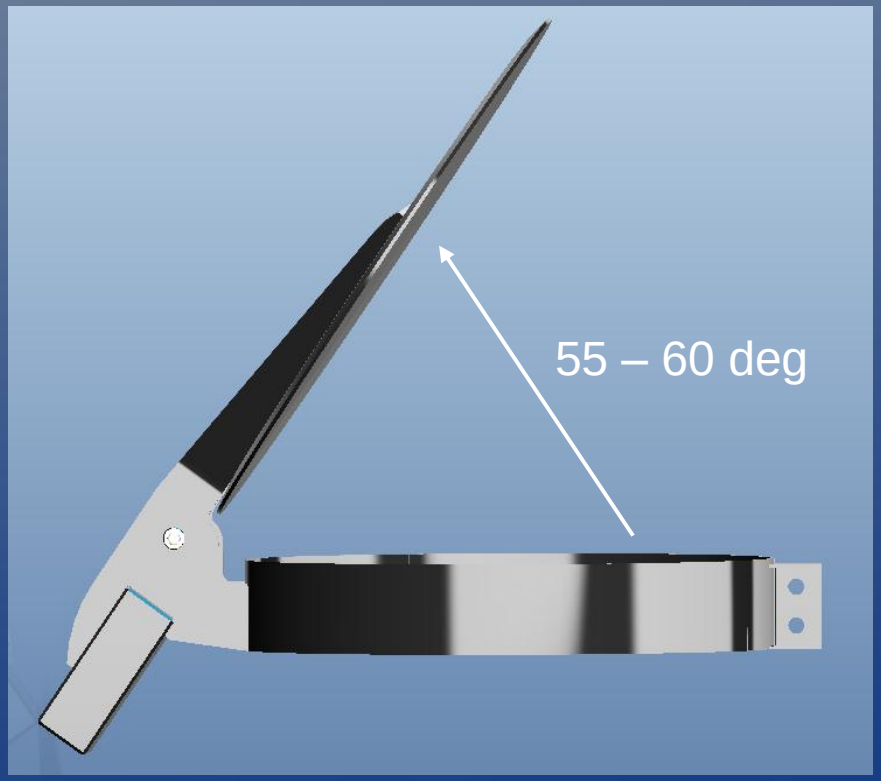


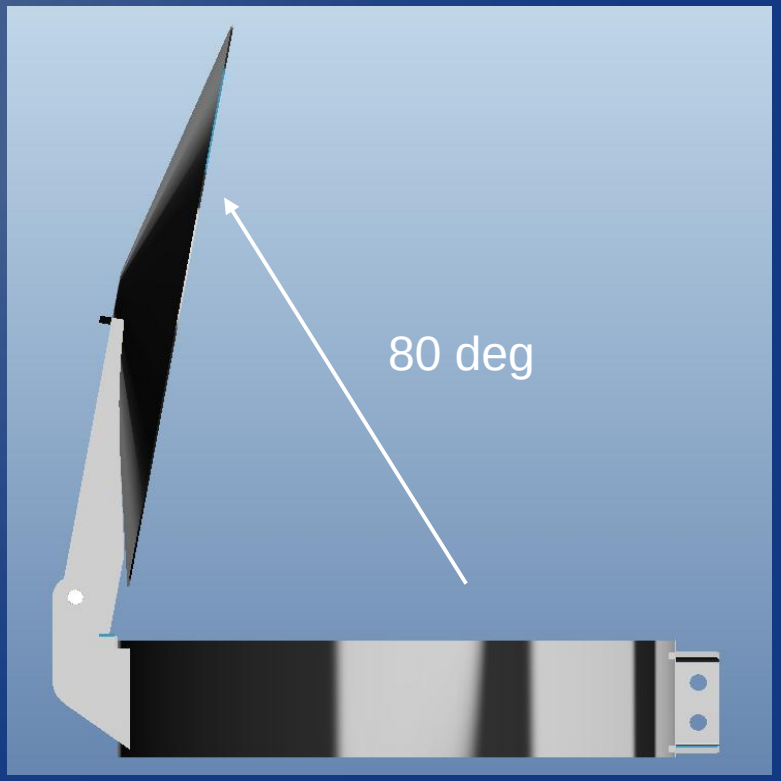
The bottom analysis is a 5 ft long stack with a rain cap at 45 deg in a 10 knot wind from the right. Note the eddy currents and back flow down the stack. This can cause exhaust fumes to cycle back to the enclosure or into ground level surrounding areas.

CFD Flow Analysis – Lid Opening Angle

The current rain cap and most competitor rain caps only open around 60 degrees. This leaves the cap obstructing ~60-70% of the stack opening thus leading to the issues shown in the previous CFD analysis.

