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TORPEDO MK 48 MOD 0 AND MOBILE TARGET MK 27 MOD 0 EXPLOSIVE DEVICE EVALUATION TEST PROGRAM

6 JUNE 1966

NOL

UNITED STATES NAVAL ORDNANCE LABORATORY, WHITE OAK, MARYLAND

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TORPEDO MK 48 MOD 0 AND MOBILE TARGET MK 27 MOD 0

EXPLOSIVE DEVICE EVALUATION TEST PROGRAM

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ABSTRACT: Information is provided on the test and evaluation procedures recommended for the development of explosive components for Naval Ordnance. Also specific evaluation test programs are provided for nine explosive devices contained in the Torpedo Mk 48 Mod 0 and the Mobile Target Mk 27 Mod 0.

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The Torpedo Mk 48 Mod 0 and Mobile Target Mk 27 Mod 0 are under development by the Westinghouse Corporation, Baltimore, Maryland under the technical direction of the Ordnance Research Laboratory Pennsylvania State University, State College, Pennsylvania. The Naval Ordnance Laboratory, under WEPTASK ASWP 10 000 W006 B0 03, Problem 121, provides consulting services for the program and this report was prepared as part of this task.

J. A. DARE
Captain, USN
Commander

R. E. Grantham
R. E. GRANTHAM
By direction

CONTENTS

REFERENCES

(a) CNM(ASWSPO) spdltr ASW:P14:GWK of 26 Jul 1965 to NOL(WO)

(b) NOL(WO) ltr JM:DES:esr 8510 Ser 5788 of 17 Sep 1965 to BUWEPS

(c) CNM(ASWSPO) ltr ASW-P-14:GWK of 13 May 1966 to NOL(WO)

(d) NOL(WO) ltr J:JMM:esr 8510 Ser 01228 of 16 Jun 1965 to BUWEPS

1.0 Introduction

1.1 By reference (a) the Naval Ordnance Laboratory, White Oak, (NOL(WO)) was requested to assist the Anti-Submarine Warfare Systems Project Office (ASWSPO) in planning test and evaluation programs. Reference (b) contained a proposed laboratory plan for laboratory environmental tests of five torpedoes exclusive of explosive components. Reference (c) requested assistance on explosive components.

1.2 This report contains a short discussion of development philosophy on explosive devices, a review of assumptions, a safety discussion, an outline of evaluation test procedures and guidelines, specific evaluation programs on nine components, and test descriptions and/or references.

2.0 Design and Testing of Explosive Devices

2.1 It has been found in the development of explosive devices that adherence to a controlled step by step procedure is required to give assurance that this type of device will perform properly for the intended purpose. The "one-shot" nature of the items presents unusual problems in design, quality control, evaluation and acceptance testing.

2.2 The philosophy normally used in the development of such items consists of the following steps:

2.2.1 Definition of the requirements

At the beginning of the design, the requirements should be clearly defined so that the designer is fully aware of the demands on the end product. Of specific interest are the following:

a. Input requirements for initiation
b. Output characteristics
c. Physical size
d. Sealing
e. Environmental requirements
f. Stockpile to target sequence expected
g. Production quantities planned

2.2.2 Design

The basic design work is directed toward meeting the specific requirements in the most economical and reliable manner. The use of proven techniques can often save time because even small deviations can often alter the performance of a "one-shot" item. There remains a certain element of "art" in the manufacture and assembly of this type of device.

2.2.3 Design Tests

As soon as a design is formulated, a representative sample is made to prove in the concept. Such samples are often hand made. These samples are used to conduct gross input and output tests, and for environmental tests which will disclose weaknesses in the design concept. In some cases two or three repeat cycles of this phase of the work are required.

2.2.4 Design Disclosures

Upon completion of design tests, a set of design disclosures (drawings and specifications) should be produced which clearly define how the device is to be manufactured. Tentative acceptance limits and tolerances are established.

2.2.5 Prototype Production

Once the design is essentially frozen and the concept confirmed by design tests, it is important to produce a quantity of units with proposed tooling using the design disclosures. During this step problems of transition from laboratory engineering models to a production item are expected to be solved. Specific problems, such as tolerances on piece part manufacture and assembly techniques, can be resolved.

