NAU
NORTHERN ARIZONA UNIVERSITY
Mechanical Engineering

Honeywell Oil Chip Detector Housing

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Abstract

Honeywell tasked us, Team Honeywell, with creating a device that would be mounted onto an engine and would slow down and direct flow around an oil chip detector, which is known as an oil chip detector housing (abbreviated as OCDH). An oil chip detector is a device that input into an oil flow and they catch and measure how many metal flake debris is in an oil system. This is useful for measuring the amount of wear an engine has gone through so the user can know when engine repair needs to be performed, as well as clean the oil of metallic impurities that may harm the engine while it in use. The OCDH that Team Honeywell was asked to design would be small and weigh less than a pound but would need to be resistive to many different strenuous circumstances that are associated with oil systems and flight conditions. To accomplish the needs of our client, Honeywell, Team Honeywell designed an elbow shaped device that would slow the oil flow around the sensor by a significant amount, as to allow the oil chip detector to pick up more debris from the flow. The final device design weighs X pounds and fits within the required amount of space. To accommodate for all safety requirements of the device, it is made of 304 stainless steel, which gives the device the strength and temperature resistance required of the device. The elbow bend shape of the device slows the flow in the device down to a requested speed.

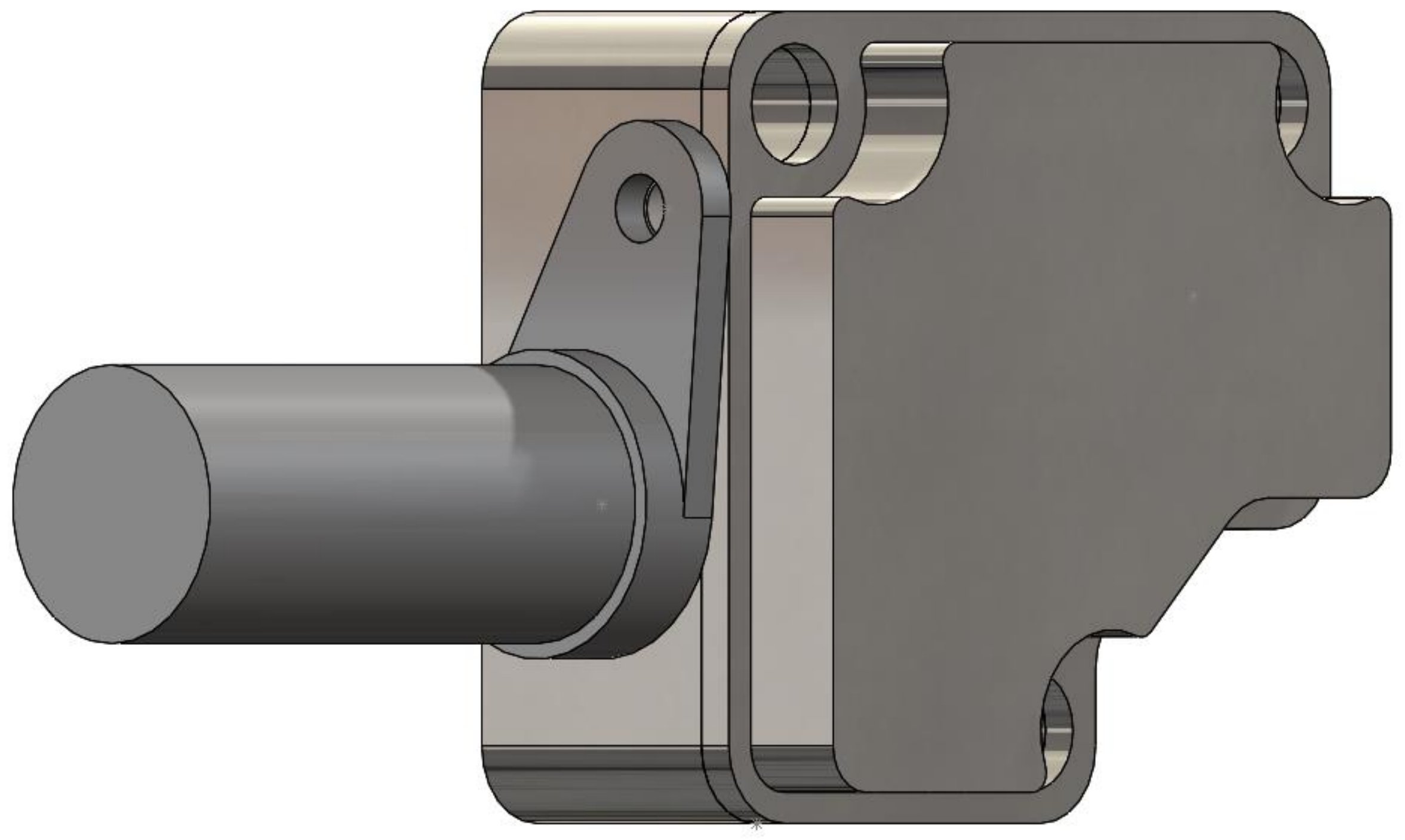
Requirements

The following are the guidelines that we were given by Honeywell to design our OCDH.

- The total weight of the device is to be under 1 lb. with a tolerance of 0.3 lbs.
