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SAFETY CONSIDERATIONS IN THE DESIGN OF RIOT-CONTROL GRENADES

by

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Safety Office

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This report evaluates the functional safety of the three riot-control grenades (i.e., the M7A3, M25A2, and M47) currently in the Army inventory. This report shows that there is a sufficient data base to perform a safety analysis, and that the analysis does provide specific, safety design criteria for developmental riot-control grenades.

PREFACE

The work described in this report was conducted in support of the M47 Riot Control Grenade Program. The work was done in September 1981.

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SAFETY CONSIDERATIONS IN THE DESIGN OF RIOT-CONTROL GRENADES

1. INTRODUCTION

One of the primary, system safety program objectives stated in MIL-STD-882A is defining a systematic approach to insure that historical safety data is considered and used in the design of new systems. This is an important objective, because it can provide design engineers with specific, safety design criteria for a new system. Too often the words "will present no unacceptable hazard" appear in a requirements document. This phrase is ambiguous and of little help to the design engineer in determining an appropriate design for a system. This study of riot-control grenades shows how historical safety data from previous riot-control grenades can be used to develop specific, safety design criteria for riot-control grenades in development.

2. EVALUATION

2.1 The Mission of Riot-Control Munitions.

Over the years, the Army has developed a variety of riot-control munitions to perform the riot-control mission. Unlike most munitions, riot-control munitions have a dual mission. They must be capable of being used in both a tactical, military situation and in a civil-disturbance situation. The first mission requires a munition that meets the safety requirements of any Army system; i.e., the munition must be safe during manufacture, transportation, storage, use, and disposal.

The second mission requires a munition which is not only safe to the user, but a munition that is safe to the target (often civilian) personnel as well. The munition must incapacitate the target personnel without presenting any unacceptable or residual hazards to the target personnel or the environment.

2.2 Description of Recent Riot-Control Grenades.

A prerequisite for the use of historical safety data in developing safety design criteria for a system is that a sufficient data base must already exist. In the case of riot-control grenades, the Army has developed and used three different riot-control grenades in recent years. The experience gained through use of these three grenades provides the data base for this study.

The first grenade used in recent years was the M7A3 "beer can" grenade (figure 1). The M7 was eventually replaced by the M25A2 "explosive disseminating" grenade (figure 2). The final grenade, developed to replace both the M25A2 and the M7A3, was the M47 "softball" grenade (figure 3). All these grenades consisted of three major components: the fill material (incapacitating compound) the fuze/dissemination mechanism, and the body.

Breaking the grenade into these three components is the first step to developing specific, safety design criteria. The next step is to evaluate the historical safety data, as it pertains to each of these components. Based on this data, safety design criteria for that component of a developmental riot-control grenade can be determined.

Figure 1. M7 Series Riot Control Grenade

Figure 2. M25 Series Riot Control Grenade

Figure 3. M47 Riot Control Grenade

2.3 Evaluation of the Incapacitating Compound.

The first component to be evaluated is the incapacitating compound. The inherent hazards associated with the use of any chemical compound, (i.e., flammability, toxicity, reactivity, and environmental impact) must be considered when employing the incapacitating compound in a system. Since 1959, the incapacitating compound used in riot-control grenades has been powdered o-chlorobenzalmalononitrile (CS). CS has proven to be a reliable riot-control incapacitating compound which incapacitates target personnel without producing any residual health hazards. Its use, however, does result in an environmental hazard because of its persistency and problems in decontamination. Safety design requirements of a developmental riot-control grenade should address this particular hazard. An appropriate requirement would be that:

(a) The incapacitating compound that is used must not present any greater health hazards than CS.

(b) The incapacitating compound must not present a persistent environmental hazard.

These requirements are, in fact, presently being addressed at Chemical Systems Laboratory (CSL).

