General Description of the Ray Westphal Neuroimaging Lab

January 2018

The purpose of this memo is to provide a concise description of the imaging research facility created for DOPS by Cedar Creek Institute (CCI), its sister non-profit research institute.

CCI purchased all of the available commercial space, approximately 5000 square feet *in toto*, in a mixed-use commercial/residential building construction of which was completed early in 2008. The building is of Class A concrete-and-steel construction with 4" concrete slab flooring. DOPS occupies portions of the first two floors as shown in the attached plans, and worked with CCI to develop the interior build-out design.

The neuroimaging lab occupies about ¼ of the total DOPS space and has components on both floors. The main lab occupies the entire south (bottom) end of the first floor, but it is also linked by pre-installed optic fiber to a satellite experimental room located in the northeast (upper right) corner of the second floor. These experimental areas are separated by approximately sixty feet, five walls, and a floor. They are located in separate building units, each of which has its own electrical supply, HVAC system and meter, and they share no HVAC ductwork. The first-floor ceilings are drywall (not "drop"), and the small overhead common space between floors does not cross the public hallway separating the units on the north and south sides. Unit-separation (exterior) walls throughout the building were built to the UL Des U453 standard, with an expected sound transmission class (STC) rating of about 59. The interior walls of the experimental areas were constructed using conventional 5/8" drywall on resilient channel on the exterior side, and QuietRock 525 from Quiet Solution (Sunnyvale, CA) on the interior side. One sheet of the QuietRock is acoustically equivalent to an 8-sheet thickness of conventional drywall. All sheetrock was hung on staggered rows of 3 5/8" steel studs packed with mineral wool fiber sound-batting, and all gaps at the floor, ceiling, and seams were carefully caulked with acoustic sealant (QuietSeal). Ceilings were also constructed using QuietRock (overlaid with fiberglass insulation), and all seams were again carefully sound-caulked. The upstairs area floor is carpeted, with Durolay Treadmore flat rubber particle underlayment, and in the downstairs lab area the slab is covered with marmoleum glued to United Process Jumpax underlayment; these underlayment materials were selected specifically for their capacity to reduce transmission of sound and vibration.

The upstairs experimental room has no windows, as shown in the floor plans, and its solid-core wooden door, which is acoustically sealed (Acoustical Solutions doorseal kit #485-2), opens into an occupied office. Inside the main lab area on the first floor is a 4200-pound electromagnetically shielded and acoustically quiet experimental chamber (Lindgren Doubly Electrically Isolated 24 ounce copper/22 gauge galvanized steel with Armstrong SoundSoak 85 interior paneling, 10' X 10' X 8'), where physiological recording will normally take place. The chamber floor is carpeted, with Treadmore underlayment. Interior lighting is provided by a 12V DC power supply, and no AC-powered devices are permitted within the room. A dedicated electrical ground, completely separate from the main building ground, is provided by two half-inch braided cables bolted to the ground-stud provided with the enclosure; these run together through PVC conduit to the nearest available outside point, and terminate approximately 35 feet from the stud on a 10-foot copper ground rod buried in a planter bed directly below the southeast side of the lab area. Ventilation and temperature control have been secured by passively coupling to the laboratory's dedicated HVAC system via twin shielded waveguide air-vents (12" X 12") built into the enclosure, one of which is fed directly by an overhead outlet. Fans located outside these vents provide additional air circulation and masking noise as needed.

The experimental areas were deliberately designed and built, as described, with the intention of excluding any realistic possibility of inadvertent or deliberate compromise of experimental results by transmission of sound and vibration between the upstairs and downstairs components of the lab. Although informal tests of our own appeared to confirm that we had achieved this, we decided, in light of the extreme lengths to which some critics have gone in raising issues of this sort (notably Wiseman, Smith, & Kornbrot, 1996), that it would be wise to have a detailed and systematic evaluation carried out by an independent contractor, using industry-standard test procedures and equipment. This was done by Gary Ehrlich of Hush Acoustics LLC in Falls Church, Virginia: The main tests used twin loudspeakers to generate unbearably loud wide-spectrum pink noise in a "source" area while measuring sound levels between 6.3 Hz and 20000 Hz in a "receive" area, and comparing the latter against background or ambient sound levels measured at that location. Note that this procedure takes account of all airborne and structure-borne sound-transmission paths – including both direct and indirect (flanking) paths – in the space *as built*. All combinations of the upstairs and downstairs experimental areas were tested in this manner, and in both directions. The main result is that neither these test sounds themselves, nor pistol shots, nor heavy banging on the walls or floor of the upstairs room produced any humanly detectable sounds or vibrations downstairs. Between-area noise reductions of 80-95 dB were found uniformly over the range 80 Hz -10000 Hz, which spans the normal range of human vocalizations (see attached figure from Hush Acoustics). Acoustic-leakage scenarios of the sort proposed by Wiseman et al. (1996) – and see also Dalton et al. (1996) – are therefore not credibly applicable to this facility. The full 22-page technical report is available by request from the laboratory.