2.2.6 Evaluation

Upon delivery of a specified number of items manufactured in accordance with the proposed design drawings and specifications, a formal evaluation program is conducted to determine the characteristics and expected performance of the device.

2.2.7 Final Revision of Design Disclosures

Usually the evaluation program discloses weaknesses or design margins in some areas. Also data is available in sufficient quantity to arrive at final specification values and acceptance criterion. At this point, there is assurance that the design can in fact be produced by a competent manufacturer in a uniform manner. The design disclosures are up dated to include all corrections considered mandatory.

2.2.8 Preproduction Acceptance

It is the general practice to require the contractor to submit a sample of preproduction units for final assessment before authorizing production of stockpile items. This is to assure that the manufacturing procedures and assembly techniques are well controlled. This is of particular importance because this type of device cannot be checked except on a sampling plan basis.

2.2.9 Periodic Sampling Surveillance Program

It is necessary to maintain some method of assessing the current readiness of stockpile items. As it is not possible to nondestructively test explosive devices, a periodic sampling and testing of the stockpile items is necessary. Such a plan should be initiated during the development so that sufficient spares are provided to maintain the proper logistics.

3.0 Assumptions

3.1 The specific evaluation programs presented as appendixes in this report are based on several assumptions that must be clearly understood. The test plans were generated without an intimate knowledge of the history and state of development of each item. It is expected that the plans could and should be modified in accordance with technical data available at any given time.

3.2 The basic assumptions are that:

3.2.1 The plans are for the explosive components only, and do not contain provisions to prove-in system safety or reliability.

3.2.2 The steps discussed in 2.2.1 through 2.3.4 have been accomplished. That is, the experimental and design phase, including design tests, has been successfully completed.

3.2.3 The items under consideration are "one-shot" devices that cannot be tested repeatedly, and therefore a fairly large sample size is required to prove-in the design.

3.2.4 The components should pass recognized safety, rough handling and environmental tests because of the potential safety hazards associated with explosives, and the high reliability required throughout the life cycle of an ordnance component.

3.2.5 Resistance to electromagnetic radiation (HERO) will be determined on a systems basis. Investigations on a component basis are not included in the enclosed plans.

3.2.6 This program does not include the evaluation of the HE warhead.

4.0 Safety Discussion

4.1 System Safety

4.1.1 Safety is primarily a system consideration. In the final analysis, it is concern for or fear of premature release of the destructive power of the weapon system which stimulates design activity and administrative procedures to obtain safety. On the other hand, every weapon system is made up of many smaller parts or subsystems. Each is contributing to safety or unsafety as the case may be. A safe system exists only if the component parts possess safety characteristics which adapt well to the system requirements and which work well as a team with the strong points of one component compensating for the weakness of another. Consequently it is first necessary to define and discuss system safety before dealing with component safety.

4.1.2 There is no single accepted definition of weapon safety. It is sufficient for this discussion to say that safety is adequate if an acceptably small chance exists that the weapon will actuate prematurely during assembly, handling, storage, transportation, check out, and launch up to a safe separation. How small this chance should be is a matter that is not easily resolved. The objective for Navy fuzes has been put at one in a million. But this was done with reservations, because an acceptable chance with one weapon may not be acceptable with another. Consequently this discussion will ignore the magnitude of chance and will instead be devoted to ways in which the chance of premature actuation can be reduced.

