

INVESTIGATION OF STRUCTURAL DAMAGE AND REPAIR COSTS RESULTING FROM AN ACCIDENTAL EXPLOSIVE DETONATION

by

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Abstract

The Department of Defense Explosives Safety Board publishes and maintains safety criteria applicable to DoD ammunition and explosives. If possible, this protection is provided by requiring a minimum separation distance between potential explosive donor and acceptor structures. At a military installation's boundary, the required separation distance is termed the Inhabited Building Distance (IBD). Beyond this distance, uncontrolled residential and commercial development must be accepted.

According to the DoD Ammunition and Explosives Safety Standard, DoD 6055.9-STD, at IBD, "...Unstrengthened buildings can be expected to sustain damage up to about 5 percent of the replacement cost." Unfortunately, cost data from recent explosive accidents, including the 1988 Pepcon explosion, indicate that actual damage costs at IBD separation distances will be significantly greater.

In this paper, we will evaluate probable damages resulting from a hypothetical explosive detonation at a DoD installation. Our evaluation will be based upon the application of the IBD separation distance at the installation boundary and will consider both residential and commercial construction.

Background

Fort Reagan is an active FORSCOM installation. It was originally constructed early in World War II. At that time, it was located six miles south of the small town of Clinton whose economy was based largely on agriculture. For many years, the installation was surrounded entirely by farmland. Since the early 1990's, however, Base Realignment and Closure activities have resulted in the assignment of several new missions to Ft. Reagan. This has increased requirements for ammunition storage and other facilities including troop housing. The expanded mission has been a boon to the local community. The nearby town of Clinton has grown significantly, expanding

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southeastward. In fact, the town limit has now reached the northwest boundary of the installation. The largest portion of the town growth near the installation has been light commercial construction and residential communities, including a new elementary school closely adjacent to the boundary.

Since its initial construction, ammunition storage activities have been concentrated in the northern end of Ft. Reagan. In accordance with the DoD Ammunition and Explosives Safety Standards, DoD 6055.9-STD, earth covered storage magazines are sited at the IBD separation distance from the installation boundary. Consequently, the incident overpressure at the boundary will not exceed 0.9 psi. Figure 1 shows a map defining the northern boundary of the installation and its relationship to the town of Clinton.