The expected electromagnetic shielding performance of the experimental chamber, shown in the left middle panel of the attached manufacturer-supplied specifications, far exceeds the (TEMPEST) requirements for Sensitive Compartmented Information Facilities (SCIFs) as set forth by the Director of the Central Intelligence Agency in DCID 6/9 issued November 18, 2002. Shielding effectiveness against ambient electrical and magnetic fields is advertised by the manufacturer, based on extensive and costly testing, to exceed 100 dB between approximately 20 KHz and 10 GHz, a range which covers all relevant sources such as cell and satellite phones, radios, and electromagnetic emissions from computers and video monitors. The shielding effectiveness of our own chamber was verified on-site, following its assembly, to be over 100 dB at 1GHz, as shown by direct testing in accordance with MIL STD-285 (see attached certificate). This one-point shielding test is a standard industry practice which reliably assures that the enclosure was properly assembled, leaving no gaps or seams, and will function at or above its rated performance as shown in the diagram. No cell phone has ever worked inside the room once the shielded door was secured.

Our main physiological experiments will be carried out using a high-quality commercial EEG data-acquisition system (Biosemi Active Two), which can support simultaneous acquisition of up to 128 channels of scalp EEG data, plus EKG (heart), EMG (muscle), and EOG (eye-movement) signals, plus a variety of standard autonomic signals such as respiration, skin temperature, peripheral blood flow and skin conductance. Analog outputs from up to 24 additional devices external to the subject, including for example specialized instruments such as PK and magnetic field detectors, can be sent to an Auxiliary Input Box (AIB) and sampled in strict synchrony with the physiological data. The main components of the Biosemi system itself are shown in the accompanying "Active Two Connection Diagram", and the specific manner in which these components are distributed between the subject area inside the shielded room and the experimenter's area outside, and their overall pattern of interconnection, are shown in the attached "Basic Layout" diagram. Secure digital communications between the upstairs and downstairs lab areas are provided by three ST-ST Multimode Duplex 62.5/125 fiber-optic cables housed in pre-installed 1" conduit.

Real-time programming in a Windows environment is notoriously difficult, because uncontrollable background activities can intervene for surprisingly long and variable times between a program's call for display of a stimulus, for example, and the actual occurrence of that event. We have therefore paid special attention to securing correct timing information for such events. Stimulus displays on the downstairs and upstairs monitors, for example, are sensed in real time by photosensors mounted on the monitors, and the sensors report that information to the Biosemi computer via dedicated channels of the AIB. Subject-initiated events such as a mouse-press are treated in parallel fashion by providing a hardwired pulse from the mouse to another dedicated channel of the AIB. Specialized preprocessing software then uses the information in the dedicated AIB channels to establish relatively exact timing (within plus or minus half a sampling interval) for events of the indicated types, coordinating this with XML-based files, generated by the Experiment Computer, which contain comprehensive descriptors of trial-by-trial experimental events and conditions relevant to analysis.

Additional EEG data-collection hardware includes a laptop-based and fully portable 64-channel EEG data-acquisition system (designed and built by Dr. Ross Dunseath, an electrical engineer and co-director of the lab), which is suitable for both field and laboratory investigations, and a 64-channel prototype of a novel fMRI-compatible EEG system (also developed by Dr. Dunseath), which removes nearly all scanner-generated RF and gradient-switching artifact at the source, *before* it can corrupt the recorded EEG.

We have recently become interested in exploring the utility of a rapidly emerging and complementary neuroimaging modality called functional near-infrared optical imaging (fNIRS). Whereas scalp EEG directly reflects large-scale properties of the underlying neuroelectrical activity itself, fNIRS depends on the hemodynamic consequences of that activity: Specifically, by sending near-infrared light through the skull at frequencies selectively absorbed by oxygenated vs. deoxygenated hemoglobin, fNIRS provides direct spectroscopic measures of the amount and oxygenation status of blood in underlying cortical tissue. In this way it provides information closely parallel to that provided by the currently dominant BOLD (blood oxygenation level dependent) functional magnetic resonance imaging (fMRI) technology, but it does so in a far more subject-friendly, EEG-compatible, and cost-effective way. To support our initial explorations we have recently acquired an NIRScout fNIRS system manufactured by NIRx Medical Technologies, LLC. This is an entry-level version of state-of-the-art fNIRS technology, with 8 LED sources and 8 detectors (expandable to 16 sources and 24 detectors), and is designed specifically to run concurrently with our Biosemi EEG hardware.

Careful attention has been paid to sources of randomness for selection of ESP targets, control of visual displays in PK experiments, construction of non-parametric statistical tests based on randomization and permutation methods, and other routine laboratory tasks. We are currently using an updated version of the Mersenne Twister algorithm of Matsumoto and Nishimura (1998) for generation of pseudo-random numbers, and the ALEA I, marketed by Araneus in Finland (www.araneus.fi), for a true hardware RNG; both are claimed by their developers to pass Marsaglia's Diehard battery of randomness tests, and we have verified this directly in our laboratory (http://www.stat.fsu.edu/pub/diehard).

