Annexure 2: Responses to vendor clarifications

Section 1: Technical clarifications

At the pre-bid meeting organized to clarify the concerns of the vendors on April 1 2016, two major clarifications were requested: (1) regarding the need for a 64-channel coil over a 32-channel coil, and (2) regarding the need for simultaneously high gradient strength and slew rates. After deliberating upon the concerns raised by the vendors the committee decided not to change these specifications for the reasons outlined below.

Rationale for 64 versus 32 channel coils

MRI technology now allows for head-neck coils containing as many as 64 channels compared to 32 channels available previously. This has two-fold advantages:

1) **Accelerated imaging**. The larger number of head-neck channels also permits parallel and multiband acquisition by simultaneous excitation of multiple brain slices. The higher coil density and multiband acquisition can be used to image the brain at higher spatial resolution, or significantly reduce scan time, with an acceleration factors of up to 8x for functional MRI and 3x for diffusion MRI. This can be crucial to get viable imaging data in older subjects and patients with neurological disorders who cannot stay in the scanner for extended periods.
2) **Enhanced signal quality**. Both simulation and experimental studies have shown that increasing the density of array elements can increase the signal-to-noise ratio (SNR) at the periphery (e.g. imaging the cortex; Wiesinger et al, 2005; Wiggins et al, 2009). A recent study which directly compared a 64 channel head-neck coil configuration with a 32 channel coil configuration found a 1.3 fold more SNR in the brain cortex (Kiel et al, 2013). The advantages in signal quality were even more apparent during accelerated imaging: During 4x accelerated imaging with the 64 channel coil SNR in the brain cortex was 1.4 fold compared to the 32 channel coil.

Taken together these factors indicate a significant advantage for greater coil density in a 64 channel compared to a 32 channel MR coil.

Rationale for simultaneously high gradient strengths and slew rates

MRI technology now permits large magnetic gradients of 80 mT/m simultaneously with fast changes (known as slew rate) of 200 T/m/s. This is almost a doubling of the current 3T MRI standard gradient of 40 mT/m. The ability to achieve high gradient strength and high slew rate simultaneously again provides two key advantages:

1) **Enhanced SNR for functional MRI.** It permits much higher signal-to-noise ratios (SNR) than previously possible. The faster slew rates, concomitantly with high gradient strengths, are crucial for enhanced

quality of EPI images, especially for high-resolution imaging (Ugurbil et al, 2013). This in turn has a direct impact in our ability to read out fine-grained functional signals from the brain, to understand brain function as well as for early detection of neurological disorders.

2) **Enhanced SNR for diffusion MRI.** Diffusion imaging is a recent technology that allows non-invasive measurement of anatomical connections between brain regions in humans. High gradient strengths and faster slew rates are beneficial for diffusion MRI, as they permit reducing the diffusion encoding period and the echo time (TE), thereby enhancing SNR (Sotiropoulos et al, 2013). The state-of-the-art high gradient strength and slew rates improves SNR by as much as 40% compared to a conventional 3T MRI (Ugurbil et al, 2013). In addition, it is now possible to trace diffusion signals along 512 directions compared to the 128/256 directions previously possible. This has a direct impact in terms of imaging brain connections at extremely high resolution.

Taken together, high gradient strength (G_{max}) as well as faster slew rates are needed for optimal neuroimaging (Ugurbil et al, 2013). This confers a distinct advantage for scanners with these specifications.

References

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Section 2: Miscellaneous Clarifications

The following miscellaneous clarifications were answered at the meeting and are summarized below.

- MRI building costs must be quoted separately but will be part of the evaluation of the commercial bid.
- Imaging phantoms must include the standard set as well as the MAGPHAN phantom. Diffusion phantoms are not required.
- The PACS system must have a minimum capacity to archive one full year of imaging data, i.e. at least 10 TB.
- The vendor is expected to cover all necessary certifications required for the building.
- The vendor should quote the price both in USD and INR.
- **The vendors were informed that no deadline extension will be given for the last date for submitting the tender.**