

specifically include costs for the instruments, including shipping and deployment/recovery, in their proposal budgets. The operation of the national pool will be described.

#### **The PCC's Building Strong Motion Virtual Instrumentation Array. Remote Access and Monitoring System for In-Situ Data Processing and Data Base Transmission to Authorized Users**

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Since 1993 an array of twelve state of art strong motion tri-axial accelerometers have been in operation to monitor the earthquake structural response of the PCC's building, which is located in the soft soils of Mexico City. It is a critical facility housing the control panel and power generators for the city subway system (METRO). Nine accelerographs are installed in the building and three in a vertical sub-soil array. The twelve accelerometers are interconnected for the simultaneous recording of the site and building's response to the earthquake ground motions. The instrument array was design to record the deformations associated with the lateral and torsional framing stiffness of the building, the rocking of the foundation and the shear deformations of the interstory slab. The virtual instrument environment is created by using PC operated state of the art interconnected accelerographs, a local PC, a remote PC, a modem, commercially communications software and signal processing programming tools based on MATLAB. The system allows the remote user to transfer the recorded data files from the instrument solid state memory to the local PC, compress and transmit the data files to the remote PC. Process the data locally to create a fax-file report with the time series and the spectral magnitude plots and transmit it to a remote fax machine or to a remote PC for visual analysis. The remote PC allows the network's operator to maintain an on-schedule routine to monitor and operate the instruments, thus improving the array performance in terms of first quality records. The use of the remote access system has minimized the number of visits per-year of a qualified technician for routine instrument supervision and dramatically reduced the overall cost to operate the array. Within the first hour of occurrence of an important earthquake. The remote access system generates a collaborative environment session for the analysis of the building's performance. With the participation of the local structural engineer visiting the building, the remote earthquake engineer and building's authorities. The array has generated a unique data base of 16 sets of records of the building's response to earthquakes located along the Middle America Trench with magnitudes in the range  $4.6 < M_w < 7.6$ .

#### **Automated PC-network-based Seismic Monitoring Systems Applied to Mining Hazards Research**

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Following closure of the U.S. Bureau of Mines, Congress transferred responsibility for health and safety research in mining to the National Institute for Occupational Safety and Health (NIOSH). NIOSH has developed a personal-computer-(PC)-based seismic data acquisition and processing system for use in studies designed to reduce hazards associated with rock bursts, coal bumps, mine collapse, and other catastrophic mine failures. The system design has its roots in IASPEI PC-based systems (Lee 1989, 1994) using the PC-SUDS data format. Design requirements include (i) low-cost, off-the-shelf, data acquisition and computer hardware, (ii) the capability of automatically merging waveform data sets from different types of monitoring systems, (iii) delivery of raw and processed data underground, on the surface, as well as to remote sites, and (iv) automated data collection and processing over long periods of time without the need for human intervention. Current installations utilize multiple, autonomous seismic networks located both underground and on the surface, providing 20 to 35 stations within a 1-km radius. In underground networks, accelerometer and/or velocity signals are digitized at a sampling rate of 1000 samples per second (SPS) using a Symmetric Research A/D converter attached to a local data acquisition PC. In surface systems, NIOSH-designed three-channel A/D units are used to digitize signals continuously at remote stations at rates up to 1000 SPS. Multiple spread-spectrum radio links continuously transmit data in the U. S. Geological Survey's digital telemetry format back to a centralized processing PC equipped with a multichannel serial port board. Fiber-optic networks connect surface and underground data acquisition and processing PCs. Waveform files are collected either in trigger-capture mode or continuously and are automatically time corrected, merged, and processed in batch mode. Event locations, magnitude estimates, and other processed data are distributed for display and analysis on network nodes both underground and in the offices of

mine engineers and mine managers. In this paper, results are presented from installations in both hardrock and coal mines.

#### **Ultra-low Frequency (60 nHz-0.4 mHz) Seismic Background Noise and Signal Characteristics Observed at BDSN Station YBH**

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The Berkeley Digital Seismic Network (BDSN) station YBH, sited in a hard rock mine in the Klamath National Forest, 120 km inland from the Pacific coast and approximately 10 km from the nearest significant cultural noise sources, is the the seismically quietest and thermally most stable BDSN station. The seismic sensors at YBH are a set of Streckeisen STS-1 broadband seismometers. Additional sensor include a barographic pressure transducer to measure local atmospheric pressure and a thermistor to measure the seismic pier temperature. All signals are recorded at high resolution (24-bit) via a Quanterra data logger.

A seven month long continuous time series from the broadband sensors, the barographic sensor, and the thermistor, all sampled at 1 Hz, are used in the analysis. The background noise and signal Power Spectral Density (PSD) over the 60 nHz to 0.4 mHz frequency band is presented. Cross-correlation techniques are used to remove the correlatable atmospheric pressure and temperature components from the broadband seismic signals and effectively lower the seismic noise PSD to a level that is below the low-noise model in the sub-seismic frequency band. At frequencies below 0.4 mHz, the newtonian attraction of the atmosphere is the dominant noise source and the dominant signals are due to the gravitational tides, the solar atmospheric heating tides, and the graver mode eigen vibrations that are occasionally excited by large earthquakes. The 1 udeg C temperature resolution of the thermistor is sufficient for removing the temperature correlatable noise. We find, however, that the 125 mPa resolution of the barometric pressure transducer is the limiting factor in reducing the pressure correlatable noise and in detecting weak infrasonic signals. We have thus acquired, and are currently testing, a barometric pressure transducer with a resolution of 4.8 mPa.

#### **The LDEO Ocean Bottom Seismometer Facility**

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The National Science Foundation is sponsoring the development of a National Ocean Bottom Seismometer facility that will provide instruments for short term active source and long duration passive seismic experiments to any researcher with a successful proposal submitted to NSF. There will be three instrument centers within the facility at: 1) Lamont Doherty Earth Observatory, 2) Woods Hole Oceanographic Institution and 3) Scripps Institution of Oceanography. The LDEO facility will provide instruments designed primarily for long duration passive experiments using earthquakes as sources. It is expected that 64 OBS systems will be available from the LDEO facility by mid 2003. Very low noise amplifiers have been developed to provide low noise seismic data over the broadest frequency band from low cost, robust, 1 Hz geophones. The LDEO instrument will use three component Mark Products L-4 1 Hz geophones coupled to these low noise amplifiers. Recent results from these sensors will be presented and compared with alternatives. The noise level on the vertical component is expected to be close to, or lower than ground noise at Pacific seafloor sites in the band from 0.01 Hz (100s) to 60 Hz.

#### **Crustal Model and Noise Parameters for New Seismic Stations in the TexSeis Network**

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A new network of seismographic stations, called TexSeis, is being established as a cooperative effort between Texas Tech University and The University of Texas at Austin. Two stations are currently operating. The former WWSSN station at Junction, Texas has been re-established as JCTX, in cooperation with the USGS, using a Guralp CMG-3T seismometer, Quanterra data logger, and satellite telemetry to the USGS NEIC in Golden, CO. A second station has been established near Lubbock (LBTX), equipped with a Guralp 40T seismometer and CMG-DM24 digitizer. These data are transmitted by FM radio to Texas Tech University. Additional stations are planned near Amarillo (AMTX), Devine (DVTX), and in a yet to be determined location in west Texas. Three of these stations will be equipped similarly to JCTX. AMTX will be similar to LBTX. So far, only LBTX has recorded sufficient data for noise analysis and