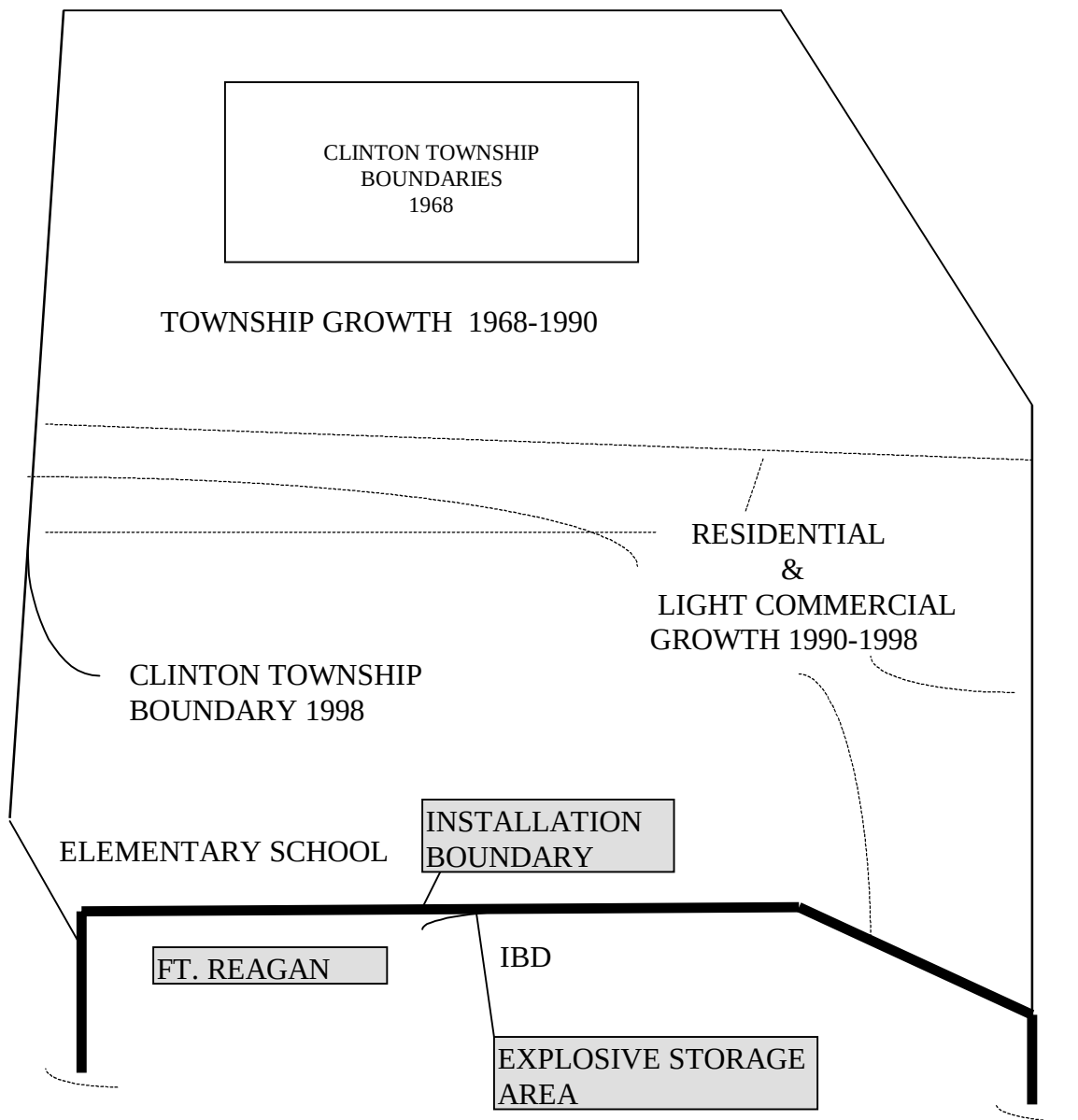


FIGURE 1

Description and Consequences of an Accidental Detonation

On 18 August 1998, at 5:00 a.m., a spontaneous detonation occurred in one of the storage magazines near the northern boundary of the installation. The resulting damage and injuries were an unexpected shock to both the installation and the community. While no one actually observed the detonation, thousands of residents were awakened by what was often described as a "sonic boom." Many also described an "earthquake" ground motion. It was later determined that the magazine that accidentally detonated had contained approximately 450,000 pounds of bulk explosives. Of more significance to both the installation commander and the community were the anxiety and panic affecting the population and the surprisingly large distances beyond the installation boundary at which damage occurred.

In explanation, DoD 6055.9-STD limits the damage expectation at IBD (0.9 psi) to mostly glass breakage and minor damage not exceeding 5% of a structure's replacement value. This damage expectation was developed through tests, performed in the 1945-1969 time frame, of sturdy, wood frame construction located at this distance from a detonation.

However, in the weeks following the accident, damage claims from the Clinton community climbed into the thousands with claims from distances of up to 8 miles (or 11 times IBD) from the detonation. In addition, the dollar value of these claims exceeded 5% of the replacement cost at distances greatly exceeding IBD. Interestingly, in areas farther from the detonation, there was a marked increase in the number and value of claims when window breakage occurred. Claims in these areas were primarily for nonstructural items such as windows, carpet, and furniture.

The Fort Reagan commander was also faced with extensive damage to facilities on the installation. He had not been aware that this level of damage could occur in an explosive accident. Figure 2 shows contours banding the approximate distribution of damage claims in percentage of replacement cost. Paired with these values are the associated separation distances as a ratio of IBD.

Total damages claimed by the community against the Army, mostly through insurance carriers, was estimated at \$25 million. This damage figure likely included many claims which were incorrectly attributed to the event (e.g., cracked sidewalks, walls, chimneys, plaster, etc.) Damage on the installation was a lessor factor quantitatively but of serious concern since the installation's operation and maintenance (O&M) budget was already severely restrained.

There were a significant number of injuries from falls and broken glass (cuts, abrasions, minor broken bones, etc.) Other reported injuries included numerous anxiety-related complaints which, in a few cases, led to chest pains and heart attacks. There were also a few vehicle accidents caused either directly by the air blast loading causing drivers to lose control or indirectly by distraction.

