Guidelines on portable earthquake monitoring equipment and deployments
Earthquake Hazards Program

Purpose
The USGS and USGS-supported seismic networks have significant portable seismograph capabilities for monitoring earthquake sequences and for supporting scientific investigations. Events in 2011-2013 provided a number of "learning opportunities" to improve the use of portable monitoring equipment for aftershock studies. Based on these lessons learned, this document presents recommendations and best practices to facilitate the recording, processing, and distribution of seismic waveform data and station metadata in future deployments.

Specific recommendations are:
- All rapid deployments should be guided by a defined set of scientific objectives determined prior to deployment. Collaborators should be encouraged to design their efforts around these same, or complementary objectives.
- The Earthquake Hazards Program (EHP) should dedicate a certain number of systems to sit on the shelf in order to be available for rapid deployments.
- The EHP systems should be maintained at a level of readiness such that the only work to be completed after a decision to deploy is attaching labels and shipping. In addition, the equipment should be pre-configured to the extent possible in terms of channels and sample rates in order to minimize the time in the field.
- All EHP equipment in the rapid deployment pool should be entered into the NEIC INV/ANSS and SIS databases in advance to facilitate acquisition and metadata construction.
- Aftershock system documentation should be installed on field staff tablets/laptops/computers and available via the FTP site in addition to the physical notebooks associated with the packed equipment.
- Annual training exercises are recommended for both Science Centers to ensure broad understanding how to deploy these systems.
- The EHP should maintain a list of contact information of critical USGS, RSN, SCEC, and IRIS personnel to facilitate coordination. It may also be worthwhile to formalize agreements with IRIS, SCEC, and UNAVCO for such deployments. We recommend that the EHP-ANSS coordinator compile and maintain such lists.
- The EHP is encouraged to invest in the resources necessary to support communications such as cell modems and 1-2 VSATs that could be used as hubs in areas without telemetry.
- Having NEIC serve as the central acquisition point is preferred from the point of view of simplicity and to reduce the work on the RSN under fire.
- The NEIC is encouraged to automatically distribute earthquake information below some magnitude (e.g., 3.0) without human review if Q/C standards are met.
- The metrics for real-time and post-processing of M<4.5 earthquakes in "Mod-High Hazard Areas" and nationally are not defined in the ANSS Performance Standards (Performance Area 1.5). Definitive metrics should be developed with input from a broad user community, as this will guide the proper technical decision for earthquake processing.

Science Goals
It is essential that every temporary seismic deployment be guided by well-defined scientific objectives**.** The particular target or objectives will depend on the event and the interests of the EHP staff and partners (such as regional seismic networks, local universities, state geologists, and IRIS). It is critical to articulate the objectives before the deployment begins, as they drive the configuration and duration of the effort.

Typical objectives include reducing earthquake location uncertainties; ensuring catalog completeness for operational earthquake forecasting and other science needs; characterizing local velocity, attenuation, and site effects; resolving questions of induced seismicity; investigating areas of significant damage; and understanding unusual sources, such as Crandall Canyon and Bayou Corne.

The number and type of portable stations required to meet these objectives will be a function of the dimensions of the structure being monitored, the rate and size of earthquake activity and existing monitoring capabilities. Typical rules of thumb for monitoring active seismicity include:

- 1 or 2 stations within approximately one focal depth of the seismicity to ensure hypocentral control of earthquakes,
- enough stations to cover the spatial extent of the seismicity to minimize epicentral uncertainty, and
- stations strategically deployed to provide a transition between the permanent stations and the aftershock deployment, if warranted.

For recent earthquake sequences (e.g. 2011/08/23 M5.3 Trinidad, Colorado; 2011/08/23 M5.8 Mineral, Virginia; 2011/11/06 M5.6 Prague, Oklahoma) monitored by EHP, approximately 8 stations would have been required to significantly reduce location uncertainties, ensure a detection/location threshold needed to define the details of the fault, and relocate previous earthquakes in the region in the context of good absolute locations.

Planning and Preparation

In nearly every response event the scientific objectives are advanced by deploying as rapidly as possible (which is why deployments are often undertaken before the goals are defined). The EHP can significantly improve its response capabilities through a number of simple steps.