Most data-analysis takes place in the computational area located west of the downstairs experimental facility, which currently houses four large desktop PCs (Dell T1700 with Xenon E3_1220 CPU and 32 GB RAM, HP EliteDesk 800 G2 with Intel Core i5-6600 CPU and 32 GB RAM, and two Dell OptiPlex 755 Smart Minitowers with Intel Core Duo CPUs). All four computers run with 64-bit Windows operating systems and dual 20" to 30" monitors driven by 256MB Radeon video cards, and have shared access to mass storage 8TB backup hard drives in addition to local SSD drives and 1-2 TB hard drives for convenient exchange and storage of our enormous (typically GB-range) datasets and associated analysis files. Currently available software resources for data management and analysis are summarized in the attached diagram of RWNL Data Processing Paths. These include an extensive package of routines developed over many years by ourselves (FILMAN) for display, editing, signal-processing, and statistical analysis (using SYSTAT) of multichannel physiological datasets, supplemented by the Data Editor module of the EMSE Suite (from Source Signal Imaging Inc.), and CURRY (from Neuroscan), which is one of the premier tools for subject-specific EEG source modeling. Finally, and importantly, we have recently added routines for exporting raw data in our internal format to an open-source Matlab-based EEG analysis platform (EEGLAB) that has become a *de facto* standard for many kinds of EEG processing including artifact detection and removal, plus routines for exporting preprocessed data in EEGLAB format back into FILMAN for further analysis.

The central strategy of our research program is to carry out extended longitudinal studies with individuals highly selected for unusual capacity to produce psi phenomena on demand under controlled laboratory conditions, and/or the capacity to voluntarily enter unusual states of consciousness such as mediumistic trance, out-of-body (OBE) states, deep hypnosis, and deep meditation that are known to be psi-conducive (Kelly & Locke, 2009/1981). Individual human brains, however, are surprisingly variable both structurally and functionally, and accurate knowledge of the electrode positions on a given subject's head, which we can obtain using a Polhemus Patriot 3-D digitizer, enables us to do two very important things in support of this central strategy: First, we can calculate the Surface Laplacian (SL) - the second spatial derivative of the raw scalp potential distribution - in a way that improves its accuracy by taking into account the widely varying shapes of individual human heads. The SL transform eliminates the effects of reference electrodes and sharply enhances EEG spatial resolution, emphasizing focal cortical sources at the expense of deeper or more widely distributed ones (Kayser & Tenke, 2015). Moreover, it has recently been shown to be uniquely capable of cleanly removing EMG (muscle) artifact from midline EEG recordings, even in the presence of severe jaw-clenching and the like (Fitzgibbon, Lewis & Powers, 2013). The latter is especially important for us in that it assures essentially artifact-free access to a midline brain system – the default-mode network or DMN – that has recently been identified as playing a crucial role in altered states of consciousness of many kinds including those central to the work of our laboratory (Kelly & Presti, 2015). Second, by measuring electrode locations precisely and then forcing candidate electrical sources inside the brain to occupy only locations and orientations that are compatible with each subject's unique cortical geometry, as determined by anatomical MRI, we are able to impose an especially powerful set of constraints on the ill-posed EEG inverse problem and thereby obtain solutions which optimally characterize each of the highly unusual individuals we bring into the lab.

References

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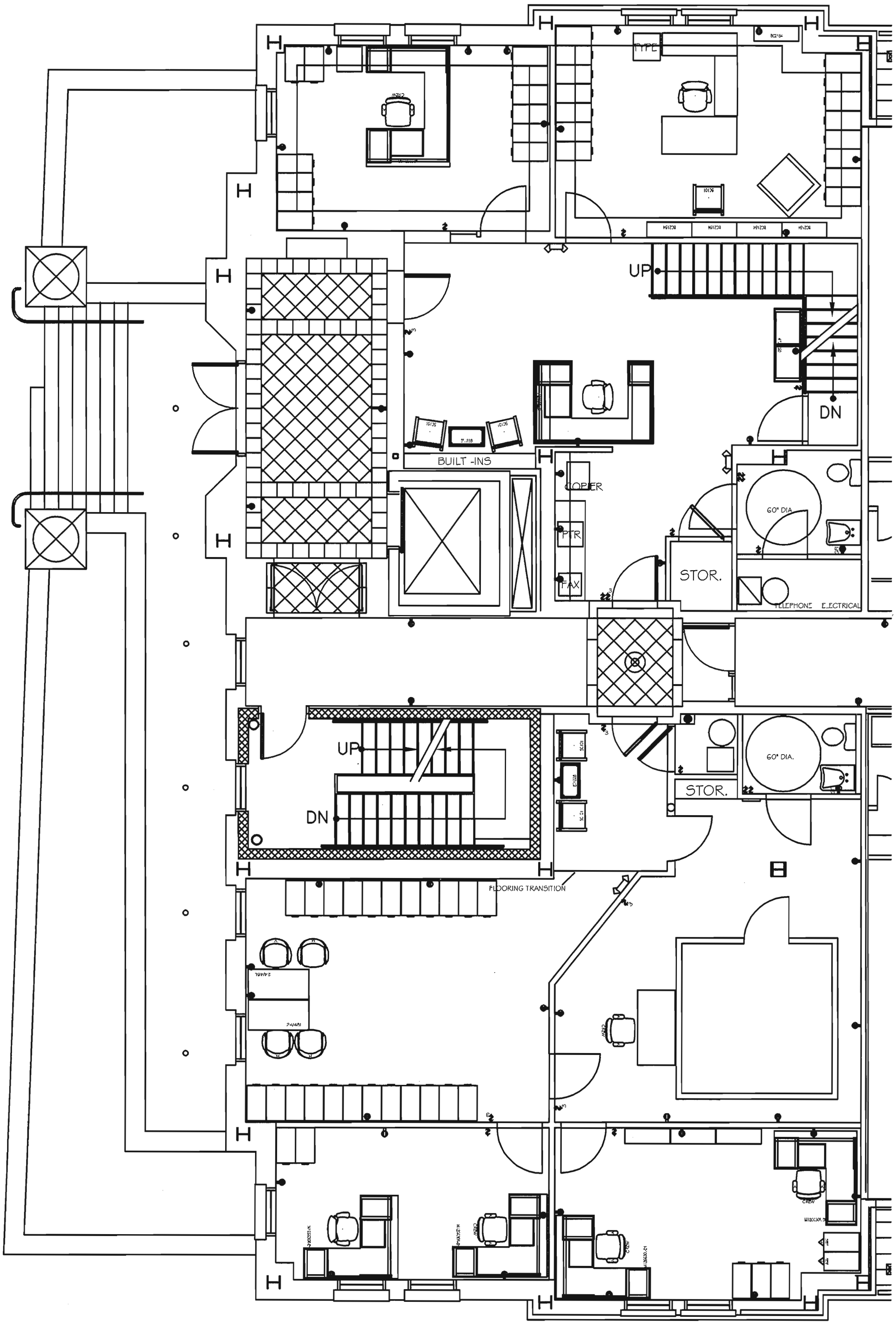
Wiseman, R., Smith, M., & Kornbrot, D. (1996) Exploring possible sender-to-experimenter acoustic leakage in the PRL autoganzfeld experiments. *Journal of Parapsychology*, 60(1), 97-128.