2.4 Evaluation of the Fuze/Dissemination Mechanism.

The second component to be evaluated is the fuze/dissemination mechanism. The most significant changes in riot-control grenades have been to this component. The M7A3 grenade used a pyrotechnic fuze with a pyrotechnics-coated CS fill. The fuze ignited the pyrotechnic coating on the CS which, as it burned, volatilized the CS. The CS was then emitted as a smoke through emission ports (holes) in the top of the grenade. This design resulted in a severe fire hazard, caused by the high heat generated at the emission ports. If the grenade was used in locations containing combustible materials, such as houses, stores, apartment buildings, and fields, the resulting fires could produce extensive property damage.

To eliminate this hazard and another hazard discussed in paragraph 2.2.3, the M25A2 grenade was designed, which explosively disseminated the CS. To control the fragment hazard to target personnel associated with fragmenting grenades, the grenade was designed with plastic parts. As an added safety precaution, the users were instructed to throw the grenade upwind of the intended target in civilian disturbances.

This new design eliminated the fire hazard of the previous grenade, but introduced two new hazards. First, the M25A2 grenade had a different fuze which did not incorporate the standard, fuze safety lever (figure 4). The new fuze required the user to maintain pressure on the arming sleeve at the top of the grenade until the grenade was thrown (figure 2). This fuze design resulted in injuries to the user, because the user would not maintain the required pressure after removing the safety pin. The grenade would then begin to function in the thrower's hand and explode in, or inches from, the thrower's hand and arm.

The second hazard identified during use of the M25A2 grenade was the accidental functioning of the grenade with the safety pin intact. If the grenade was dropped onto a hard surface, the plastic fuze housing would break and the grenade would subsequently function. Because of these hazards, the M25A2 grenade was type reclassified "obsolete" and work was begun on a new riot-control grenade, the M47.