4.1.3 Safety is usually obtained by purposely inserting barriers in the operating train. For the weapon to function these barriers must be removed. These relations can be illustrated by logic symbols. Let X, Y and Z be three series barriers (safety components). Each of these can have two configurations; i.e. operated (safety removed) or unoperated (safety effective). X, Y and Z can be considered as two-valued variables. X can have the value x (operated) or $\bar{x}$ (unoperated). Y can have the value y (operated) or $\bar{y}$ (unoperated), and Z can have the value z (operated) or $\bar{z}$ (unoperated). The possible combinations of these variables appear in Figure 4.1 which employs the Euler Circles. The region $\bar{x}\ \bar{y}\ \bar{z}$ represents the usual safe condition of the weapon with all three safety components supplying designed safety. The region x y z represents the armed condition of the weapon with all three safety components operated in preparation for weapon functioning. Between these extremes there is a designed order of removal of safety. If in normal operation X operates first, Y second, and Z third, the sequence is $\bar{x}\ \bar{y}\ \bar{z} \rightarrow x\ \bar{y}\ \bar{z} \rightarrow x\ y\ \bar{z} \rightarrow x\ y\ z$. This is the operating logic. If this were the only way to remove safety and arm the weapon, the regions $x\ \bar{y}\ z$,

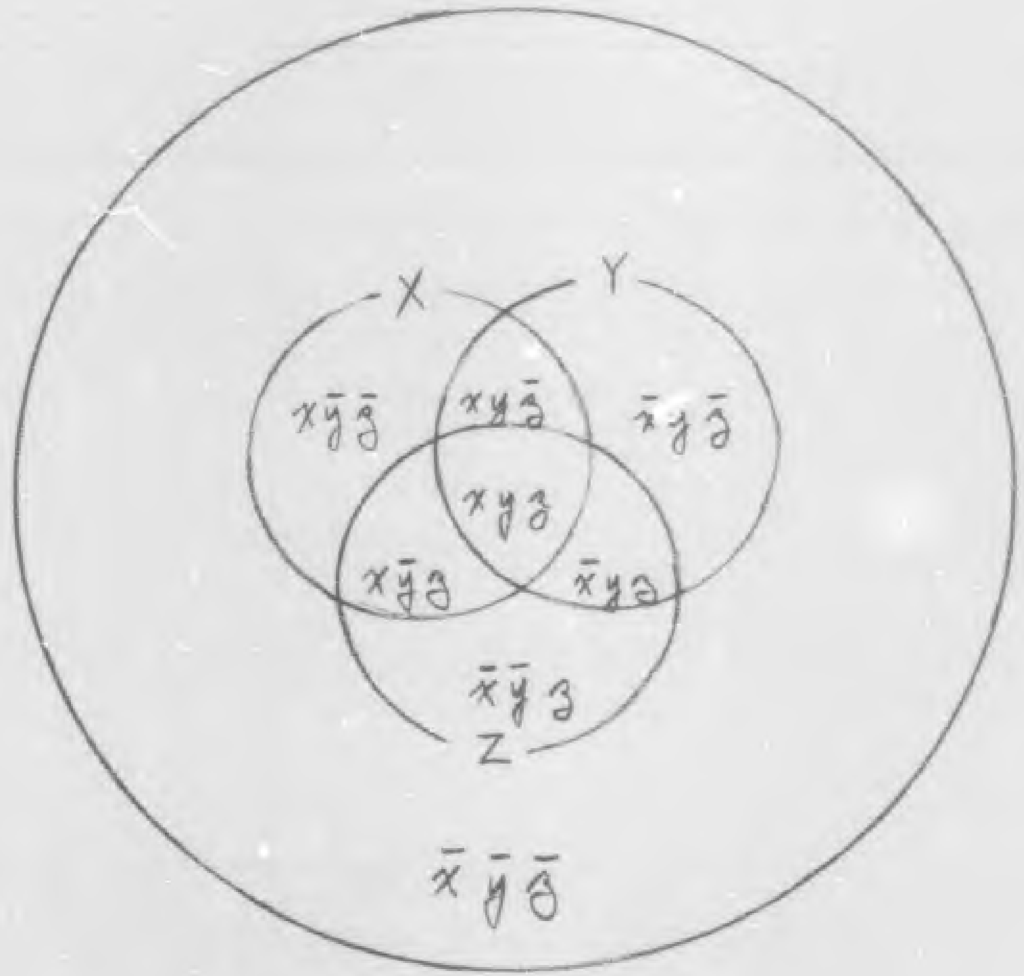


Fig. 4.1 Safety Component Configurations Illustrated by Euler Circles

$\bar{x}\ \bar{y}\ z$, $\bar{x}\ y\ z$, and $\bar{x}\ y\ \bar{z}$ would not exist. But experience has proved there are many ways the safety of a component can be defeated. It may be a faulty part that got by inspection. It may be a weak but acceptable part that was broken by rough treatment. It may have operated normally from an accidental signal. It may have been operated through personnel error. Any of these things by-pass the designed safety of the device. As far as the logic is concerned x may become $\bar{x}$ regardless of whether the operation of X was normal or abnormal. Therefore, the design problem is to obtain a combination of components, like X, Y and Z, such that environments, conditions, or personnel errors likely to defeat one component will not be likely to defeat another.

4.1.4 Hazards analysis is a term applied at the NOL to describe a systematic identification of environments, personnel actions, or other conditions, occurring in normal or abnormal situations in phases from manufacture through weapon launch, which can produce accidents unless preventive measures are taken. It is a systematic listing and analysis of those things which have happened or which can be forseen as happening during assembly, handling, storage, transportation, check out, and launch of the weapon. This list is then used as a guide to the design of safety components or the development of safety procedures. Its value is in suggesting design approaches or procedures to counter the safety threats of the events listed. Since the analysis considers abnormal as well as normal evnironments, personnel actions, and other conditions, a refined analysis must also consider the likelihood of encountering these events, for it is more important to provide protection in likely than unlikely situations. For example, it would be intolerable if a check out procedure performed on every weapon produced an unsafe condition. Design to preclude this would be necessary. But an unsafe condition produced by a very unusual circumstance would be more acceptable because the circumstance might never arise. Design to preclude this would be desirable but the risk might be acceptable without preventive measures.