Equipment Preparation

One of the easiest ways to facilitate rapid deployment is to have equipment on the shelf, ready to go. This is typically difficult to do, since there is a large demand for portable equipment for a variety of scientifically important experiments. Nonetheless, it is critical for the EHP to dedicate a certain number of systems to sit on the shelf in order to be available for rapid deployments.

The Geologic Hazards Science Center (GHSC) maintains a pool of 32 systems, consisting of a 6 channel datalogger, broadband seismometer, accelerometer, shipping cases, materials to construct vaults and insulate the sensors, power systems, and ancillary equipment. A combination of radios and cell modems are available for communications. The GHSC has also set aside spares for the major items, including the datalogger, seismometer and accelerometer at the 10% level. These spares are maintained in the aftershock lab in order to facilitate deployments (i.e., to have spares in the field if needed). The GHSC expects to maintain at least 15 instruments in house to respond to a major disaster. They will consider going below that level (to a minimum of 8) if they receive a formal request from a State (typically through a State Geologist) to provide assistance. In addition, some equipment could be borrowed from the ANSS Depot for a significant event.

The Earthquake Science Center (ESC) has a variety of seismic systems available, but most of the equipment managed by individual projects and is not dedicated for rapid deployment. In Menlo Park there are typically 8-10 Refteks with Episensors/Trilliums (Fletcher), 10-20 NetQuakes (Luetgert), and usually a modest inventory of spare equipment or equipment scheduled for upgrades (NCSN). Pasadena and Seattle each have 6 Refteks with Episensors and Trilliums. In addition, there are ~70 K2s with Episensors deployed in Seattle, Portland, and the Easy Bay region (Pleasanton/Hayward/San Leandro) (Frankel/Hartzell). For geodetic deployments, there are 18-21 GPS receivers in Menlo Park (Svarc) and 3 in Pasadena (King). The ESC is beginning the process of managing and augmenting this inventory to support a rapid deployment effort.

In order to facilitate rapid deployment, the in-house systems should be maintained at a level of readiness such that the only work to be completed after a decision to deploy is attaching labels and shipping. In addition, the equipment should be pre-configured to the extent possible in terms of channels and sample rates in order to minimize the time in the field. Configuration recommendations are found in Appendix A.

The ANSS Depot will support the dedicated EHP rapid deployment pool for those items that are stocked by the Depot. If an item is damaged, the equipment will be sent to the Depot, and the Depot will be responsible for having the equipment repaired and tested, and returned to the Science Center pool. This approach, combined with the local spares, should address the concerns about inventory.

Metadata Preparation

An equally important component of pre-event planning is metadata preparation. Much of the information can be prepared in advance and setup in software systems such as INV or SIS. All EHP equipment in the aftershock pool should be entered into the NEIC INV/ANSS and SIS databases in advance in order to facilitate acquisition and metadata construction. This includes serial numbers and information about configuration (see Appendix A). These issues should be communicated to the SIS developers to ensure that the program needs can be met.

Field Support

Aftershock system documentation (procedures/programs/configurations/checklists) should be installed on field staff tablets/laptops/computers and available via the ftp site in addition to the physical notebooks associated with the packed equipment. The GHSC checklists/guidelines/helpful hints are located at: ftp://ftpext.usgs.gov/pub/cr/co/golden/hazards/Eq_Effects/GeekPack/ .

Annual training exercises are recommended for both Science Centers to ensure broad understanding how to deploy these systems. These exercises should in general focus on the field staff and maintaining their familiarity with the equipment and deployment instructions (e.g., vault construction, shipping directions, etc.).

Coordination

Many USGS partners have some capability for supporting aftershock deployments. For example, IRIS has a set of instruments set aside for rapid deployments (RAMP). Coordinating with partners is challenging, particularly when there are multiple scientific objectives at play. It is critical for the EHP to maintain a list of contact information of critical USGS, RSN, SCEC, and IRIS personnel to facilitate coordination. It may also be worthwhile to formalize agreements with IRIS, SCEC, and UNAVCO for such deployments. We recommend that the EHP-ANSS coordinator compile and maintain such lists.