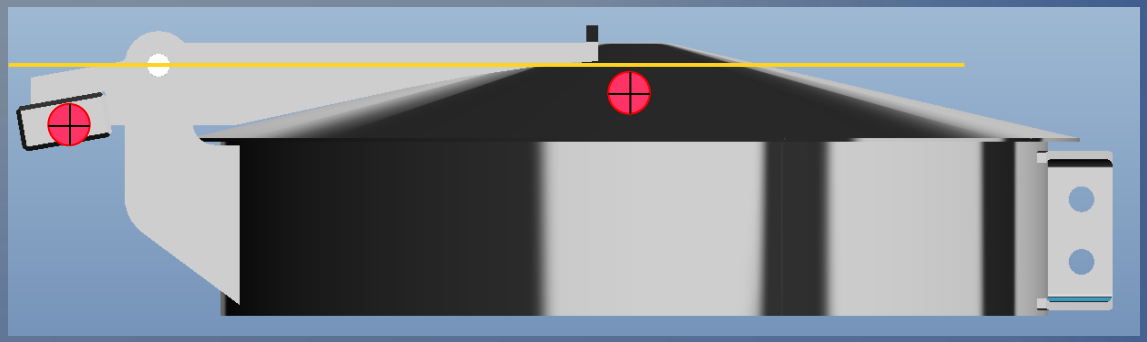
The new Parker Fabrication rain cap opens to 80 degrees. The larger opening angle allows for the lid to only obstruct ~15% or less of the stack opening, therefore alleviating the flow and back pressure issues caused by former caps.