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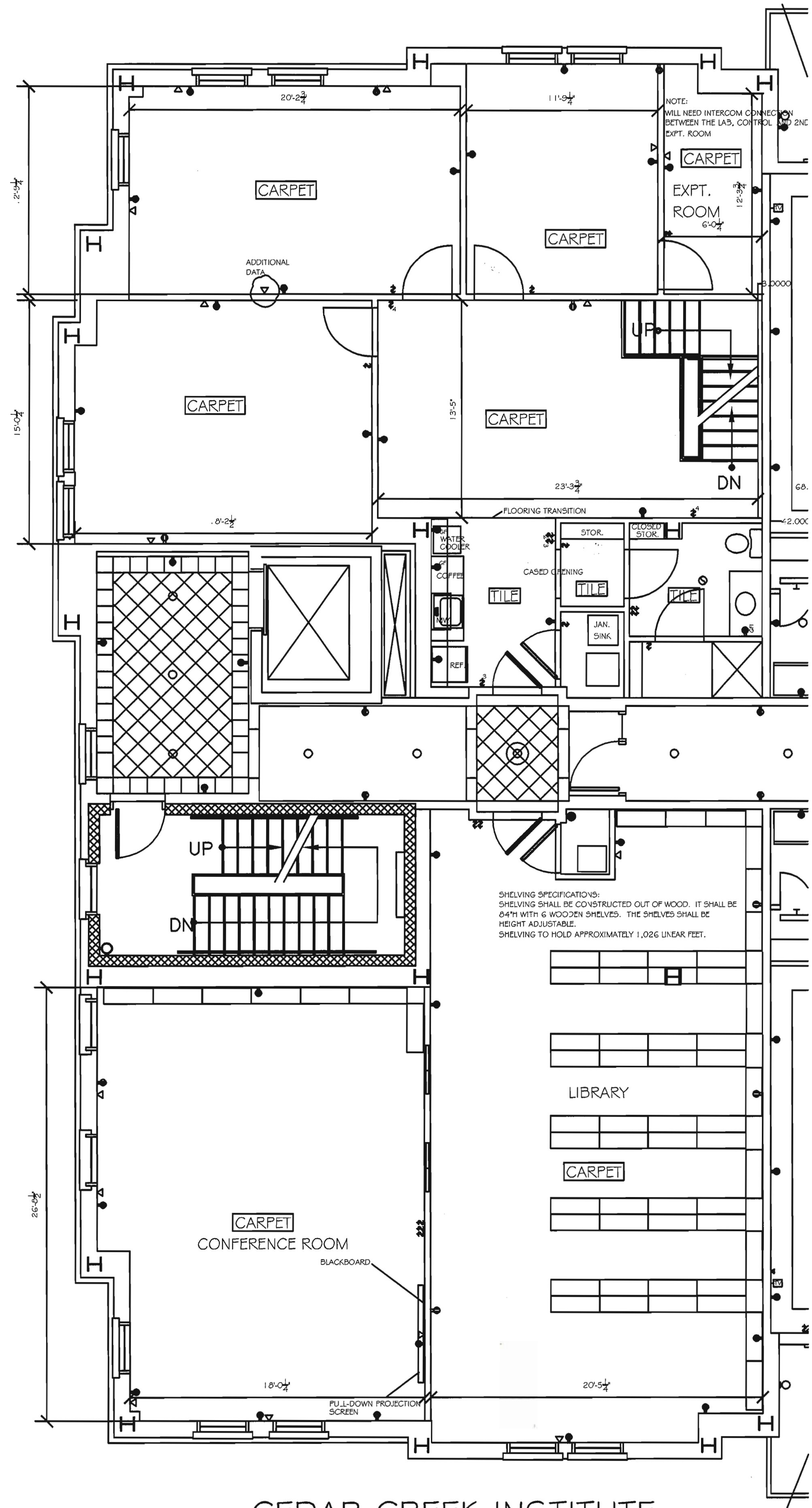