During the Event

The EHP typically designates an individual to serve as the “Event coordinator” during significant events. If a decision to deploy equipment is made, a Deployment coordinator will be assigned to work with the Event coordinator. The Deployment coordinator will work with the Event coordinator, EHP staff and partners (regional seismic networks, local universities, state geologists, and organizations such as SCEC, UNAVCO and IRIS) to define the scientific objectives of the experiment, the configuration of the deployment, and duration of the deployment – prior to departure. The Deployment coordinator will encourage partners to follow the ANSS recording standards.

Good communication about the scientific goals of the deployment is critical to the success of the effort. The Deployment coordinator will post information about the deployment as it develops (scientific goals, experiment design, maps, station lists) on the EHP Post-Earthquake site. The EHP currently uses a

Sharepoint site (https://xcollaboration.usgs.gov/wg/eqcom/default.aspx) for sharing information, maps, photos, etc. This tool is not viewed as particularly easy to use and it is difficult to add non-USGS participants. It is strongly recommended that a different tool be identified for future events.

Deployment teams will generally be composed of experienced EHP field staff, drawing from Menlo Park, Pasadena, Seattle, Golden, and Albuquerque as needed. When additional personnel are needed, they should be paired with experienced staff.

The USGS has numerous guidelines for siting and installing seismic equipment. While developed for permanent stations, many of the general concepts apply. As part of the installations, thorough documentation of the site must be compiled through station logs.

To the extent possible, equipment deployments will include real-time telemetry. Real-time data makes it easier to process the data automatically and ensure the equipment is operating correctly. Although there may be some deployments where telemetry is not available, the EHP is encouraged to invest in the resources necessary to support telemetry such as cell modems and 1-2 VSATs that could be used as hubs in areas without telemetry. A necessary condition for real-time communications is the ability to collect high sample rate data in real-time. High sample rates (100 – 200 samples per second) are needed for waveform modeling; if these data cannot be provided in real time, then reprocessing of latent data is required, which reduces the value of the real-time data.

The acquisition of deployed stations with telemetry can be performed by the relevant regional network or by the NEIC. Having NEIC serve as the central acquisition point is preferred from the point of view of simplicity and to reduce the work on the RSN under fire. NEIC can redistribute the data as needed in real-time to the RSN.

It is essential to complete the process of building the metadata as soon as possible. Field staff must communicate the necessary information to the appropriate center. The NEIC has the capability to build the metadata for a partner's deployment using INV as long as the necessary information is provided. In the case of IRIS, they will build their own metadata later, but that may not always be true for all partners.

Consistent with ANSS data management policy, waveform data will be sent to an ANSS archive (IRIS or the NCEDC/SCEDC as appropriate in California) for all EHP deployments, for deployments where the USGS lends equipment, and generally for USGS-funded deployments of a RSN. In general, the waveform data will be made available as soon as the metadata are validated. [Although outside of the focus of this document, it's worth noting that this distribution policy also applies to waveform data collected for research projects.] All data should be distributed as soon as possible in order to provide access to the research community.

Data Acquisition and Processing

Regardless of the scientific goals of the deployment, the EHP has a responsibility to create an event catalog as rapidly as possible. Such a catalog and the associated waveforms are essential to support time-critical studies. This goal is helped immeasurably by the use of telemetry during deployments - data playback, while possible, is slower, requires additional human resources, and delays scientific analysis. It is also important to process all available data together (or as much as possible) in the generation of this catalog – not just subsets of the data. All earthquake products should be available through ComCat.

When an event of interest occurs within a regional seismic network, the RSN will in general be able to incorporate real time data from the deployment into their routine processing stream (either acquired directly or via NEIC), producing picks, amplitudes, locations, magnitudes, and mechanisms as part of their automated systems. Outside of a RSN, such as the 2011 Mineral, VA, earthquake, the situation is more difficult, both because of the limited number of seismic stations and because of the higher magnitude threshold associated with the NEIC's standard processing.

In response to the Virginia event, the NEIC created an instance of Hydra, known as Portable Array (PA) Hydra. PA Hydra provides the capability for playing back data from portable deployments, and running the typical Hydra pickers and location algorithms. This instance has been used to process data from Maule (Chile), Mineral (Virginia), Trinidad (Colorado), and Prague (Oklahoma) sequences. However, this system does not currently provide the ability to process data in real-time and requires a certain level of resources to configure, play back, and review the events (ways to automate this process in the future are being explored).

