

Questions & Answers (Set 5)

1. Magnetic susceptibility.

This has been revised, yet some inconsistencies and unsubstantiated requirements remain. For the borehole sensor, the specification is now cited as $0.3 \text{ ms}^{-2} \text{ T}^{-1}$. Yet for the vault sensor, a different, more restrictive specification is cited as $0.1 \text{ ms}^{-2} \text{ T}^{-1}$.

Both of these specifications appear to be inappropriately restrictive for the intended application. As of this writing, the only formally published studies on magnetic susceptibility are a series of papers by Forbriger, including the most recent Forbriger, et al., 2010, *GJI*, (183), pp. 303-312. In this paper, Forbriger concludes (highlights are mine):

"Noise induced by the permanently present magnetic field background variations can exceed the NLNM in the normal-mode band (between 0.3 and 3 mHz) for instruments with sensitivity to magnetic field being larger than 0.2 and $0.5 \text{ ms}^{-2} \text{ T}^{-1}$ to the horizontal and vertical components of the magnetic field, respectively. The actual sensitivity of modern broad-band seismometers to magnetic field varies from individual sensor to sensor and can exceed these limits. It is thus crucial to find appropriate means to ensure a low sensitivity to magnetic fields when designing and installing high- resolution broad-band seismometers for the observation of normal modes."

In other words, for an application well beyond the intended capability of the general-purpose broadband sensors sought under this RFP, which are not suitable for measurements at the level of the NLNM in the normal-mode band (the specification does not require resolution of the levels of the NLNM at frequencies below 10mHz, which is above the normal mode band), a specification on magnetic susceptibility is requested that would exceed even the level cited by Forbriger for a much more demanding application. The magnetic susceptibility specifications in the RFP for both the borehole and vault sensors therefore appear inconsistent and unsubstantiated. A more appropriate value might be in the range of $<1.0 \text{ ms}^{-2} \text{ T}^{-1}$.

Answer: For both sensors, the requirement can be relaxed to $0.5 \text{ m} / \text{sec}^2 - \text{T}$. The $0.3 \text{ m} / \text{sec}^2 - \text{T}$ value is considered typical from measurements of magnetic sensitivity of existing vault type sensors at ASL, STS-2 and T240. The requirement is aimed at reducing magnetic interference in confined spaces due to changes in DC currents, not natural magnetic variability, which may be more extreme in the arctic. While evidence of magnetic pulses affecting STS-2 are known (e.g. Stuttgart railway), more common are pulses on T240 sensors due to TA equipment like Baler14 cycling at 12V 0.5A and battery switching devices. We expect the location of the posthole sensor far from such electronics would make it less prone to interference, but would prefer to maintain a performance similar to existing BB vault sensors as possible.

2. The power consumption specification for the borehole sensor was revised, although the vault sensor remains at <2W. Is that intentional, or should the vault sensor spec also be revised?

Answer: The vault sensor should also be revised.

3. The "Offset of Seismic Signal vs. Temperature" spec has been discussed in the Q&A. In known velocity broadband sensors, the offset of the seismic output signal does not vary with a change in temperature, once the sensor's thermal and electrical transient response has decayed. Any static Offset appears at a separate output from the sensor, the "boom position" output, not the "Seismic Signal" output. This spec should relate not to the "Offset of Seismic Signal.." but the "Offset of the Boom Position Signal", if indeed, the particular sensor supports such a signal. As it is written, the specification achieves no purpose, since the "Offset of Seismic Signal vs. Temperature" after equilibration is, by design, near zero in known sensors. The "Offset of the Seismic Signal" may vary as the time derivative of temperature. That is a separate specification which I believe is not the intent. I believe the intent is that the boom position should not reach more than 10% of its maximum range for a 1 degree change in temperature. The stated specification does not embody that requirement.

Answer: IRIS has attempted to indicate that the mass position should remain onscale for temperature variations of +/-10C, in two places for each sensor.

4. The "Total Harmonic Distortion (THD)" measurement conditions are not specified. Define, omit, or allow bidder to specify test conditions.

Answer: Bidder may describe the test conditions and results.

5. The RFI susceptibility specification states "no easy spec". Clarify or omit.

Answer: Interested vendors may describe the test conditions and results.