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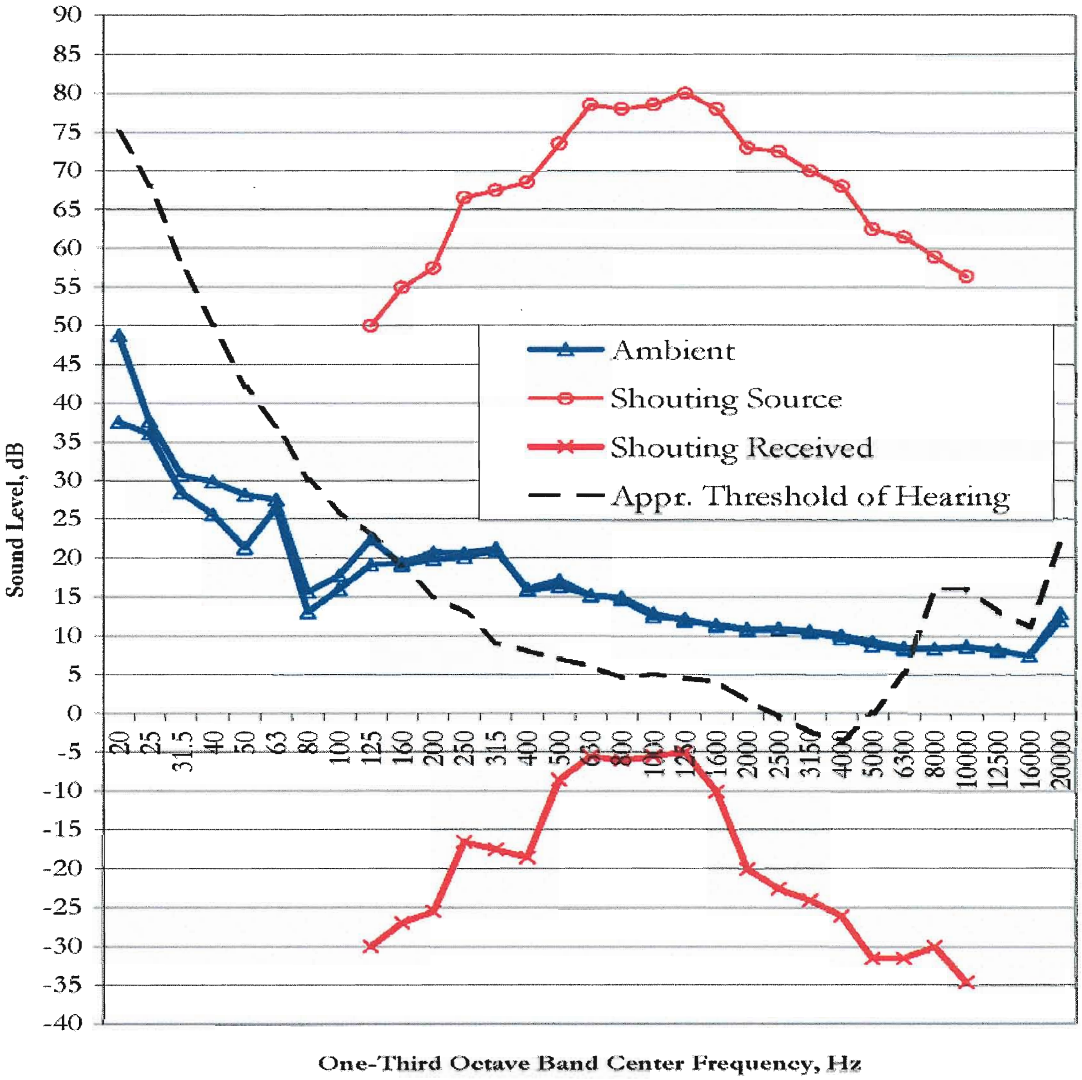
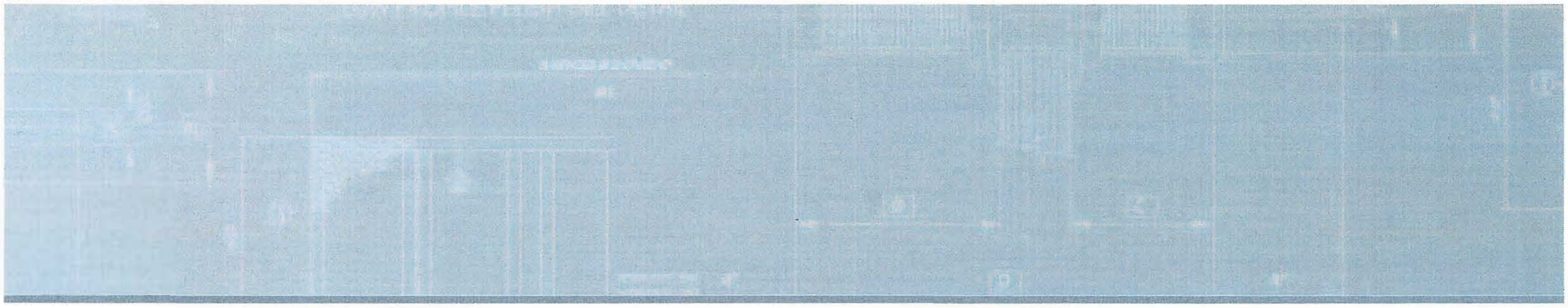
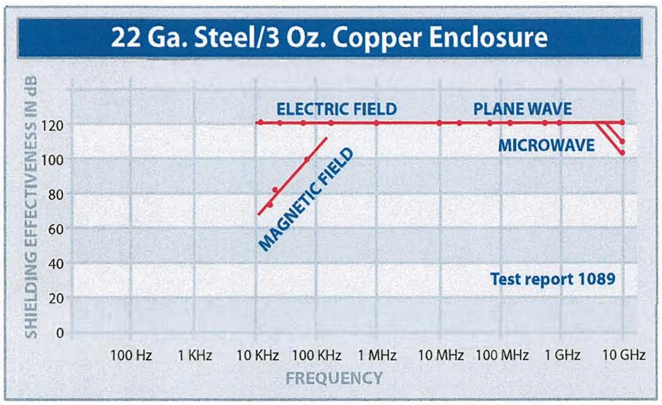


