METHOD #2

Determining what measurement equipment is required begins with understanding what variables are needed to solve for specific impulse. Starting with the basic equation for thrust,

\[ F_{\text{thrust}} = \dot{m}V_e + (p_e - p_0)A \]

we find key variables the NEO test fixture cannot currently measure such as: force \( (F_{\text{thrust}}) \), pressure \( (p_e) \), and exit velocity \( (V_e) \). Neo does have flowmeters which help determine mass flow \( (\dot{m}) \). However, mass flow measurements are inaccurate without temperature sensors nearby to help determine the proper density \( (\rho) \) of the flow.

However, unlike the basic equation for thrust, finding specific impulse only relies on accurate measurements of Force and mass flow \( (\dot{m}) \):

\[ I_p = \frac{F_{\text{thrust}}}{\dot{m}g_0} \]  

(2)

By taking mass out of the equation we need only one variable to solve for, exit velocity \( (V_e) \):

\[ I_p = \frac{V_e}{g_0} \]  

(3)

Using the installed Flowmeters, and solving for equation 2, load cells and thermocouples would be needed to find specific impulse. An axially mounted load cell need only have a range up to 7000 lbs. Also, we would need to include temperature sensors near the flowmeters. Including temperature sensors will provide us with more accurate mass flow calculation. Data logging equipment would need to be attached to the flowmeters and sensors to capture the data. Data could then be easily transferred to a graph displaying specific impulse as the dependent variable with many points of data.

METHOD #3

Using method 1 along with more equipment can provide more data that method 1, and an analytical solution for exit velocity. Knowing exit velocity allows us to use equation 3 which provides a second method to find specific impulse. Using a second equation to find specific impulse will let us double check, or use a statistical method to verify our specific impulse.

The only equipment needed for this method is a combination of the equipment from method 1, tubing, and pressure transducers. The tubing allows for the pressure transducers to be located at some distance away from the heat of the exhaust. Knowing the exit pressure \( (p_e) \) allows us to use equation 1. Solving equation 1 for exit velocity \( (V_e) \) gives us specific impulse by use of equation 3. Also, using method 1 we can solve for equation 2.

The tubing can be configured in various ways from 1 tube located in the center of the exit area, or a series of tubes placed along the radius of the exit area from the center to the outer diameter. Figure 1 shows a possible configuration.

Although, the only measurement needed will be the center pressure. The tubes may all be connected a short distance away from the plume to allow for easy replacement when damaged. However, the pressure transducers should remain and last for a normal lifespan, saving money.