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RAIN PREMATURE SUSCEPTIBILITY STUDY ON THE PROPOSED PIEZOELECTRIC CONTACT FUZE SYSTEM FOR TRIGGERING THE MC-132 IN THE TX-5X1 WEAPON

Robert D. Wehrle

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ABSTRACT

The probability of the occurrence of rain during the "Armed" portion of the fall of a bomb is approximately 1/25. Ref. (1). Therefore, rain is considered a problem in premature detonation of the warhead thru activation of the contact fuze system. Laboratory tests simulating raindrop impacts have been conducted by Division 5341, to determine the seriousness of the problem. These tests indicated that some local attenuation system should be used for the units located on the nose plate to insure safety against the possibility of prematures during fall through rain. Suggestions are made as to the solution of this problem. An analysis is also suggested to determine whether or not the simulated rain tests, made to date, are overly severe.

11 pages

Case No. 562.0

June 18, 1953

CENTRAL RECORD FILE
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References: 1. "An Evaluation of the Probability of the Occurrence of Hail and Rain during Strategic and Tactical use TX7X1, TX12, Corporal, and Honest John", Ref. Sym: 5132-(6), dated July 8, 1952.

2. Tech. Memo No. 25-53-53, "MC-300 and MC-343 Summary Report", R. D. Wehrle and D. W. Brees, dated April 10, 1953.

Enclosures: A - Sketch of TX5X1, Rain Shield Fairing.

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INTRODUCTION

Summarizing reference (1), the probability of the occurrence of fall through hail is at worst 1/2000 and more realistically, less than 1/20,000; and the probability of fall through rain is at worst 1/10 and probably 1/25. Based on this information, hail is not considered to be a problem in causing premature detonation of the warhead in the TX5X1. Since the probability of hail is so low, no hail sensitivity study has been made. However, the occurrence of rain is considered a problem and various tests are being employed, or have been suggested, to determine the seriousness of the problem. An outline of suggested rain premature tests with respect to scope and method is given in reference (2).

SUMMARY OF RESULTS

Tests conducted by Division 5341, using plastic balls to simulate rain, indicate that the impact of rain (of 5.75 mm diameter or larger) in the immediate area of the MC-300 locations at station 0, could cause the contact fuze system, as it now stands, to function prematurely. The use of rain shield fairings of the type shown in Enc. A, reduced the voltage output in the immediate area of the crystal units; however, the attenuation was not sufficient to eliminate the possibility of rain prematures. The situation could be eliminated by the use of attenuating resistors placed in series with the crystal units that produce the unsafe condition. This method of desensitization would affect only the individual units requiring the resistor and would leave the remainder of the units in the network at full sensitivity. It is felt that considerably more data must be collected, as per reference (2), before a definite conclusion can be drawn as to whether or not there is a real probability of rain prematures. All tests to date have been laboratory simulated rain (plastic ball) tests, which may be overly severe.

DISCUSSION

The tests mentioned above consisted of shooting an MC-33 forward nose section with an air rifle modified to shoot 0.1875" diameter plastic balls at a velocity of approximately 1100 feet per second. The kinetic energy of the plastic balls at impact was approximately 3.5 foot pounds. The shots were made directly over the crystal units and at approximately one inch intervals away from the crystal in various directions. The angle of attack of the plastic balls was perpendicular to the skin and/or parallel to the longitudinal axis of the weapon case. The electrical impedance used for the tests corresponded to actual impedance of the contact fuze system of the weapon as it now stands. The crystals were in the same locations as those of the present system, with four units per network connected in parallel. The results of the tests of the present system are tabulated below.

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MAXIMUM PEAK POSITIVE VOLTAGE OUTPUT OF CRYSTAL NETWORK

Impact	Station Location	Shot Number 1	2	3	4	5	6	Remarks
Perpendicular to skin	0 Units not under hinge	6.0	11.0	16.0	70.0	14.0	8.0	Without rain shield fairings. Shot No. 4 was directly over the crysta unit.
"	0 Units not under hinge	---	7.1	14.0	22.0	8.8	---	With rain shield fairings. Shot No. 4 was directly over crystal un
"	0 Units under hinge	7.0	15.5	3.8	100.0	20.0	13.2	Without rain shield fairings. Shot No. 4 was directly over crystal un Shots No. 2 and 5 were just off hin
"	0 Units under hinge	---	---	2.2	1.0	---	---	With rain shield fairings. Shot No. 4 was directly over crystal un
"	10	6.0	5.0	6.1	7.8	4.4	4.0	Shot No. 1 was directly over the crystal unit.
Parallel to axis	10	2.6	2.3	2.[illegible]	2.6	3.2	2.4	Shot No. 1 was directly over the crystal unit.

It should be noted that the voltage outputs tabulated above are the maximums that resulted from a series of tests with impacts at various points in the immediate area of the MC-300 units. It should also be noted that impacts perpendicular to the skin of the weapon at station 10 are overly severe since high velocity perpendicular impacts with rain at this location are not possible and are included in this report only for comparison with impacts that were parallel to the longitudinal axis of the weapon. The units at station 10 appear to be safe against the possibility of rain prematures, but the system at station 0 is questionable.

