II. Control Measures

The laser guide star technique involves the propagation of a laser beam towards stars and other astronomical objects to provide a beacon or guide star, for use with adaptive optics as a means of compensation for atmospheric turbulence. This laser system is not powerful enough to damage materials but it is hazardous to human eyes if the beam is viewed directly. Viewing diffuse reflections of the beam is not hazardous to human eyes. These conclusions are based upon the Maximum Permissible Exposure (MPE) levels set by ANSI standard Z136.1. It is therefore required that adequate safety procedure be implemented to prevent direct exposure of the beam to persons on the ground or in aircraft.

The safety procedures for the Lick installation are based on the experience gained at LLNL in over two years and greater than 25 propagation events, and on the techniques developed at the Starfire Optical Range at Kirtland Air Force Base, Albuquerque, New Mexico in the 1990s. The aircraft safety system for Lick Observatory consists of two Visual Observers (VO) located on the ground on opposite sides of the dome at a distance of at least 20 feet, which provides each VO with a greater than 180 degree visual observation, and an "intrusion" radar which is boresighted to the laser beam. The VOs are trained to look for aircraft and are in constant communication via an intercom link with the Laser Operator (LO). The VOs keep the LO informed of air traffic so that the LO can shut down the laser system in an orderly fashion well in advance of approaching aircraft. This is the normal mode of operation. The VOs also have cut off switches that enable them to immediately activate the laser beam block if a low flying aircraft suddenly appears or if the LO fails to respond.

The intrusion radar protects highflying aircraft from being illuminated by the laser beam. These aircraft may not be visible to the VO. The intrusion radar is a modified weather radar which has a narrow cone of radiation approximately 7.5 degrees wide centered about the laser. An aircraft entering the radar cone at an altitude of 10,000 feet (or 5600 feet above Mount Hamilton) at a speed of 250 knots would require over a second to intersect the laser beam, which is in the center of the radar cone. The time to block the laser beam is under 0.1 second giving an acceptable safety margin for this operation. It is the experience at LLNL and elsewhere that a VO can easily detect aircraft at altitudes well beyond 5000 feet so there is considerable overlap between these two aircraft detection methods. The intrusion radar is effective in detecting all aircraft to an altitude of 60,000 feet so that full coverage is provided.

Mount Hamilton is the highest peak within a hundred mile radius and the closest local airport (Reid Hillview) is 10 miles away. The normal approach patterns for Reid Hillview Airport are not over Mount Hamilton. To the West the entire San Jose area is visible. To the East lies the San Antonio Valley and an unobstructed view to the first range of hills at a distance of about 10 miles. To the South there is an unobstructed view across the Santa Clara Valley to Loma Prieta and Mout Umunhum at a distance of about 20 miles. To the North, Mount Diablo is visible. Under these conditions the two VOs have an excellent viewing capability and a search radar is unnecessary and serves mainly

as a backup safety system. Laser propagation is limited to nighttime hours between nautical (12-degree) evening and dawn twilights so that the laser beam can be seen by the VOs.