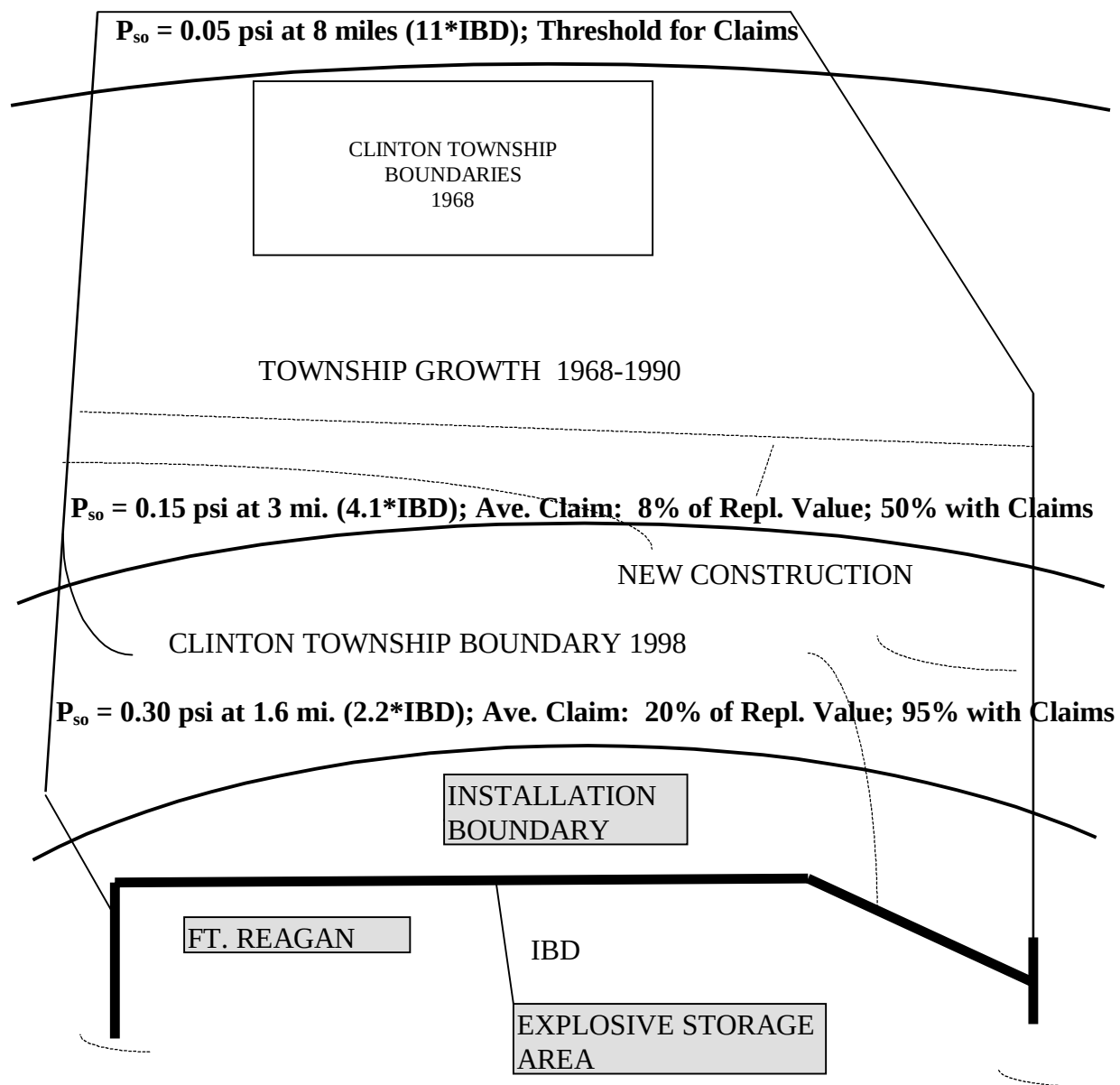


FIGURE 2

After the event, a great deal of intense dialogue occurred, some within the community, some at the installation, and some between the two. All discussions received a great deal of coverage in the local and regional press and some national coverage. The local emergency management agencies were greatly concerned about their complete lack of awareness of the possible consequences of such an event on the community. There was also a great deal of confusion in the coordination of information released to these agencies immediately after the accident.

Although relationships between the installation and the community historically had been good,

most community members clearly did not understand the possible consequences of living near an ammunition storage area. For example, although residents were thankful that the nearby school was not in session at the time of the accident, they were shocked by the extensive breakage of classroom windows and the clear potential for injuries to their children in a future accident. Similar concerns were raised at several churches that, although several miles from the accidental detonation, had lost several large stained glass windows. Residents were also stunned by the extensive damage to a few lightweight, pre-engineered metal buildings adjacent to the installation boundary; these buildings were near total collapse.

Not surprisingly, the residents nearest to the installation boundary were the most vocal. Since they experienced the greatest property damage, they held the common perception that their property values would suffer. In addition, since the closest residential areas had been recently constructed, residents tended to be younger and less tolerant of the risk imposed on the community by the presence of a military installation.

There was considerable discussion of the damage guidelines presented in the DoD safety standard and the need to provide the installation safety community with a better understanding of the consequences of such events. Senior Army and DoD leadership was extremely concerned about the consequences of this event on future safety policy, such as reduced storage limits as community growth increased in the vicinity of installations. There was public discussion over the regulation of ammunition storage under EPA regulations, a concept that had been proposed by EPA in the 1990's but withdrawn.

Conclusions

The scenario described in this paper is hypothetical. It is intended to raise awareness in the DoD safety community of the consequences of a maximum credible explosion based on the storage capacity of a typical magazine in an area where civilian population growth in proximity to an installation has occurred. The fact that such an event is still hypothetical is a demonstration of current safety processes in place in the design and storage of munitions and explosives. However, these processes are under constant pressure as we see draw down in the number and experience level of safety management staff and reductions in O&M funds.

Risk is the product of the probability of an event occurring and the consequences of that event. The current DoD regulation is just beginning to wrestle with the concept of risk based management of ammunition storage. The damage consequences in this paper are extracted from an actual event which is discussed in detail in another paper in this seminar (Ref: Reed/Zehrt). It is important to understand that the public will decide what is the likely cost of damage from an event (through insurers and lawyers), not the DoD regulations. It is also important to understand the public standard of acceptable risk may be significantly different from that defined by the DoD safety standard.

In dealing with community relations, it would suggest that closer coordination with local emergency management agencies over possible event consequences and response expectations

would be a wise initiative. This coordination is already standard policy at chemical storage facilities and would benefit conventional ammunition storage installations as well.