NEIC could have enhanced real-time capability with a minor modification of their existing system. An instance of the binder association algorithm (used in AQMS), fed with picks from a set of stations specific for the sequence and using the global location algorithm in Hydra, would have the lower threshold for event detection needed to support data processing. At present, it is NEIC policy to review all events prior to releasing them to the public, and lowering the magnitude level has significant implications for the human resources needed for event review. NEIC is currently considering revising its policy to release events below magnitude 3 if they meet Q/C standards.

Alternatively, a standalone version of the AQMS could be configured for processing data for an aftershock sequence outside of an authoritative RSN region. In addition to using the binder association algorithm, AQMS also provides the capability to implement event triggers based on combinations of stations (subnet triggers). The system would require some configuration for the specific sequence, such as the velocity model used for the location. While incorporation of late, non-telemetered data into AQMS systems is technically possible, the procedure would require developer time to load the waveforms into waveservers and write scripts to associate late arriving waveforms with existing events or declare new events. The EHP would have to assign responsibilities for maintaining a standalone version of AQMS for this purpose – either at an RSN or NEIC. AQMS systems release automatic locations without review if certain Q/C standards are met.

We note that the metrics for real-time and post-processing of M<4.5 earthquakes in "Mod-High Hazard Areas" and "Nationally" are not defined in the ANSS Performance Standards (page 3, Performance Area 1.5 of http://earthquake.usgs.gov/monitoring/anss/docs/ANSS_Perf_Standardsv2_7.pdf). Definitive metrics should be developed with input from a broad user community, as the metrics will guide the proper technical approach for real-time and post processing of earthquake locations and magnitudes.

There is no one-size-fits-all-solution at this time, and we advocate a hybrid approach defined by policy and governed by ANSS performance standards.

- If an earthquake occurs within the processing polygon of an RSN and portable instrumentation can be installed with real-time telemetry, then the RSN should be responsible for all processing of the sequence, including the portable data, via its production system. Data that cannot be telemetered should be archived at the appropriate ANSS data center after retrieval, but further development of AQMS would be needed to guarantee that such data will be included in a timely fashion with the catalogued information. NEIC should provide backup to the RSN, especially in the computation of magnitudes and mechanisms.
- If an earthquake occurs outside the authoritative region of an RSN, the NEIC should be responsible for processing of the sequence via Hydra with a specific instance of binder. Hydra should be

configured to automatically distribute earthquake information below some magnitude (e.g., 3.0) without human review if Q/C standards are met, especially if telemetered data are available. NEIC should study whether it is feasible to incorporate subnet triggering into Hydra.

- If an earthquake occurs outside the processing polygon of an RSN but within its authoritative region (e.g., Wells NV sequence), then the NEIC and RSN should negotiate what network will be responsible for processing of the sequence.

During the Deployment

The initial design and duration of the deployment proposed at the time of the event should be revisited as the sequence develops. The decision on when to remove aftershock equipment is typically (and will remain) situational, depending on the science goals of the deployment, the rate of seismicity, the need for the instrumentation in other areas, and similar issues. In general, however, we recommend that the establishment of guidelines, such as terminating deployments when the activity decays to some level (e.g., probability of a M>3 earthquake over the next 30 days is <5%). Similarly, long-term deployments of portable equipment should be reviewed periodically to evaluate progress toward their science goals.

In some deployments, maintenance visits are necessary to support the operation of the equipment. When maintenance visits are performed, it is important to provide updated metadata (if appropriate), collect and distribute non-telemetered data, and update station logs as soon as possible.

Post Deployment

Post-deployment activities are critical to the success of the deployment – and to future deployments. These activities include verifying and updating station metadata through a cross-check with the station logs (and closing the open epochs!) and retrieving and distributing all non-telemetered data to the ANSS archives.

Finally, as equipment is returned from the field, it must be checked out, cleaned up, and repacked for future deployments within 5 work days, although this may not be possible in cases where replacement parts have a long lead time.