- The device should be durable enough to function for the entire length of the engine's life
- The envelope size for the device is 3"x3'x2" and can be smaller, with the location of the oil chip detector being free for us to decide.
- The device must operate between altitudes between –2,000' and 55,000'.
- The device must operate under an operating pressure of 5 – 15 psig, with a tolerance of 1 psig.
- The device must operate under force loads of 2 g's, with a tolerance of 0.1.
- The device must be able to withstand a shock force of 20 g's with a tolerance of 1 g.
- The device will have an internal interface of 0.75" with a tolerance of 0.005", as to accommodate the intake and outtake line fittings.
- The device must be able to function after heat tests of 2000°F for 5 minutes with a tolerance of 5°F
- There are to be no leaks in the device.
- The device must be safe to use and install.

Final Design

Total Weight	0.99 lbs.
Expected Durability	Lifetime of Engine
Cost	$1,000
Size	2.74"x2.86"x1.5"
Sensor Interface	0.75"
Temperature Resistance	2000 °F for 5 minutes



Analysis

Fluid flow analysis was conducted using SOLIDWORKS Flow Simulator. Assuming steady, incompressible flow we expect total head loss to account for lost mechanical energy. Energy balance is represented by the modified Bernoulli equation (1).

$$\left(\frac{p_1}{\rho g}+z_1+\frac{V_1^2}{2g}\right)=\left(\frac{p_2}{\rho g}+z_2+\frac{V_2^2}{2g}\right)+h_L \qquad (1)$$

Continuity for a steady, incompressible flow is given by equation 2 where *A* represents cross-sectional area.

$$A_1V_1 = A_2V_2 = Q \qquad (2)$$

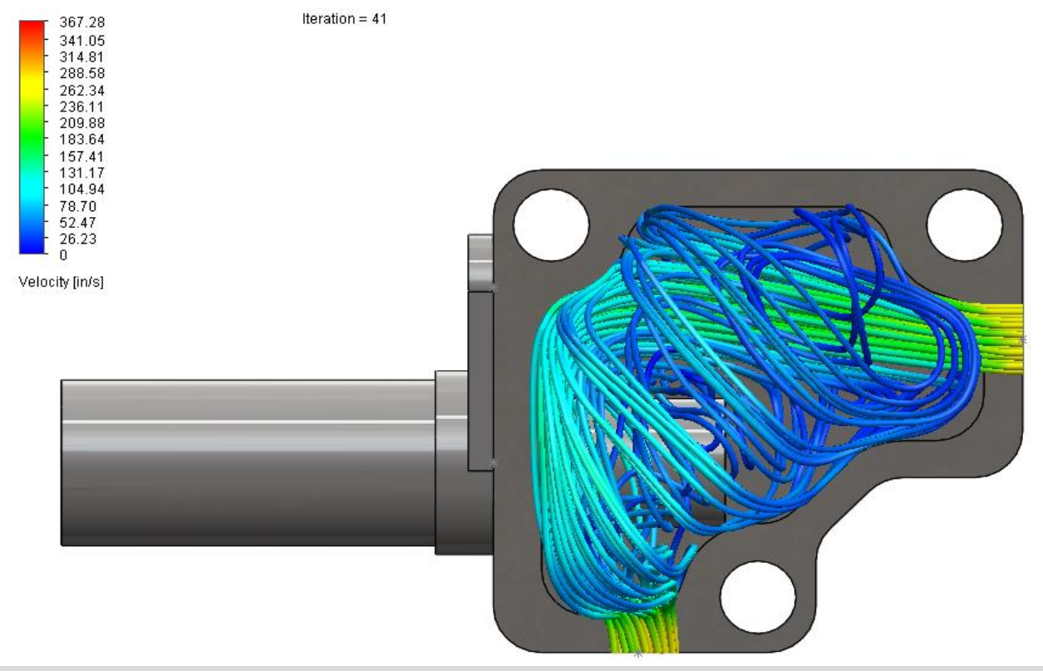
The calculation for the head loss and resulting velocity drop assume a value for the loss coefficient, *K* corresponding to a threaded long radius 90° elbow. Minor head loss, h_L is given by solving equation 3 where V_1 is the inlet velocity.