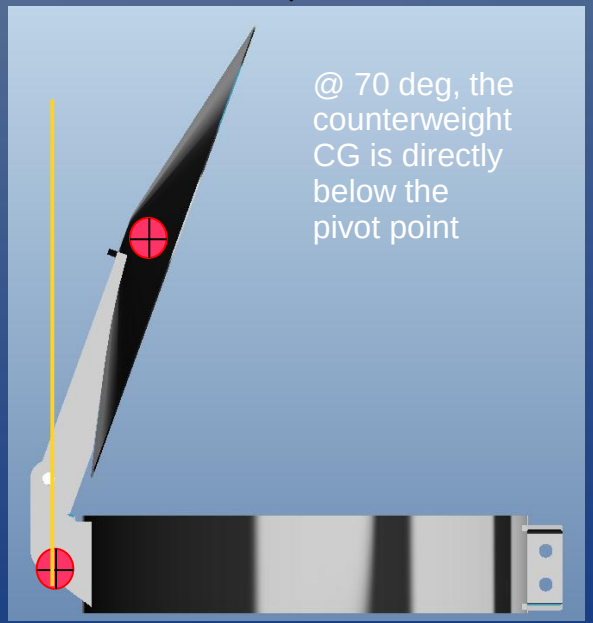


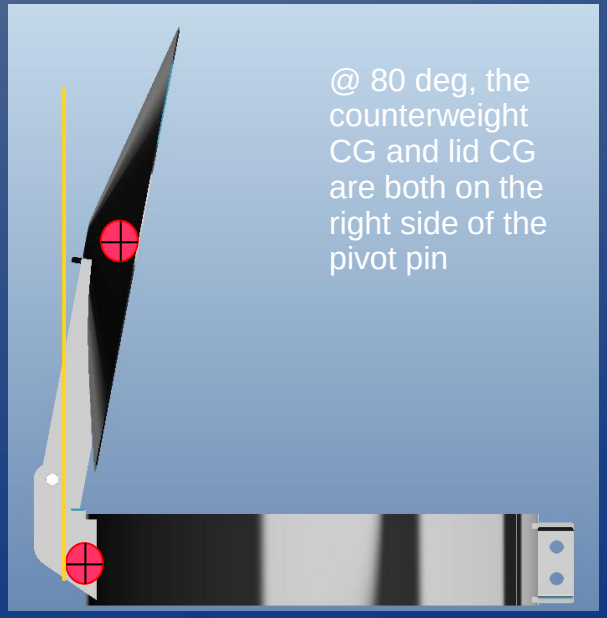
Optimized Kinematic (Pivot) Points

Improved Closing Torque



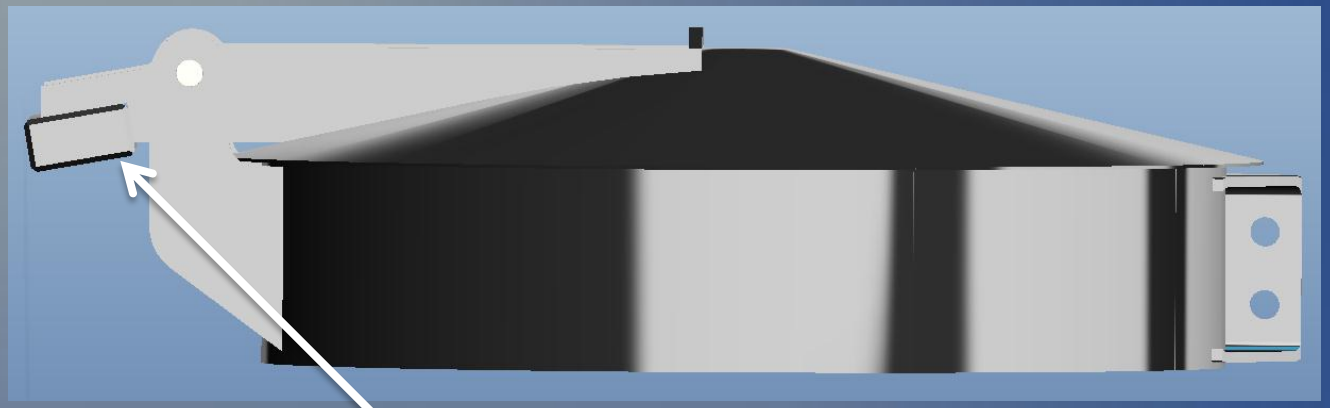
The counter weight CG and lid CG were optimized by placing them below the pivot axis instead of on the same plane as the pivot axis. With most other product, the closing force approaches zero as the lid opening angle approaches 90 deg, therefore the lids only open to a smaller angle in order to maintain a closing force.

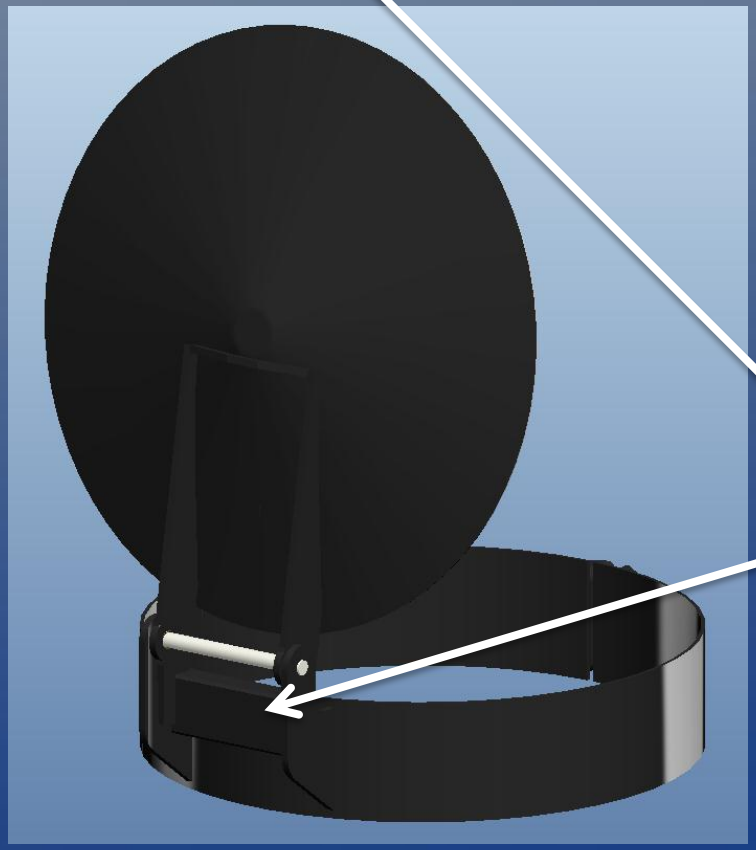




With the new design, at 70 deg, the counterweight CG is directly below the pivot axis, therefore from 70 to 80 degrees, **both the lid CG and counterweight CG work in an additive function, increasing closing force as the lid approaches 90 deg.** This allows for the greater opening angles without compromising closing force.

Improved Packaging – Small Counter Weight Packaging Envelope





Overall packaging dimensions for any rain cap are available upon request. Rain caps up to 16 inch in diameter use a 3 inch band clamp. Rain caps 18 to 24 inch use a 4 inch band clamp.

Packaging improvements include the reduction of the counter weight packing envelope. The counter weight never swings below the bottom of the band clamp, allowing for lower profile roof exhaust outlets.

Summary

- Parker Fabrication feels the new design is a significant leap forward in rain cap design, function and dependability.
    - Parker Fabrication Engineering is willing to customize rain cap features, such as customer defined “lift off / closing” pressures in order to better adapt our components to customer needs and environment.
    - Parker Fabrication Engineering will custom design rain caps to any special customer requirements.
- We appreciate any feedback on the current and new rain cap designs.

Thanks,
Parker Fabrication Engineering