The plastic balls used for these tests had a specific gravity of approximately 1.5, and the diameter corresponds to a raindrop of 4.75 mm. The kinetic energy of these balls at 1100 feet per second is equivalent to the energy of a raindrop of 5.75 mm diameter at 1000 feet per second. The ball impacts are believed to be more severe than raindrop impacts, since they approach an elastic collision, and a raindrop would probably approach inelastic collision.

It is understood that the TX-5 falls at a velocity of approximately 1000 feet per second during the armed portion of its trajectory. Assuming the weapon is armed for the final 10,000 feet of fall, and the affected cross-sectional area to be approximately one square meter, and also assuming the weapon falling thru a thunderstorm, it statistically would be possible for the weapon to strike from 0.69 to 0.97 raindrops of 5.75 mm diameter and 1.35 to 2.32 drops of larger size (calculated from data of Ref. 1). If the forward projection of the extremely sensitive areas of the four units located on station zero is estimated as 0.03 square meter, the number of raindrops encountered of the sizes mentioned above would be reduced to approximately 3 per cent of the values quoted.

Other factors which may or may not have an effect on raindrops striking the weapon are air shock waves, slip streams, and pressure build-up. Since little information is available on these items and the data that is available is somewhat controversial the tests that were discussed above were conducted under the assumption that all raindrops encountered were not affected, deflected or atomized in any way by the action of the air around the weapon case. Another factor which was also neglected in the tests, due to lack of information on the subject, was the effect of a number of raindrops striking the weapon case simultaneously or at extremely short intervals of time which possibly could initiate vibrations in the weapon case and excite the crystal units. However, it is felt that any effect of this type would be of rather low amplitude and would not be serious. It is also believed that a factor of safety is produced in the plastic ball tests due to difference between the ball impacts and actual rain impacts. It is hoped that the Holloman sled tests using various weapon cases will provide sufficient information and data to give a correlation between laboratory tests and track tests where drops of water strike the weapon, so that a more realistic evaluation of this problem may be made.

CONCLUSIONS

The tests outlined in this memo indicate that the present TX-5 contact fuze system might function prematurely, during fall through rain. This probability could be reduced or eliminated by either or both of the following methods:

1. Redesign the rain shield fairing to provide a greater area of coverage and a more efficient attenuation of impacts.

2. Addition of electrical resistors in the cable harnesses and in series with the individual crystal units requiring attenuation. This method would desensitize local units while the remaining units of the system maintain full sensitivity but, adds the problem of sealing the resistors against moisture.

It is felt that additional information from sled tests through simulated rain are required before a definite answer to the problem can be obtained. It is also felt that a more thorough evaluation should be made as to the probability of large size raindrops impacting the sensitive area of the nose during armed portion of flight; in order to determine definitely whether or not there is a rain premature problem with the system as it now stands.

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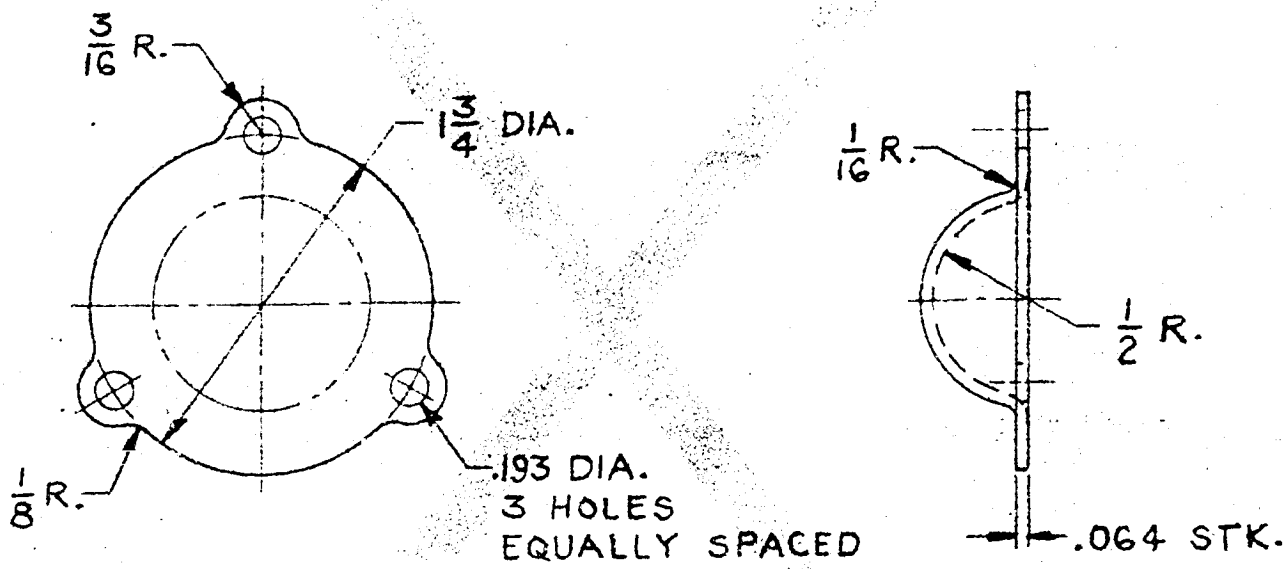

TX5X1 RAIN SHIELD

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