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COMMENTS ON THE USE OF PARACHUTE RECOVERY OF AIR-DEFENSE WARHEADS TO PREVENT PLUTONIUM CONTAMINATION

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COMMENTS ON THE USE OF PARACHUTE RECOVERY OF AIR-DEFENSE WARHEADS TO PREVENT PLUTONIUM CONTAMINATION

INTRODUCTION

Many of the warheads being considered for use in the air defense of the U. S. contain plutonium. Since plutonium is a dangerous contaminant* there exists a serious problem in disposing of aborted missiles. Present self-destruct plans call for a one-point detonation or shaped-charge destruction of the warhead, which would scatter the plutonium in the atmosphere. Full-scale nuclear detonation of the warhead has been suggested as an alternative procedure. The use of all-oralloy systems is also being considered, although this alternative may require a warhead whose diameter is at least 14 inches.

Parachute recovery systems have been employed successfully to recover various parts of missiles and, in one case[2] have been suggested for the recovery of atomic warheads.

It is the purpose of this report to revive the suggestion to use parachute-recovery systems, and to describe some of the problems which arise. Parachute-recovery systems have the advantages of permitting the costly nuclear warheads to be recovered and of reducing the probability of plutonium contamination. The biggest disadvantage is that most missiles would require redesign to provide space of about one-half to one cubic foot for the parachute system. However, since the diameter may be held constant, this redesign problem may be less drastic than the problem of redesign to accommodate a larger-diameter, all-oralloy system, if that is considered the only other alternative.

THE RECOVERY SEQUENCE

The following is a possible sequence of operations which might be employed in the parachute recovery of missile warheads:

1. Abort signal is received.
2. X-unit unloads.
3. Warhead separates from missile.

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* e.g., see Reference 1.

4. Parachute-opening delay timer starts.
5. Parachute is deployed.
6. Warhead impacts.
7. Warhead is recovered.

Each of the steps in the sequence is considered below:

1. The Abort Signal. -- Present air defense missiles and warheads are provided with a variety of sensing systems to initiate self-destruction. These sensing systems may be used to initiate parachute recovery.

2. X-Unit Unloading. -- A warhead with a charged X-unit may undergo a full-scale nuclear detonation if it is mechanically shocked. In a parachute-recovery system, the warhead will receive large shocks at three different times:

a. At the time the warhead separates from the missile and during its free-fall,

b. At the time the parachute opens, and

c. When the warhead hits the earth.

It is not obvious that the X-unit would discharge under any of these shocks. Thus, two approaches to the problem may be followed:

(1) Design an X-unit unloading or safing device.*
(2) Design an experimental program to see if the anticipated shocks cause the X-unit to discharge. Such an experiment may show that it is unnecessary to unload the X-unit. (This experiment could be conducted from a drop tower if dummy spheres were used.)

3. Warhead Separation. -- Warhead separation from the missile must be considered on an individual system basis, but probably should make use of small explosive charges or explosive bolts to provide positive and rapid separation.

4. Parachute-Opening Delay. -- Much flexibility in the parachute-system design may be obtained simply by delaying the parachute opening long enough to insure that the warhead has slowed down to some fixed speed and Mach number before deploying the parachute. That is, if the

*One idea for such a device was proposed in Reference 3.

parachute must be capable of deployment at M = 3 at 10,000 feet it will be stronger, and therefore bulkier, than a parachute which is opened a few seconds later when the warhead has slowed down.

The maximum allowable delay time is probably determined by the minimum altitude at which parachute recovery must be initiated. If the maximum delay time is specified, some approximate warhead trajectories may be computed to estimate the speed at the delay time of interest. When the warhead speed at the time of deployment is known, the required strength of the parachute may be determined.

To estimate the feasibility of employing a delay timer, two trajectories were computed for a spherical warhead separated from a missile traveling at M = 3 at 10,000 feet. Figures 1 and 2 present trajectory data for a warhead whose initial speed is 3240 ft/sec in horizontal and vertical directions, respectively. The sphere has an 18-inch diameter, and weighs 300 pounds. The drag coefficient for a sphere (given in References 4 and 5) is approximately unity for the Mach number range of interest. Note that both trajectories indicate that the speed of the warhead decreases to 1500 ft/sec in about 2 seconds. (Time delays of this size can be measured satisfactorily with small pyrotechnic timers.)

A cylinder would probably slow down faster than a sphere, because it would have about the same drag for axial flow and about twice the drag of a sphere for an angle of attack of 90 degrees (see References 4 and 5).

5. Parachute Deployment. -- To obtain satisfactory separation of the parachute from the tumbling warhead section, explosive deployment will probably be required. Rapid deployment would reduce the chances of entangling or cutting the parachute risers.