$$h_i = K_i\frac{V^2}{2g} \qquad (3)$$

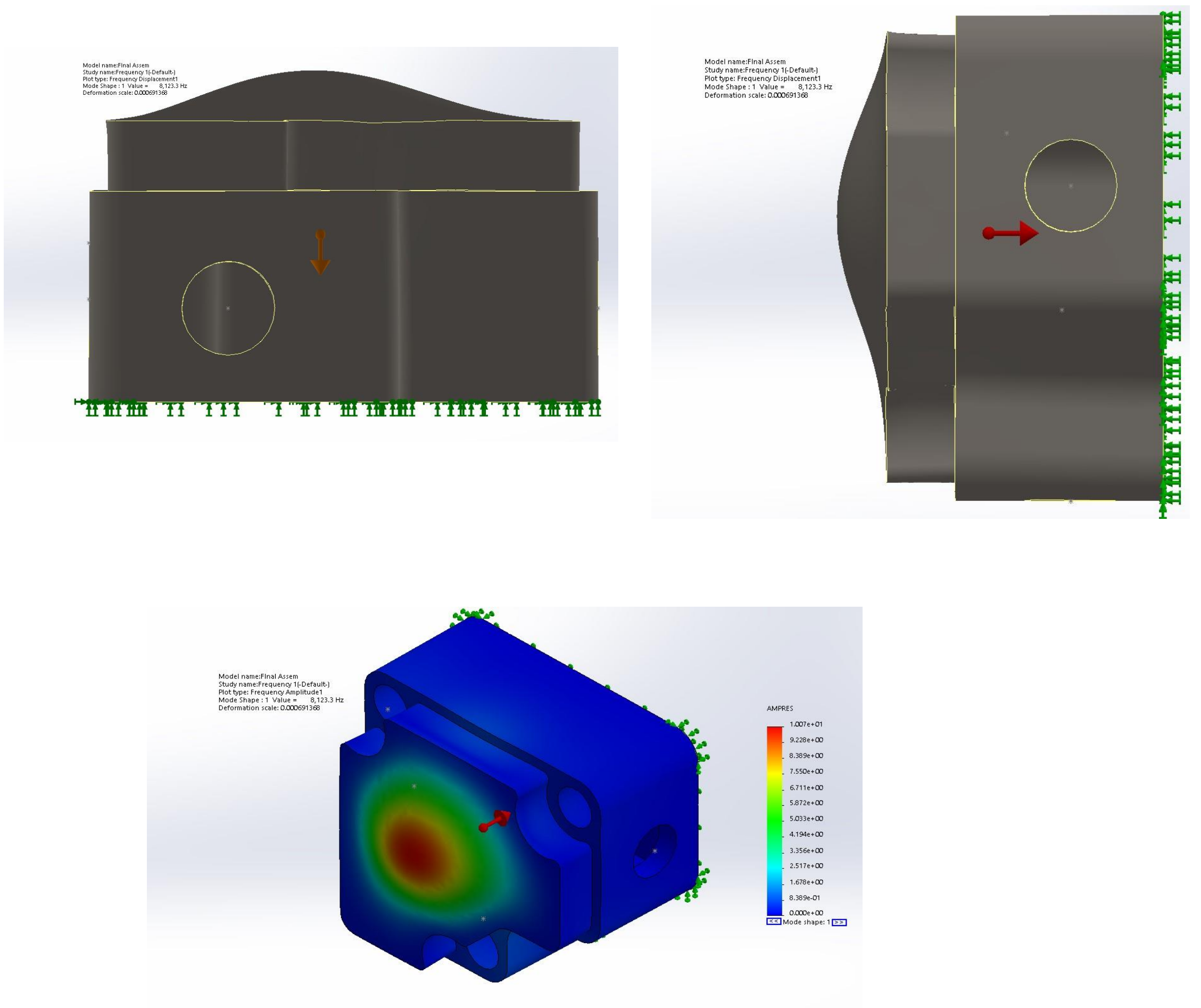
The resulting minor head loss represents the pressure difference seen below in equation 4. Using the density of the working fluid and head loss, the resulting velocity can be calculated.