Appendix A

ANSS Recommended Best Practices
Portable Deployment Configuration, Recording and Distribution

Background
To improve the quality of the seismic waveform recordings and to enhance efficiency of data collection for either real-time or post-earthquake processing, the ANSS provides the following best practices to help facilitate the recording, processing, and distribution of seismic waveform data and station metadata.

Format
SEED is the standard of the seismological community. All time-series data must be generated in MiniSEED or converted to MiniSEED prior to distribution.

Configuration

SEED Naming Conventions:
Because all waveform data will be distributed in MiniSEED, channel naming should follow the SEED convention. The SEED standard consists of 4 parts:

2 character network code (e.g. NN)
5 character station code (e.g. SSSSS)
3 character channel code (e.g., CCC)
2 character location code (e.g., 00).

Network codes: The network code for each experiment/deployment should either be assigned by the IRIS DMC or should utilize the institution's network code. The GHSC uses GS routinely, rather than using a different network code for each experiment.

Station codes: To make it possible to prepare metadata in advance of real-time station deployment, the station names for a deployment will be pre-assigned. Normally, this will be a two character deployment code followed by a station number. For example, "VA01" and "VA02" would be appropriate station numbers for the Mineral, Virginia aftershock study. As a deployment unfolds, each field group should be assigned a group of station codes by the Deployment Coordinator. In return, the field group should provide the intended equipment serial numbers for each station code to the coordinator as soon as possible, preferably before the equipment is shipped to the field. It is understood that sometimes equipment must be swapped due to failures in the field and that this is unavoidable, but the equipment should be deployed as prearranged whenever possible.

Channel codes: SEED naming conventions apply (SEED Reference manual Appendix 1- http://www.iris.edu/manuals/SEED_appA.html). The components will be Z, N, and E only if oriented within 5 degrees of TRUE north. If not oriented within 5 degrees of TRUE North, the components will be Z, 1, and 2. The short form is:

Broadband:	digitizing rate < 80 SPS BH* >= 80 SPS HH*
Short period:	digitizing rate < 80 SPS SH* >= 80 SPS EH*
Strong motion:	digitizing rate < 80 SPS BN* >= 80 SPS HN*
Low gain seismometers:	digitizing rate < 80 SPS BL* >= 80 SPS HL*

Location codes: Location codes are the least standardized component of the SEED nomenclature.

The GHSC uses the following approach:
00: Broadband sensor (Trillium, CMG-3, STS-2, etc.) flat to some domain (e.g., from 20 sec to 30 Hz).

10: Short period sensor (L4, L22, etc.) with attenuated response at 10 seconds.
20: Strong motion accelerometers – (FBA23, MEM, RT147, etc.)

If additional instrument types are deployed, they will be given codes 30, 40, etc. If there is a naming conflict created by sampling the same seismometers at rates that have the same channel code, then the conflict will be resolved in the location code 2^{nd} digit. Example: If a broadband is sampled at 100 SPS continuously and 200 SPS triggered, the channel codes for both would be HHZ, HH1 and HH2 and the location code for the continuous data would be 00 and for the triggered data would be 01.

Other implementations of location code are acceptable.

Sample rates and filters

In order to ensure recording of the full bandwidth of interest, the USGS recommends the following configuration

Strong motion accelerometers sampled at 200 sps or higher; gains should not clip below 3.5 g.

Broadband sensors should be sampled at 100 sps. If telemetry bandwidth is limited, then telemetered broadband should be 40 sps with on-site recording at 100 sps continuous if the equipment allows

All digital filtering should employ causal filters to enable RT algorithms to reliably pick P arrivals.

Deployment and Installation

For effective coordination and maximum data recovery, it is imperative that information about a deployment be provided to the Deployment Coordinator as soon as the instruments are fielded. This is especially true when data are being telemetered or when there is a need to manage deployments involving multiple institutions.

Site Selection and Installation:

The guidelines for selecting portable sites are similar to those for permanent installations, although it is recognized that compromise must be made for security, power, or other reasons. Source documents for permanent installations are below:

Free-field Sites:

Open File Report 02-144 "Methods of Installing United States National Seismograph Network (USNSN) Stations-A Construction Manual" (http://pubs.usgs.gov/of/2002/ofr-02-0144/ofr-02-0144.pdf), provides general background information on selecting quiet locations, issues related to power, sources of cultural noise and how to protect equipment from foraging animals. The USGS GHSC also provides manuals on temporary vault construction for specific dataloggers and sensors on its FTP site.