6. Warhead Impact. -- The impact speed must be low enough to insure that neither the detonators nor the high explosive will explode. Thus, an experiment is required to determine the maximum allowable impact speed. When this speed is known, the required parachute diameter is specified for any given weight. Figure 3 indicates the required parachute diameter as a function of weight for terminal speeds (V_f) of 50, 100, 150, and 200 ft/sec.

A small number of Mk 7 spheres with detonators installed were dropped from a 40-foot tower onto an extremely hard surface. None of the spheres exploded at this speed (50 ft/sec). Accidents provide a few more data points at higher speeds, but are inconclusive because of the small numbers involved and because of the presence of materials surrounding the warheads. However, it seems reasonable to expect allowable impact speeds to be at least 100-150 ft/sec. For this speed range, Fig. 3

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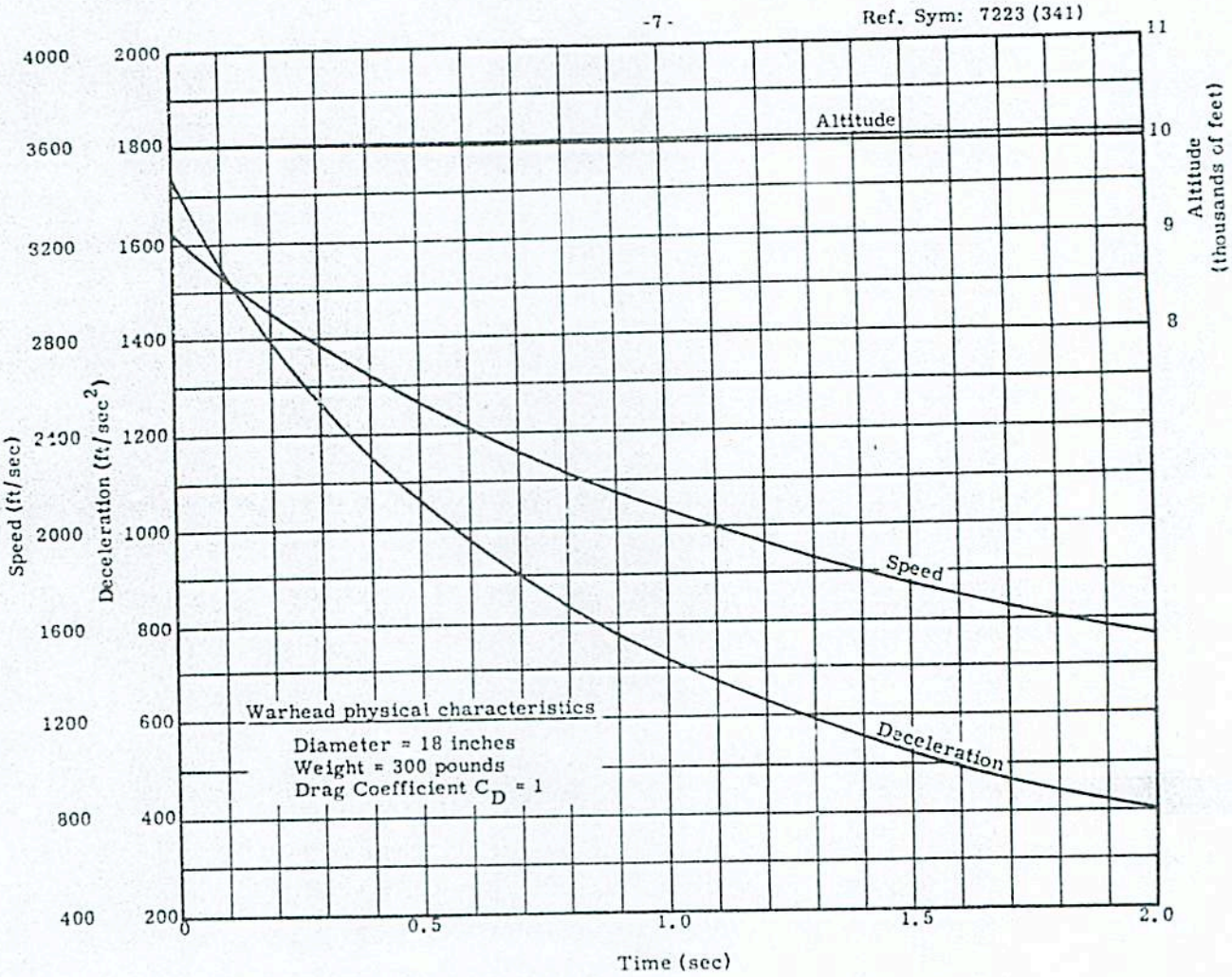