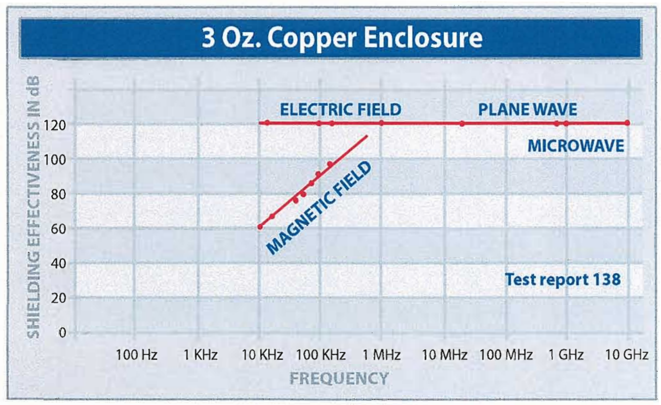
This figure presents projected maximum sound levels of an unassisted voice in the "sender" room reaching the shielded enclosure of the Cedar Creek Institute at the Division of Perceptual Studies (DOPS), Neuroimaging Laboratory at 210 Tenth Street, NE, Charlottesville, Virginia. This figure shows that sound from an unassisted voice in the sender room would be inaudible in the shielded enclosure for two reasons. First, the sound levels are lower than the approximate thresholds of hearing. Second, the sound levels are more than 10 dB lower than the background sound levels in all frequency bands given our test conditions (i.e., doors closed, and background sound levels in the shielded enclosure no lower than they were during the tests). Approximate values for the thresholds of hearing were obtained from the book Architectural Acoustics by Mehta, Johnson, and Rocafort, page 29; note that the value for individuals could certainly vary from these values. One-third octave band sound levels were determined for shouting from the "Handbook for Sound Engineers, The New Audio Cyclopedia", Glen Ballou (Ed.), c. 1987, page 160.

