NGS POLICY 03-1992

Earthquake Response Policy

National Geodetic Survey

Approved by the Executive Steering Committee

28 August 1992

This policy has been retired and is no longer in effect

August 28, 1992

MEMORANDUM FOR: Captain Melvyn C. Grunthal, NOAA
Chief, National Geodetic Survey

FROM: Sandford R. Holdahl
Chief, Advanced Geodetic Science Branch

SUBJECT: Earthquake Response Policy Statement

The attached policy statement has been prepared by the Advanced Geodetic Science Branch. It outlines how NGS will respond in the event of a large earthquake. The policy has undergone an internal NGS review. Helpful comments were received from C. Challstrom, J. Spencer, and B. Remondi. The attached statement reflects those comments.

August 28, 1992

ATTACHMENT -- Policy Statement: NGSD Response to an Earthquake.

Background:

The National Geodetic Survey (C&GS,NOS,NOAA) performs geodetic measurements to measure deformation resulting from earthquakes. The NGS response to hazardous earthquakes is coordinated with FEMA (Federal Emergency Management Agency). NGS has the responsibility for re-positioning geodetic control points that have been offset horizontally and vertically by the earthquake. The geodetic determination of the extent and magnitude of deformation, and subsequent mathematical modeling, provides scientists with knowledge that can be correlated with geophysical information concerning faulting, stratigraphy, state of unreleased strain, previous non-geodetic measurements, etc. This information is synthesized in many different ways to improve warning systems, zoning regulations, insurance rating, and the integrity and safety of infrastructure engineering.

The timing and strategy of a NGS response to a particular earthquake depends on several factors such as the geometry of faulting, magnitude of earthquake, location of earthquake, geometry and type of pre-existing geodetic monumentation in the area of suspected deformation, and funding.

Geometry of Faulting:

The geometry of faulting is critical for determining the type of survey response. Preliminary indications about the type of fault slip can be derived from seismic records obtained while the earthquake was occurring, or from field inspection of scarps and offsets. If a fault slips in a direction which is mostly parallel to the direction of the fault (strike), the resulting deformation will be primarily horizontal, although a small amount of vertical motion may also occur. If a fault slips in the direction normal to strike, the deformation will be mainly vertical. If the dip angle of a fault is significantly non-vertical, the deformation is likely to have both vertical and horizontal components. If the deformation is primarily vertical, then releveling may produce the most accurate assessment of monument shifts. If the deformation is primarily horizontal, EDM or GPS measurements will provide accurate shifts. In the event that deformation is a mix of significant vertical and horizontal motions, then GPS or a combination of leveling and GPS can give a clear result.

Earthquake Location:

The earthquake location will also influence the type of survey response. Earthquakes in coastal regions will normally require a very accurate assessment of vertical changes because of the possibility of shifting flood plains. NGS will coordinate its response to coastal earthquakes with components of NOS responsible for tide levels. Earthquakes near population centers, rivers, dams, nuclear power plants, military installations, and other critical facilities may require a response with special considerations for future safety and commerce. Earthquakes in the proximity of volcanoes are likely to be indicators of major volcanic activity which may worsen and pose a greater threat. The focus of survey efforts may temporarily be directed towards monitoring surface deformation associated with volcanic activity, rather than in assessing the amount of seismic deformation.

Pre-existing Geodetic Control:

The spatial distribution, types, and history of pre-earthquake geodetic measurements govern the potential for deriving a good mathematical description of crustal deformation by resurveying. For example, horizontal motions will usually not be well detected if only leveling surveys predated the earthquake. Very sparse or poorly located configurations of pre-earthquake measurements have little potential to reveal deformation by re-surveying.

Earthquake Magnitude:

The magnitude and depth of an earthquake primarily determine the regional extent of deformation, and therefore the ultimate cost of resurveying. Small earthquakes ($M < 6.0$) do not generally cause significant deformation, and therefore seldom require a response from NGS. Deeper earthquakes cause less deformation at the earth's surface. Great earthquakes, such as the 1964 Prince William Sound event ($M=8.4$), caused deformation over hundreds of miles, with maximum horizontal shifting of 20 m, and vertical changes of 10 m. Large earthquakes ($M > 7$) normally are followed by a period of rapid

deformation. During this period, which may last a decade or more for a great earthquake, the direction of motion is often opposite to that which occurred during the earthquake. This type of postseismic motion decreases exponentially with time, although postseismic motion can have several causes - with part of the post-earthquake deformation being a much slower long term reaction. Therefore the geodetic survey response after a great earthquake should be well planned, considering both the determination of the coseismic as well as the postseismic effects. To determine total postseismic motion, and to clearly distinguish it from coseismic motion, a comprehensive survey of the region should be undertaken within a few weeks after the earthquake.

Timing of Response:

A great earthquake will damage infrastructure over a wide area. For this reason, immediate attempts to resurvey after an earthquake are likely to be impeded, but also might interfere with restoration of power and transportation facilities. NGS will use the period immediately after an earthquake to research how to make the best survey response possible. This will be done in consultation with other interested and responsible agencies, and will include a search and evaluation of pre-existing monumentation and measurements, formulation of a geodetic resurvey plan, and estimation of costs. The period immediately after the earthquake will also be used to coordinate personnel, equipment and monetary resources to support the survey project.

Funding of the Survey Response:

NGS will normally have very limited funds which can be redirected to an unscheduled survey to determine crustal motions caused by an earthquake. For this reason funding of such a survey is usually provided by one or more agencies which have a mission involving public safety or seismology. NGS provides expertise in planning and execution of these surveys, and in the cataloging of the resulting measurements and descriptive information for future purposes. NGS enters into cooperative funding agreements to support projects which are of critical importance to the National Geodetic Reference System.