Fig. 1 -- Warhead trajectory data for initial horizontal speed of 3240 ft/sec

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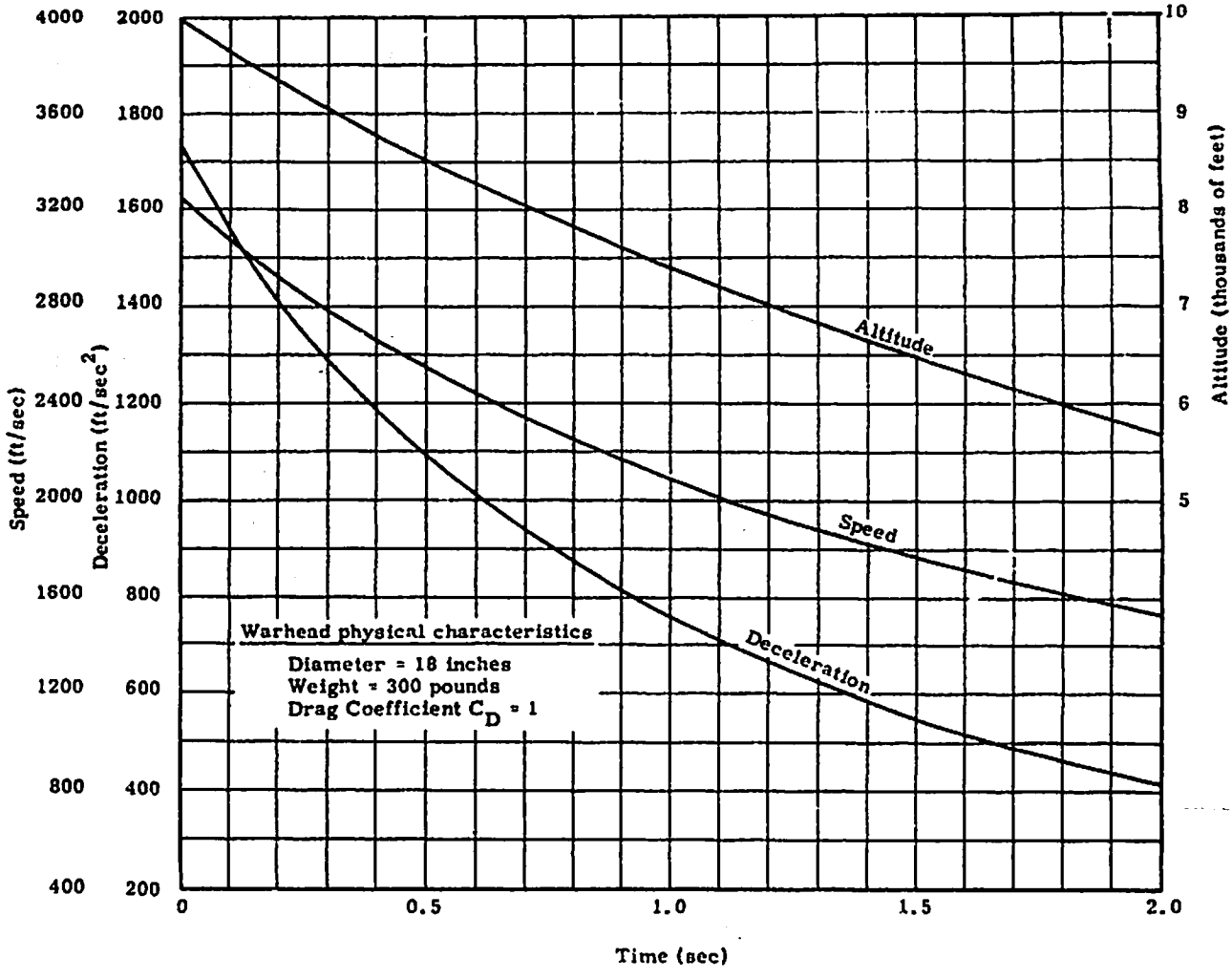