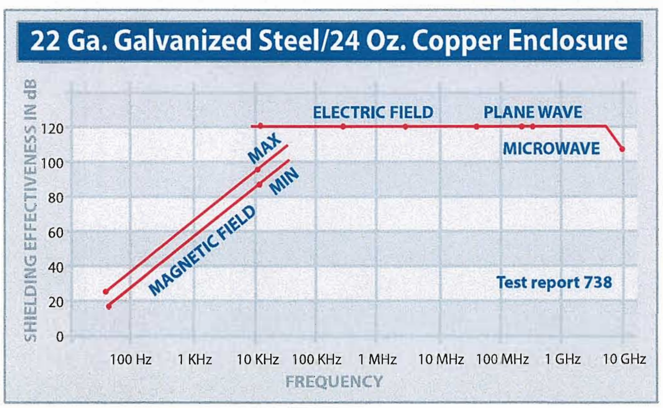


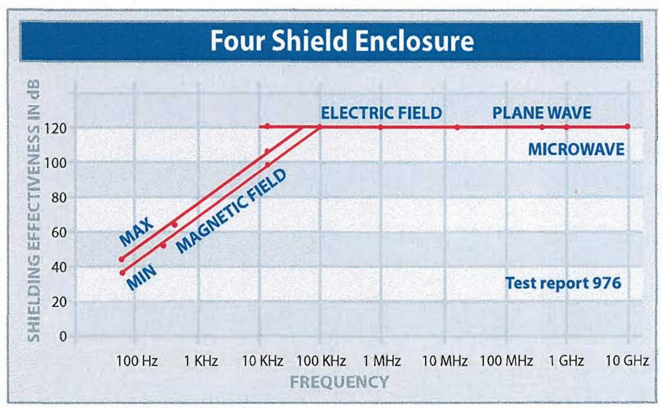
Four Shield DEI Enclosure

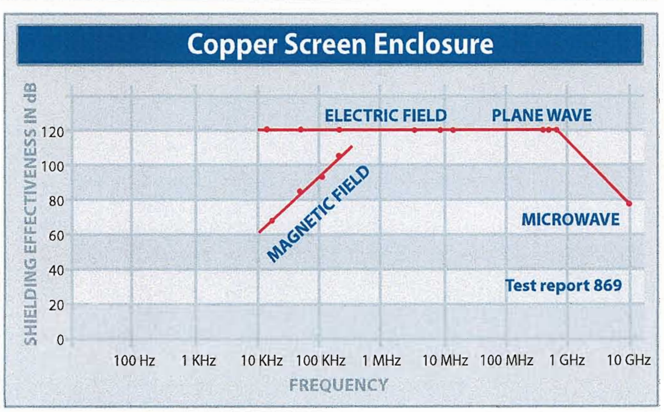
Four shield enclosures use 24 ounce copper as an over layer on both inner and outer shields to provide the best combination of high frequency microwave and low frequency magnetic field attenuation characteristics in a modular enclosure. Coupled with an additional layer of 24 gauge silicon steel placed behind the copper, this material application maximizes the low frequency magnetic shielding characteristics. The enclosure achieves over 120 dB of shielding effectiveness from 14 KHz to 10 GHz. This material application permits the enclosure to achieve over 120 dB of shielding effectiveness from 14 KHz to 10 GHz. The special 24 gauge silicon steel maximizes the low frequency magnetic shielding characteristics.











Note: The performance characteristics shown in all the above charts are from test reports performed by an independent testing company in accordance with MIL-STD-285, which are available on request.

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Hereby certifies that RF Shielding System, ETS-Lindgren Serial No. 30863, was installed at The Randolph, Charlottesville, VA, and meets the required shielding effectiveness specifications.

1 GHz	*PLANEWAVE FIELD*	*> 100 dB*

Test Date: March 28, 2008
Tested By: S. Rodriguez, ETS-Lindgren
Witnessed By: Edward Kelly, Cedar Creek Institute

Certified By:

Christakis Christou
Quality Assurance Manager

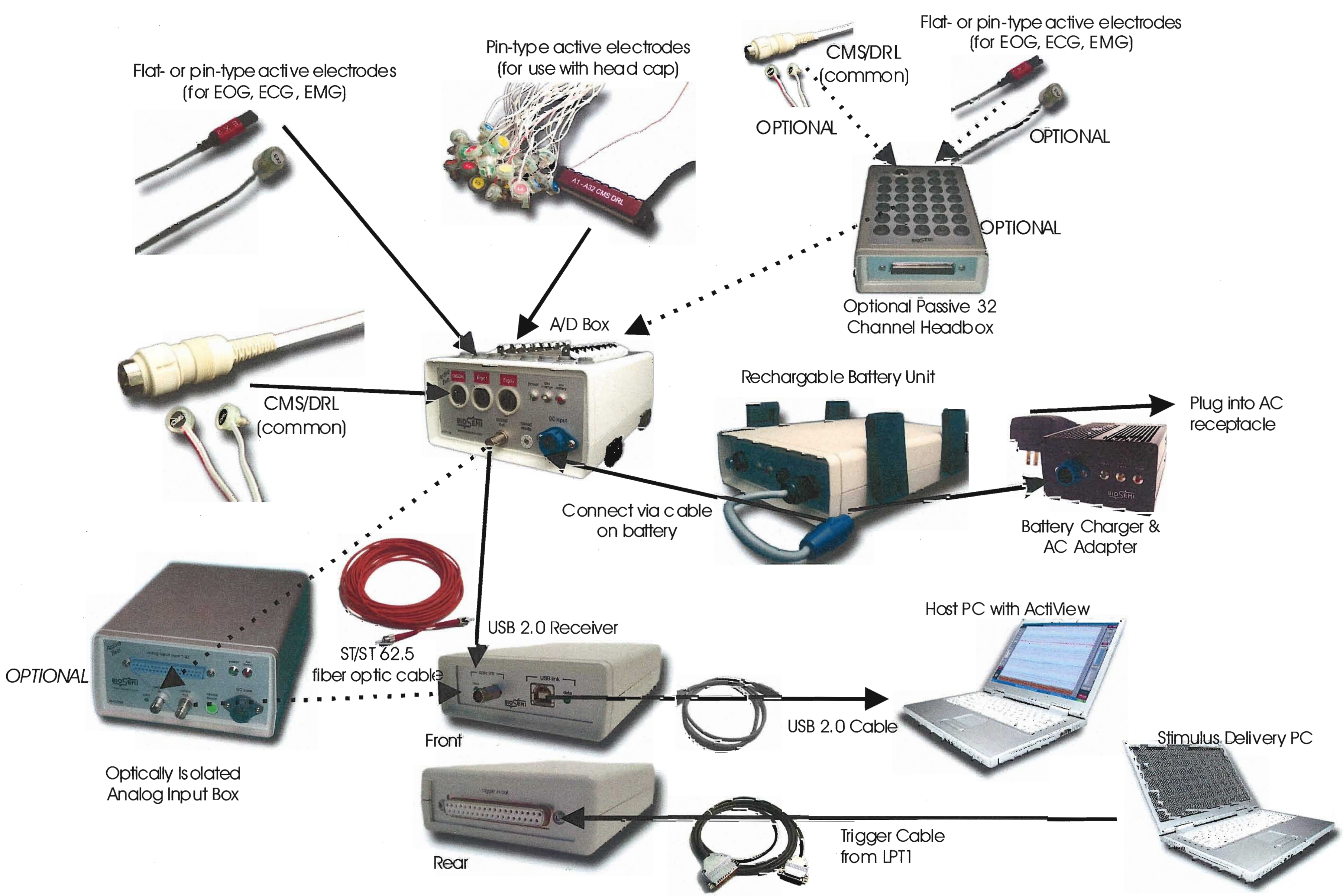
Test performed in general accordance with MIL-STD-285.
Actual test results available upon request.