Strong-motion Sites:

COSMOS document "Guidelines for Installation of Advanced National Seismic System Strong-Motion Reference Stations" (http://www.cosmos-eq.org/publications/reports/Guidelines_PDF.pdf) provides technical guidelines on installations of reference strong motion stations.

Structural Strong-motion Sites:

Open File Report 2005-1039 "Guidelines for ANSS Seismic Monitoring of Engineered Civil Systems-Version 1.0" (http://earthquake.usgs.gov/monitoring/anss/docs/ANSS_Guideline_civil.pdf) provides general information about strong-motion installations in structures.

Examples of installation techniques for portable systems may be found here:

ftp://ftpext.usgs.gov/pub/cr/co/golden/hazards/Eq_Effects/GeekPack/Procedures-Configs-Info/5B_Vault_Install/Vault-Bucket_Install-Procedure_Text-Photos_Apr2013.pdf

Documentation
It is essential that a station installation form/log must be completed for each site. This form includes station name, instrumentation, coordinates, address, directions, access keys/restrictions, and owner contact information. It also includes information needed to assess the type of site (e.g. free-field, reference, or structure), geology, and proximity to any significant cultural noise sources (e.g. driveway, train tracks, pumps). The log should include a drawing/outline of the installation and photographs. The logs should made available on the EHP Post-Earthquake collaboration site or through tools such as SIS. An example of a site installation log is here:

ftp://ftpext.usgs.gov/pub/cr/co/golden/hazards/Eq_Effects/GeekPack/Procedures-Configs-Info/Forms_Maint-%26-Signs/A_RT_Site-Installation-Form_SEP2012.pdf

Metadata and Communication
Once an installation is complete, the Deployment coordinator should be contacted and provided with the following information:

- Latitude (Degrees)
- Longitude (Degrees)
- Elevation (Meters)
- Network code
- Station Code (generally pre-assigned by coordinator)
- Date of Installation

The metadata describing the station should be reported via standard tools in dataless SEED or Station xml as soon as possible. If the metadata are being built by a third party (such as NEIC using INV) then additional information is required:

- Station description (Example: Small Town Fire station, Small Town, Virginia, USA)
- Sensor Type(s) (Example: Trillium Compact, L22)
- Sensor Serial Number(s)
- DAS Type (Example: Q330, RT130)
- DAS Serial Number
- DAS configuration (Appendix B)

For real-time data collection, the full configuration information of the data loggers must be recorded in the field. Each data logger has unique properties that must be captured so that the recorded waveform data can be correctly described. In addition to the data logger configuration information detailed above, the following information is needed for metadata preparation. This information can be provided after the deployment is complete.

- Sensor Poles and Zeros response
- Sensor Sensitivity and Frequency of Sensitivity
- DAS channel configuration

Real-time Data Acquisition and Exchange:
The NEIC acquisition system is capable of ingesting the real-time waveform data from most of the dataloggers used by ANSS networks. As a result, NEIC can be used as a support facility for the acquisition and re-distribution of real-time data from the field to RSNs and IRIS. NEIC supports the following data loggers:

- Quanterra Q330
- Reftek RT130

- Kinemetric Basalt via SEEDLink
- Nanometrics Taurus
- Guralp DM-24 via SCREAM

The NEIC can distribute real-time data in the following protocols/services for data exchange to IRIS and ANSS partners:

- Ring Replicator Protocol (RRP)
- Earthworm Import/Export
- SeedLink
- CD1.1

The USGS Menlo Park is the support facility for the acquisition and distribution of NetQuakes data.

The ANSS archives are the distribution point for data for the research community

Details about the dataloggers supported by NEIC are in Appendix B.

Maintenance and Data Retrieval

When site visits are made, the service log should be updated to reflect any changes and modifications at the station. Modifications that affect the instrument response must be reflected in the metadata for the station (such as replacing sensors or dataloggers) as soon as possible. Updated logs should be posted.