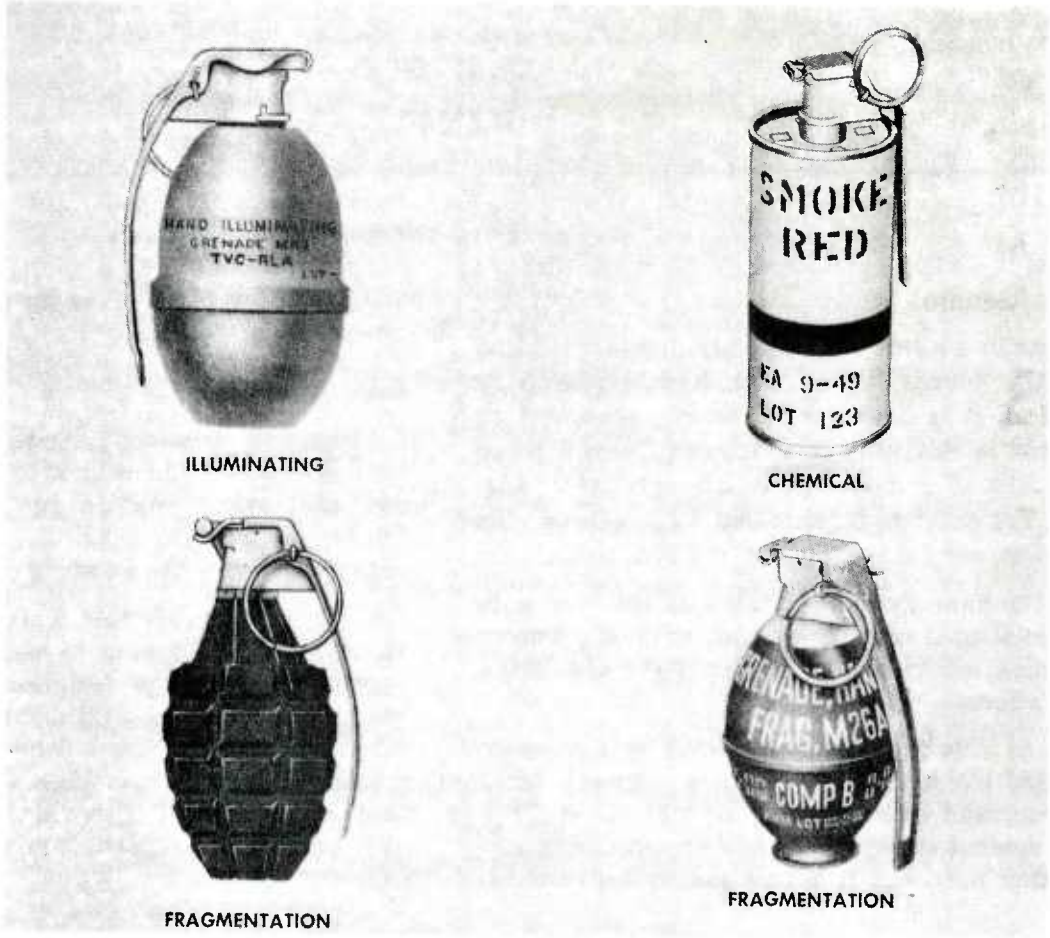

Figure 4. Grenades with Standard Fuze Safety Lever

The M47 riot-control grenade employed pyrotechnic dissemination of CS. To overcome the fire hazard inherent in the M7A3 grenade, this grenade had a spherical body which allowed the grenade to skitter as it disseminated the CS. The fuze design returned to use of the standard grenade safety lever, and a second safety device was incorporated. When the grenade functioned properly, it did not present any hazards to either the user or target personnel. During initial production testing, a fragment hazard to target personnel was identified in the event of a "hangfire". The arming pin, which is normally ejected with the handle when the grenade is released from the thrower's hand, did not eject, in some cases, until the grenade hit the ground. Were this to occur in the vicinity of the target personnel, the arming pin would present a significant eye hazard to the target personnel. Identification and evaluation of this hazard led to a redesign of the fuze/dissemination mechanism for the M47 grenade. This effort is currently in progress.

Based upon this evaluation of the historical safety data pertaining to the fuze/dissemination mechanism, the safety design criteria for this component of a developmental riot-control grenade can be established. The developmental grenades should meet the following requirements:

(a) The grenade must not present a fire hazard when used in its intended operating environments.

(b) The grenade must not produce hazardous fragments during normal functioning.

(c) The fuze design must be similar in appearance and operation to standard hand grenades.

(d) The grenade must be fail-safe to both the user and target personnel should a hangfire or dud occur.

2.5 Evaluation of the Grenade Body.

The third component to be evaluated is the grenade body. The M7A3 grenade used a metal "beer can" type body. This body was both an impact hazard to target personnel and to user personnel if the grenade was thrown back by the target personnel. The M25A2 grenade eliminated this hazard by explosively disseminating the CS, and thus eliminating any components that could be thrown back. When it was decided to design a third riot-control grenade, deploying CS in the same way as the M7A3 grenade, this hazard had to be eliminated in another way. The M47 grenade used a soft-rubber body, which effectively eliminated any impact hazard to either the target personnel or the user. Any developmental riot-control grenade should include the following requirement to ensure that the level of safety achieved in M47 body design is not degraded in a subsequent design. The grenade must not present an impact hazard to either target personnel or user personnel.

3. SUMMARY

By systematically evaluating the historical safety data generated from use of previous riot-control grenades, specific, safety design criteria for a new grenade has been established. The resultant design criteria obtained from this evaluation are summarized below.

(a) The incapacitating compound must not present any greater health hazards than CS.

(b) The incapacitating compound must not present a persistent environmental hazard.

(c) The grenade must not present a fire hazard when used in its intended operating environments.

(d) The grenade must not produce hazardous fragments during normal functioning.

(e) The fuze design must be similar in appearance and operation to standard hand grenades.

(f) In the event of a hangfire or dud, the grenade must be fail safe to both the user and target personnel.

(g) The grenade body must not present an impact hazard to either target or user personnel.

4. CONCLUSIONS

4.1 A sufficient data base exists to perform a safety analysis of previously fielded riot-control grenades.

4.2 A systematic approach, based on historical safety data, can be used to develop specific safety design criteria for developmental riot-control grenades.

5. RECOMMENDATIONS

5.1 The requirements established in this report should be included in the design requirements of developmental riot-control grenades.

5.2 A detailed hazard analysis should be performed to provide even more specific and complete safety design requirements for developmental riot-control grenades.

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