- There is a slight bias toward overstating the Hospital Act's effectiveness when comparing the performance of buildings built to its requirements with those that were not, because these are by definition post-1973 and pre-1973 buildings respectively. It is generally found that the later-model buildings perform better than those that did not benefit from mid-'70s code changes, whether they received only typical local enforcement of UBC requirements or whether special design and construction quality control was implemented directly by the state, as for public schools or hospitals.

With these qualifications, the striking conclusion from the following data on Northridge performance is that the Hospital Act was very effective in limiting structural damage; to a lesser extent, the act was also effective in controlling nonstructural damage. As noted in the preliminary draft of the OSHPD report to the Building Safety Board:

> Post-1973 hospital buildings and other health care facilities constructed under the requirements of the Seismic Safety Act performed very well with respect to the primary structural systems and with very few problems except for Holy Cross Hospital which suffered severe structural damage. However, the performance of nonstructural parts of the buildings and the equipment and piping systems performed poorly, resulting in extensive damage to the building interiors including flooding, which resulted in the temporary shut down of several post-1973 hospital buildings and the evacuation of patients either fully or partially until extensive repairs and clean up could be effected. (OSHPD, 1994a)

PHOTOGRAPH B7.6: Damage to penthouse HVAC fan units, Holy Cross Medical Center, which pounded out portions of the penthouse wall and caused damage to the sign. At this facility, HVAC outage was the single most disruptive effect of the earthquake. *photo credit: Bob Reitherman, Earthquake Engineering Research Institute*

There were 89 buildings located on the 23 medical sites (hospitals and skilled nursing facilities) where one or more buildings were tagged either yellow (approved for only limited occupancy, or only some areas safe) or red (unsafe to enter or occupy) by OSHPD inspectors. **TABLE B7.1** summa-

TABLE B7.1

Performance of Healthcare Buildings at the 23 Hospital Sites with One or More Yellow- or Red-Tagged Buildings

Structural Damage	Pre-1973, Pre-Act Buildings	Post-1973, Post-Act Buildings
Red tags	20	0
Yellow tags	16	1
Green tags	22	30
Non structural Damage		
Major: # of Buildings	40	9
% of Buildings	74%	29%
Minor: # of Buildings	14	22
% of Buildings	26%	71%
Total Buildings	54	31

Source: derived from OSHPD, 1994a; structural data from July 7, 1994 draft; nonstructural from May 1994 draft.

rizes their structural and nonstructural performance.

Nine pre-1973 hospital or convalescent-care buildings had to be evacuated and could not provide basic services, while two (Olive View and Holy Cross) post-Act hospitals were in this category (McGavin and Patrucco, 1994). Six pre-Act hospitals, but no post-Act buildings, were partially evacuated. Throughout Los Angeles County, 928 patients were evacuated because of damage to hospitals (LAFD/EMS, 1994). By comparison, in the 1971 San Fernando earthquake, 17 out of 23 hospitals in the San Fernando Valley were damaged or destroyed, and 1 327 beds out of 6,751 (~20%) were long-term losses. (Munroe, *et al.*, 1975, p. 61)

Murray (1994) summarizes water and electrical problems at hospitals and skilled nursing facilities under the jurisdiction of the Office of Statewide Health Planning and Development (OSHPD). Twenty health care facilities suffered broken non-sprinkler water lines. "Most of the damage was to small lines, less than 2 1/2 inches in diameter for which bracing is not required by code." Sprinkler line breakage occurred at 29 facilities, all of which, again, was to small unbraced branch lines (see **Photograph B7.1**). At six facilities (not counting the Veterans Administration's Sepulveda facility), emergency power generator systems failed to operate. In some cases, "auxiliary stairwell lighting was not connected to emergency power, necessitating evacuation of patients down totally darkened stairwells...." (Snyder, 1994).

A snapshot of the duration of disruption caused the earthquake can be obtained from the OSHPD Daily Hospital Damage Report from Monday, February 7, two weeks after the event. It points out that only two facilities, St. John's Hospital in Santa Monica and the VA Sepulveda facility under federal jurisdiction, were still closed, both because of major structural damage. (Though the overall Los Angeles County/University of Southern

PHOTOGRAPH B7.7: Los Angeles Department of Building and Safety "red tag" placarding of front door of Indian Hills Medical Center. *photo credit: Bob Reitherman, Earthquake Engineering Research Institute*

California hospital campus of many buildings was functional, one building there was also closed because of structural damage.) Thus nonstructural damage, even in post-Act facilities, was often very disruptive, if only on a temporary basis, for the facilities shaken most intensely, and repairs and cleanup to respond to this damage were effected within days. Only structural damage caused longer-term closings. At Holy Cross, for example, nonstructural damage required evacuation on January 17; the main building received a green tag on January 20 (steel frame damage was discovered much later); the emergency room, pharmacy, radiology, laboratory, respiratory, and most diagnostic and therapeutic services were operational January 21; the facility was re-opened for most services January 24 in a ceremony attended by the Governor; the trauma and paramedic units were opened February 10. (OSHPD, 1994b). A reasonable conclusion is that financial losses to hospitals due to disruption of service are more severe when there is serious structural damage, while loss of ability to serve the community during the hours following the earthquake is more likely to be due to nonstructural damage.

Because of the difficulty in separating the relevant variables out of the overall data, it is also instructive to look at the three acute-care hospital facilities that had one or more buildings designed and constructed after the Hospital Act was implemented and that were the most heavily shaken: Holy Cross and Olive View Hospitals, both ironically replacement facilities for hospitals severely damaged in the 1971 San Fernando earthquake, and Northridge Hospital Medical Center. (The Veterans Administration's Sepulveda facility mostly consists of buildings designed in 1952 and, although heavily shaken also, does not represent a test of the federal equivalent of California's Hospital Seismic Safety Act). The main hospital buildings at the Olive View and Holy Cross Medical Centers are the two buildings that constitute the post-Act yellow tags in TABLE B7.1.