If non-telemetered data are being recorded on the datalogger, they should be retrieved during a site visit and distributed as soon as possible to the selected ANSS archive.

Post-deployment Data Management

Post-deployment reporting, validation, and verification procedures are often the least rigorously followed, yet are some of the most important to ensure the quality of the collected data. Consequently, the USGS recommends more documentation and checking within this area of a deployment to ensure a comprehensive close-out of a deployment.

Recommended USGS best practices following a field deployment include the following:

- Validation of station metadata, including cross-check of site service logs for serial number match and channel configuration match between the log and the inventory database used to generate metadata.
- All time-series data must have supporting station metadata in dataless SEED format or StationXML. The dataless SEED volume is to be submitted to IRIS and/or NEIC within one week of removal of field equipment.
- Update the inventory system within one week of removal of the equipment from the field to reflect the return of the instrumentation to the depot.
- Written report provided on damaged or lost equipment within one month after removal of the equipment from the field, clearly identifying damaged or broken equipment and storing of field-ready equipment for the next deployment.
- Post all site service logs on SIS or an accessible internal website or SharePoint site.

Appendix B

Datalogger configuration requirements for NEIC acquisition

Reftek RT-130/RT-72:

RefTeks must be configured to send the "ethernet" data to 136.177.24.132, port 2543, which runs an RTPD server. It is imperative that the serial number of the unit and its configuration of data streams be communicated to the NEIC before installation so that data can be converted to MiniSEED and be available for redistribution.

The configuration of channels will have continuous BH or HH and sensor mass position as the only channels sent via real-time feeds.

Configuration items to be recorded for each Data Stream:

- DataStream number
- Sample Rate in SPS
- Channels Sampled (like 456)
- Channel orientations (like ZNE where channel 4 is Z, 5 is N, 6 is E)

Q330:

Real-time data collection on Q330's is supported using the normal Q330 dataport 1-second protocol. The NEIC-supported acquisition system is 136.177.24.132. The networking equipment must NAT or pass traffic to UDP ports 5330-5334 and TCP/IP port 5380, 5354 (for balers). Data port one will be used to provide the real-time data feeds to the NEIC.

Configuration items to be recorded:

- Hex and equipment serial numbers
- Hex password for data port 1
- Q330 is Standard Resolution or High Resolution (SR or HR)
- Preamplifier Gain
- Linear Filters below Frequency : (this should be set to "All Frequencies" on global configuration page)

DM24:

The NEIC will perform real-time data collection via SCREAM protocol. The equipment must allow connection from NEIC host 136.177.24.132 to the port on the SCREAM server.

Basalts:

For real-time transmission to NEIC, any communications gear connecting the Basalt to the Internet will be configured to allow access from computers at 136.177.24.132 to this port including any NAT's that need to be set up for connections on private networks. The Basalts must run the SeedLink server available from ISTI. Networking at the station must permit the above IP to connect to the SeedLink port (normally 18000).

Configuration items to be recorded (minimum):

- Preamp setting (1, 2, 4, 8, 16)
- Input range – Vpp (40, 10, 5)
- Filter type (Causal or Non-causal – always should be causal)
- Sample rate in SPS
- Channel Mapping

K2s:

K2s are not easily supported for real-time deployment, although recent developments in Menlo Park may change this situation. Data can be provided in K2 disk format, but written configuration data about each unit must accompany the data.

Configuration items to be recorded (minimum) :

- Preamp setting (1, 2, 4, 8, 16)
- Input range – Vpp (40, 10, 5)
- Filter type (Causal or Non-causal – always should be causal)
- Sample rate in SPS
- Channel Mapping

NetQuakes

There are no configuration changes possible on a NetQuakes that are not reflected in the output miniSEED data.

Taurus

Information required for NEIC data acquisition include

- Input Range Vpp (40, 16, 8, 4, 2)
- Input Impedance mode (High or Low)
- DC Removal filter (Off or 1 mHz)
- Sample rates is SPS

Guralp DM24

The NEIC can acquire realtime data in GCF (SCREAM) format at host 136.177.24.132.

Configuration items to be recorded:

- Unit is Mk2 or Mk3
- Preamp gain
- The Tap Table Lookup (TTL) number
- Sample rates in SPS