Fig. 2 -- Warhead trajectory data for initial vertical speed of 3240 ft/sec

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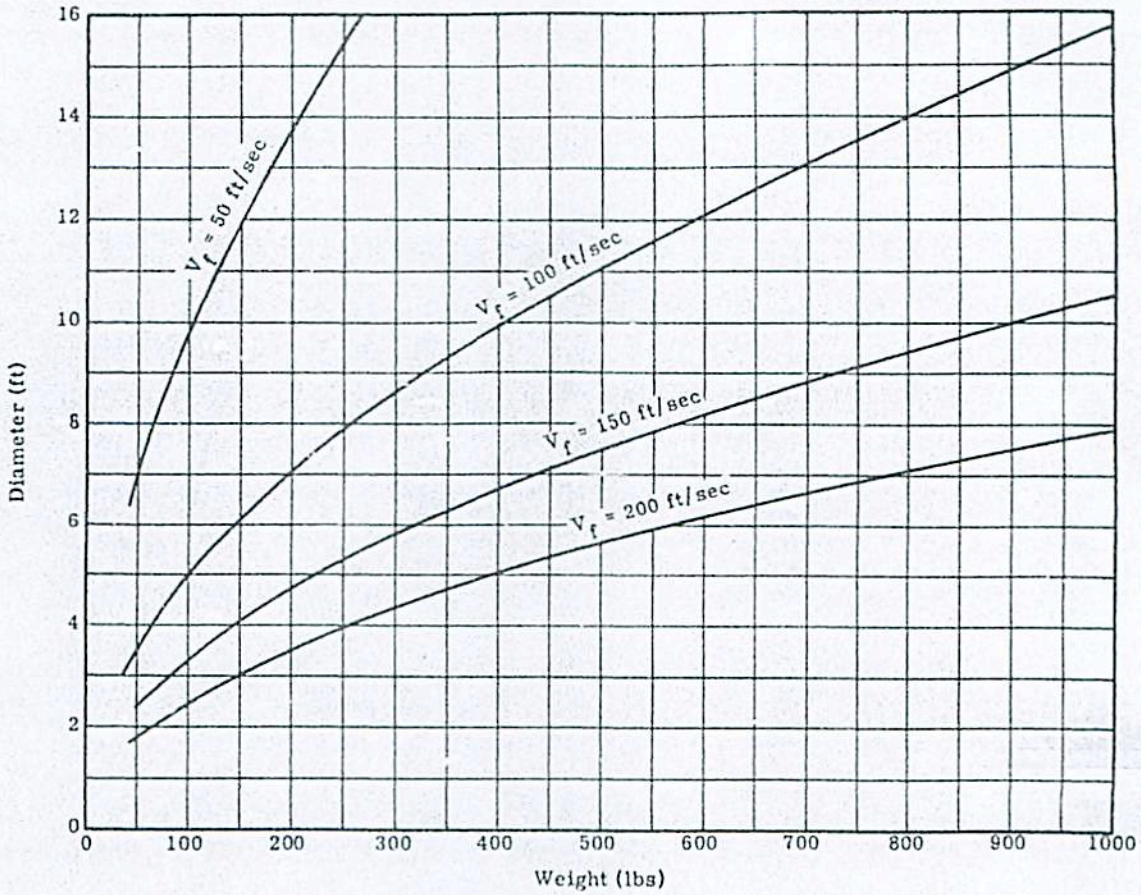

Fig. 3 -- Parachute diameter versus weight of load for given terminal speeds, V_f

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indicates that a 200-pound warhead would require a parachute diameter of 4-1/2 to 7 feet. A parachute of this size and adequate strength for opening at M = 1.5 would occupy about 1/2 to 1 cubic feet. While these volumes are rather large, no major effort has been made to minimize the volume strength ratio in parachute design, and significant improvement should be possible. Of course, even these volumes are not completely impractical. For example, the present Talos W (XW-30) missile has about 0.8 cubic foot available in the forward end of the inner body. The XW-30 weighs about 450 pounds and would require a 7-foot parachute for a 150 ft/sec impact speed. This size chute may fit into the 0.8 cubic foot available, even though some insulation may be required to protect the nylon from the aerodynamic heating expected at the forward end of the inner body. Present plans call for an all-oralloy system in the XW-30, but warhead recovery may be desirable for economic reasons.

7. Warhead Recovery. -- To aid in locating the warheads after they have impacted, it may be desirable to attach a beacon to the warhead. A Co^{60} source would probably be detectable at 1/4-mile distances, and only light shielding would be necessary between the source and the warhead. A simple radio or flashing light beacon might also provide a satisfactory solution to the problem.

SUMMARY

Parachute recovery of small air defense warheads may be feasible. The following design problems require investigation:

1. Unloading or safing the X-unit. If this approach is difficult or undesirable for reliability reasons, an experiment may be designed to establish whether or not the X-unit would explode the warhead when subjected to the expected mechanical shocks.

2. Separation of the warhead from the missile. This problem must be examined on an individual missile basis.

3. Deployment of the parachute from a tumbling warhead.

4. Maximum allowable impact speeds of HE warheads with detonators installed (and possibly with the X-unit charged).

5. Parachute designs which minimize the volume strength ratio.

6. A beacon device for warhead recovery.

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Of course, the question of desirability (reliability, etc.) also remains to be investigated.

The following other ideas may be worthy of consideration:

1. The use of small rotochutes.

2. Separation of the HE warhead prior to parachute deployment so that only the fissionable material is recovered.

R. J. FLANAGAN - 5124

Case No. 417.00
October 15, 1956

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