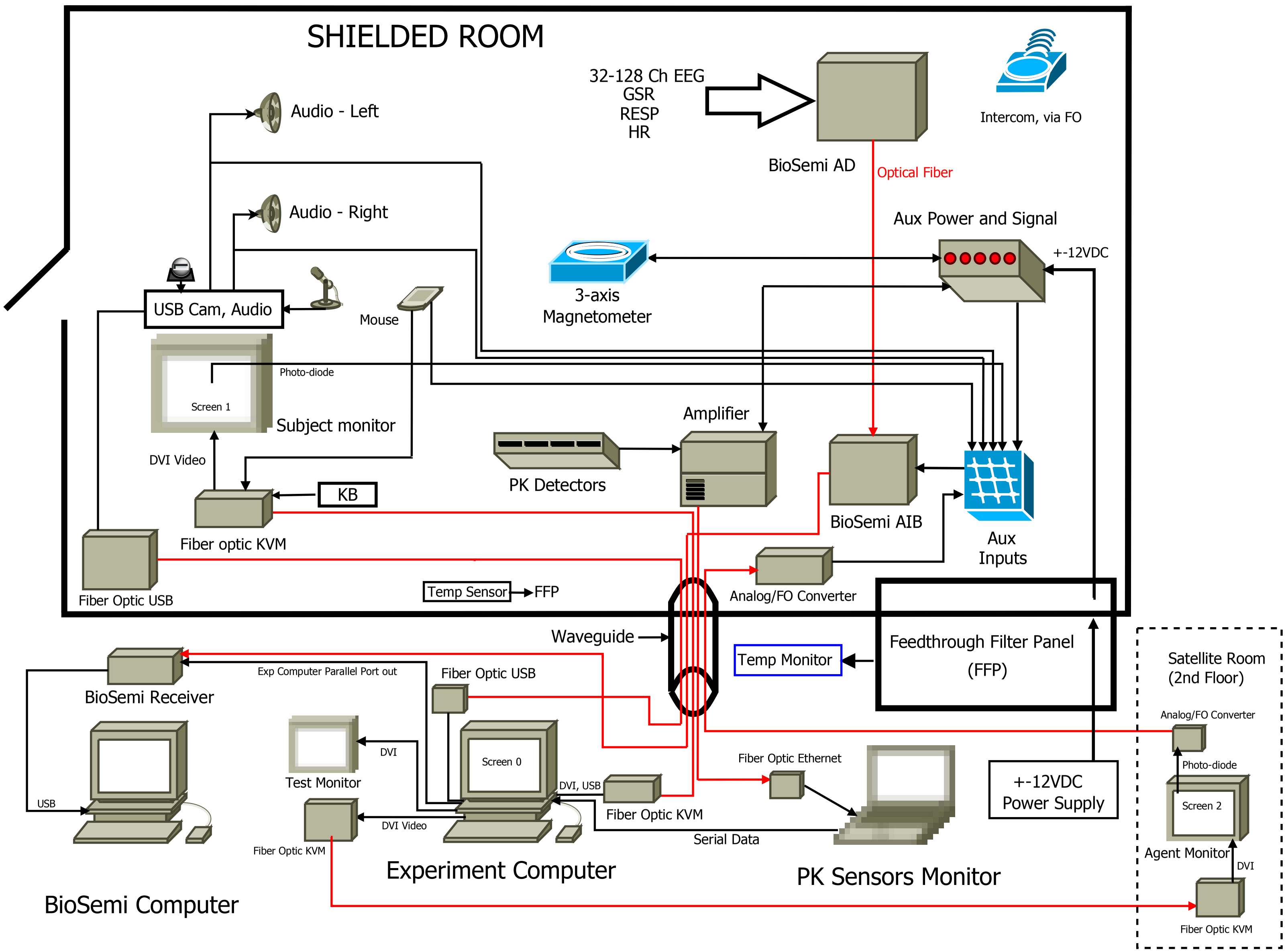
Re: 1C/03

Lindgren Document: Q-T04006 – Test Certificate – DEI-Cell

ActiveTwo Connection Diagram

Rev C, Apr 10, 2008





Westphal Neuroimaging Lab

Basic Layout V1.1 09/03/2013 wjrd

RWNL Data Processing Paths