$$V = \sqrt{\frac{2(p_0-p)}{\rho}} \qquad (4)$$

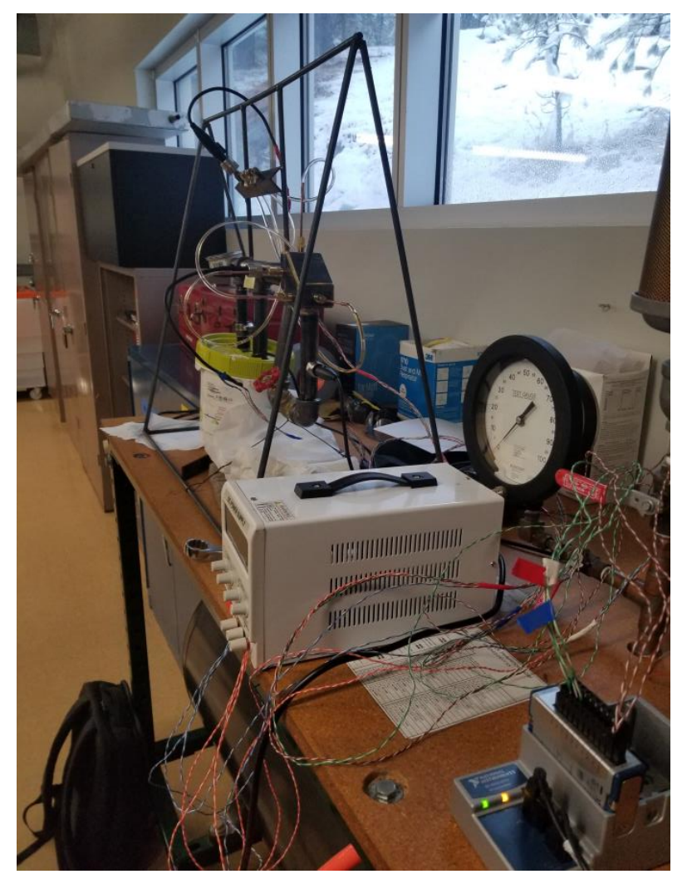
The velocity measurement V_2 reflects what is expected across the sensor surface. The figure below shows the flow profile with achievement of the target flow rate across the sensor.



Vibrational Analysis



Physical Flow Analysis/Flow Velocity Verification
Insert commentary/figures from report about the flow velocity



Testing

All testing is performed by Honeywell during their full system engine test with our device attached. The following are they tests they performed to assure the device we designed accomplishes all of their requirements.

- **Weight Test:** The device is weighed using a scale after manufacturing is complete
- **Vibration Test:** To assure that the device will work after engine use, the device is tested on a vibration table and checked after to assure that it is still in working condition
- **Envelope Size:** The device will be measure with calipers to determine that the size of the device fits in the required envelope size.
- **Operating Pressure:** Operating pressure test will be conducted using internal pressure tapping's.
- **Sensor Interface:** Calipers will be used to measure the sensor interface size.
- **Temperature Resistance:** The temperature resistance will be measured with an open flame test in which the device will be exposed to an open flame at approximately 2000°F

Acknowledgements

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[1]"Honeywell," *Honeywell*. [Online]. Available: https://www.honeywell.com/. [Accessed: 10-Sep-2019].
[2] Honeywell, "Procurement Specifications for the Oil Chip Detector Housing," Honeywell Aerospace, Phoenix, 2019.