Hypotheses for CMG Engine Vibration Research Analysis

**Hypothesis 1: Distinct Frequency Patterns for CMG Engine Subcomponents**

* Hypothesis Statement: The 3ms data acquisition rate of the vibration device will reveal frequency patterns when placed on the overall body versus the internal rotating module of the CMG engine, which allows a difference of specific vibration sources.
* Rationale: Each CMG subcomponent, like the rotating module, has specific mechanical characteristics that are expected to produce distinct vibration frequencies. A 3ms acquisition rate (333 Hz) enables the device to capture vibrations up to 166 Hz, which is sufficient to capture frequency differences in these components. It would be sufficient due to some factors:
  + Eye test assumptions are that expected vibrations would be 50-100hz.
  + According to Motor specifications, it runs at 3000rpm, which means the expected vibrations should be close to 60hz. Apart from that, it would be due to noise, alignment of components, etc. Misalignment would mean 1-2x of rotational frequency (60-120hz), which means that if we receive a peak of 60hz, that is primarily from the system, if it’s higher than that, that would be accounted as noise or loose parts in the system causing that.

<https://www.simscale.com/blog/vibration-in-rotating-machinery-analysis-solutions/>

* Measurement Strategy: Placing the device on both the engine body and the rotating module, then analyzing frequency peaks via FFT to identify distinct frequency signatures for each area.
* Expected Outcome: Detecting separate dominant frequencies between the body and rotating module would indicate distinct vibration contributions from each part, which would help in isolating the primary vibration source.

**Hypothesis 2: Variation in Vibration Intensity Indicates Primary Source Location**

* Hypothesis Statement: The vibration intensity will be highest near the estimated primary source of vibration within the CMG engine, enabling localization through intensity mapping at different points on the engine body and rotating module.
* Rationale: By comparing intensity readings across various points, the primary vibration source can be inferred based on the area with the highest amplitude readings.
* Data Acquisition Application: With the fast 3ms acquisition rate, the device allows detailed intensity sampling. By taking measurements at multiple points on the engine body and rotating module, we can map amplitude variations to localize the primary vibration source.
* Expected Outcome: A consistent high intensity reading in one location (such as the rotating module) would suggest it as the main source of vibration, while decreasing intensities at points further away would confirm this localization strategy.