

SETTING THE CWB STANDARDS FOR FREE-FIELD ACCELEROGRAPHS

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ABSTRACT

In the strong-motion program of the Central Weather Bureau(CWB), 600 free-field accelerographs are to be deployed in Taiwan. The CWB Advisory Committee established its Instrumentation Subcommittee chaired by Y. B. Tsai to advise CWB in the implementation of this extensive deployment. Members of the Subcommittee realized that it is essential to set high standards for the accelerographs to be purchased through an open bidding process. During the past three years, the Subcommittee enlisted many international experts in drafting technical specifications, conducting compliance tests, and evaluating the submitted accelerographs.

The primary purpose for the deployment of the free-field strong-motion accelerographs is to record large earthquakes(at various distances) at locations of major scientific and societal significance. Consideration of the infrequency of large earthquakes, uncertainty in the location and time of occurrence of these events, and the social significance of the data dictates the following engineering and scientific requirements for the accelerographs:

- (1) The transducers for the required accelerographs must respond accurately in the frequency range from DC to 50 Hz in order to record faithfully the ground motion caused by large earthquakes. In order to record suitably a wide range of earthquakes, the complete system must be digital and have at

least 16-bit resolution.

- (2) The accelerograph must be rugged, compact, weighing less than 25 kilograms, transportable over rough terrain by vehicle, and then capable of being installed and field calibrated with a minimum amount of adjustment. The accelerograph must be able to withstand extremes of humidity, dust, and temperature, and be waterproof.
- (3) After installation, the accelerograph shall remain in a standby condition until actuated manually for test purposes or triggered by ground motions satisfying the trigger criteria. After actuation, it shall record data for a prescribed time period, and return to the standby condition ready to record the next event without servicing or attention. In addition, the accelerograph must be able to provide (i) a continuous digital data stream output for telemetry according to the USGS standards and (ii) recorded data that are compatible with the IASPEI software.
- (4) Since maintenance will be at infrequent intervals, reliability of the accelerograph is of utmost importance. The accelerograph must be capable of recording at least 90 minutes of data for 3 channels at 200 samples per second per channel, and for three days without external power. The accelerograph must be able to keep accurate timing (i) to better than 5 msec with a GPS receiver, and (ii) to better than 26 msec per day with its internal clock.
- (5) The accelerograph must be designed for quick trouble-shooting by performing functional tests so that a technician can locate faulty component(s) or circuit board(s) under field conditions. A field installation site may be a simple instrument shelter in a remote region with extreme environment conditions.

In practice, implementation of the CWB standards for free-field accelerographs is carried out according to the following steps:

- (1) A draft of the CWB specifications of the free-field accelerographs is prepared after extensive discussions among the members of the CWB Instrumentation Subcommittee.
- (2) The draft is circulated among manufacturers and instrument experts for comments and suggestions.
- (3) The revised draft is discussed and revised by the CWB Instrumentation Subcommittee, and then by the CWB Advisory Committee so that the CWB specifications of the accelerographs are finalized for a given year.
- (4) The CWB specifications are announced with the procurement invitation for bids.
- (5) Bidders are required to submit detailed technical proposals and production models of accelerographs for evaluation.

- (6) A "technical compliance test" of the submitted accelerographs and transducers is performed, including shaketable, laboratory, and field tests; test procedures are given in the CWB specifications.
- (7) Report of the technical compliance test, the bidders' technical proposals, and information about bidders' past performance are sent to an Independent Evaluation Panel (chaired by Prof. Bruce Bolt of UC Berkeley and Dr. Gerald Brady of USGS, and includes Dr. Peter Rodgers of UCSB, and Dr. Tony Shakal of CDMG). An evaluation report is prepared by the Independent Evaluation Panel on the status of each submitted accelerograph: "acceptable", or "unacceptable".
- (8) The CWB's Instrumentation Subcommittee makes final recommendations to CWB and prepares a technical report documenting the above proceedings.
- (9) CWB announces the successful bidder according to the procurement regulations.
- (10) CWB retains the submitted accelerograph of the successful bidder for one year. This instrument serves as the "standard" against which to check the delivered units of the successful bidder at the "performance acceptance test" as specified in the CWB specifications.
- (11) The delivered units are put through a performance acceptance test to ensure that every unit meets the CWB specifications.

The above procedure has been refined through annual iterations, taking advantage of the CWB's multiple-year procurement schedule. Through the above process of setting the CWB standards and implementing the procurement, and with the cooperation of the interested instrument manufacturers, we believe that we have taken a significant step towards achieving the following for the seismological community:

- (1) Cost-effective accelerographs are now commercially available with features that meet scientific and engineering requirements and use modern technology.
- (2) Standardization in data format, data stream, and data retrieval through IBM-compatible PCs has been accomplished such that data from different manufacturers can be easily merged and analyzed using the IASPEI software.
- (3) A procedure for testing and evaluating accelerographs has been documented. This document may serve as a reference for other institutions in their procurement of accelerographs.