8.1 INITIAL COSTS

The initial construction cost of protection has two components: fixed and variable. Fixed costs include such items as security hardware and space requirements. These costs do not depend on the level of an attack; that is, it costs the same to keep a truck away from a building whether the truck contains 500 or 5000 lbs. of TNT. Blast protection, on the other hand, is a variable cost. It depends on the threat level, which is a function of the explosive charge weight and the stand-off distance. Building designers have no control over the amount of explosives used, but are able to define a stand-off distance by providing a secured perimeter.

The optimal stand-off distance is determined by defining the total cost of protection as the sum of the cost of protection (construction cost) and the cost of stand-off (land cost). These two costs are considered as a function of the stand-off for a given explosive charge weight. The cost of protection is assumed to be proportional to the peak pressure at the building envelope, and the cost of land is a function of the square of the stand-off distance. The optimal stand-off is the one that minimizes the sum of these costs.

If additional land is not available to move the secured perimeter farther from the building, the required floor area of the building can be distributed among additional floors. As the number of floors is increased, the footprint decreases, providing an increased stand-off distance. Balancing the increasing cost of the structure (due to the added floors) and the corresponding decrease in protection cost (due to added stand-off), it is possible to find the optimal number of floors to minimize the cost of protection.

These methods for establishing an optimum stand-off distance are generally used for the maximum credible explosive charge. If the cost of protection for this charge weight is not within the budgetary constraints, then the design charge weight must be modified. A study can be conducted to determine the largest explosive yield and corresponding level of protection that can be incorporated into the building, given the available budget.

Though it is difficult to assign costs to various upgrade measures because they vary based on the site specific design, some generalizations

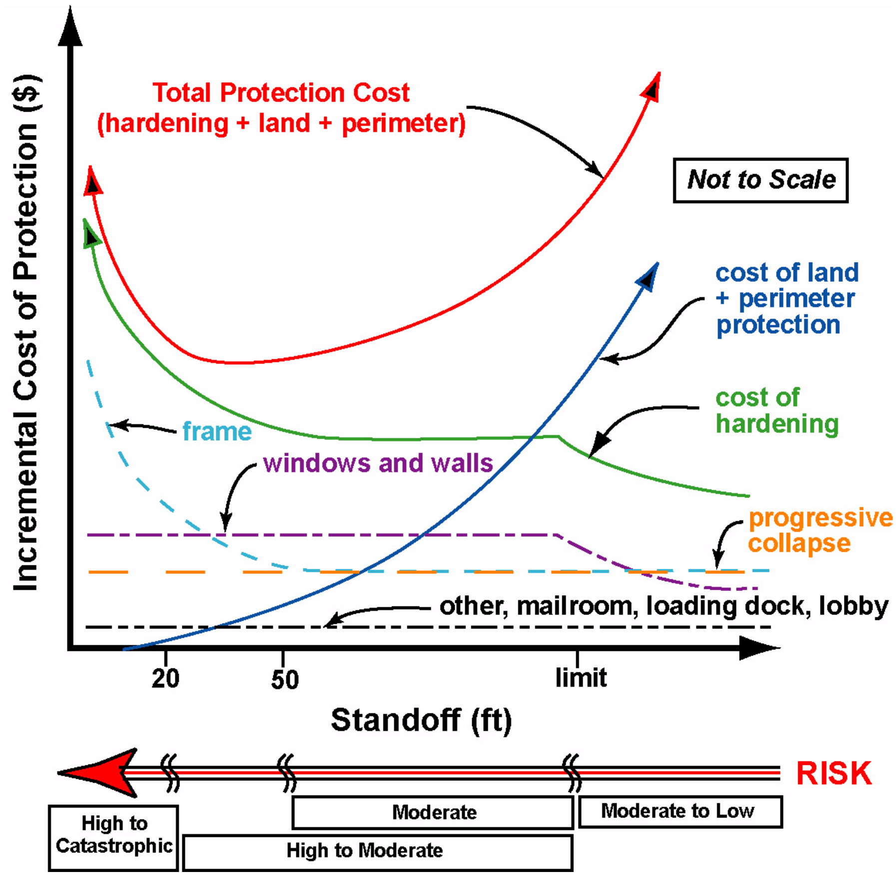

Figure 8-1 Plots showing relationship between cost of upgrading various building components, standoff distance, and risk

can be made (see Figure 8-1). Below is a list of enhancements arranged in order from least expensive to most expensive.

- Hardening of unsecured areas
- Measures to prevent progressive collapse
- Exterior window and wall enhancements

8.2 LIFE-CYCLE COSTS

Life-cycle costs need to be considered as well. For example, if it is decided that two guarded entrances will be provided, one for the visitors and one for the employees, they may cost more during the life of the building than a single well designed entrance serving everyone. Also, maintenance costs may need to be considered. For instance the initial costs for a CBR detection system may be modest, but the maintenance costs are high. Finally, if the rentable square footage is reduced as a result of incorporating robustness into the building, this may have a large impact on the life-cycle costs.

8.3 SETTING PRIORITIES

If the costs associated with mitigating man-made hazards is too high, there are three approaches: (1) reduce the design threat, (2) increase the building setback, or (3) accept the risk. In some cases, the owner may decide to prioritize enhancements, based on their effectiveness in saving lives and reducing injuries. For instance, measures against progressive collapse are perhaps the most effective actions that can be implemented to save lives and should be considered above any other upgrades. Laminated glass is perhaps the single most effective measure to reduce extensive non-fatal injuries. If the cost is still considered too great, and the risk is high because of the location or the high-profile nature of the building, then the best option may be to consider building an unobtrusive facility in a lower-risk area instead. In some cases, for instance for financial institutions with trading floors, business interruption costs are so high they outweigh all other concerns. In such a case, the most cost-effective solution may be to provide a redundant facility.

Early consideration of man-made hazards will significantly reduce the overall cost of protection and increase the inherent protection level provided to the building. If protection measures are considered as an afterthought or not considered until the design is nearly complete, the cost is likely to be greater, because more areas will need to be structurally hardened due to poor planning. An awareness of the threat of man-made hazards from the beginning of a project also helps the team to decide early what the priorities are for the facility. For instance, if extensive teak paneling of interior areas visible from the exterior is desired by the architect for the architectural expression of the building, but the cost exceeds that of protective measures, than a decision needs to be made regarding the priorities of the project. Including protective measures as part of the discussion regarding trade-offs early in the design process often helps to clarify such issues.

Ultimately, the willingness to pay the additional cost for protection against man-made hazards is a function of the “probability of regrets” in the event a sizable incident occurs. In some situations, the small probability of an incident may not be compelling enough to institute these design enhancements. Using this type of logic, it is easy to see why it is unlikely that they will be instituted in any but the highest-risk buildings unless there is a mandated building code or insurance that requires these types of enhancements. This scenario is likely to lead to a selection process in which buildings stratify into two groups: those that incorporate no measures at all or only the most minimal provisions and those that incorporate high levels of protection. It also leads to the conclusion that it may not be appropriate to consider any but the most minimal measures for most buildings.

8.4 FURTHER READING

Bryant, L., & Smith, J., 2003, *Cost Impact of the ISC Security Criteria*. General Services Administration & Applied Research Associates, Inc., Vicksburg, Mississippi. http://www.oca.gsa.gov

Department of Defense, 1999, *Interim Antiterrorism/Force Protection Construction Standards.* [For Official Use Only]

Naval Facilities Engineering Service Center, 1998, *User's Guide on Security Glazing* Applications, UG-2030-SHR, Port Hueneme, California.