4.1.5 The principal value of the hazards analysis is that it produces a list of events to be considered in the design of the safety system of the weapon. The design solutions to counteract these events become objectives. The designer may choose component X to counteract a dangerous environment. But X may not be particularly effective for another event on the list, so he adds a component Y. If this latter event occurs the system may take the configuration $x\ \bar{y}$, and an accident has been prevented by the presence of Y. On the other hand, the dangerous environment for which X was chosen might defeat Y. In this case the configuration becomes $\bar{x}\ y$ and the accident was prevented by X. By this process a combination of safety components is selected giving the best forseeable protection. To be sure, many of the environments, conditions, and personnel actions developed by this process will be familiar ones that would be thought of anyway. But by using a systematic process the opportunity to overlook the less obvious events is reduced. Furthermore when these events are uncovered before a design is frozen rather than as a result of experience with the design, costly redesign or retrofit can be avoided.

4.1.6 When a design has been frozen the hazards analysis loses much of its purpose. At best it can then only serve to check adequacy of the objectives to which the hardware was designed. The process of analyzing the safety provided by existing hardware is termed 'safety analysis' at the NOL(WO). The safety analysis has much in common with the hazards analysis. It considers normal and abnormal environments, conditions, and personnel actions and considers the likelihood of encountering these. However, it goes further. It considers known and anticipated failure modes of the actual hardware as they relate to these environments, conditions, and personnel actions. It considers the effects of breakage of parts, omission of parts, sneak paths around parts, etc., all related to the actual design and known characteristics of the hardware. It traces out the effects of these to show ways in which the condition x y z (the armed condition) may occur when unwanted. It considers ways in which the safety components can be by passed singly or collectively. For example, if static electricity should ignite an in-line detonator initiating the main charge, the condition of components X and Y located ahead of the detonator was of no consequence for they were completely by passed. Fear of such an event is one of many reasons for the interrupted explosive train which puts a safety barrier after the detonator to preclude such an accident. All of these possible accident paths are listed and evaluated. The purpose of the analysis is to gain assurance that reasonable and adequate protection from accidents through the conceived accident paths has been obtained through design and procedures.

4.1.7 The NOL(WO) does not have available documented procedures for conducting the hazards analysis and the safety analysis. The hazards analysis is still considered experimental and requiring further development before a fixed procedure can be documented. A report describing a safety analysis was written a number of years ago but it is now out of print and needs extensive revision to bring it in line with present analysis procedures. It is believed that with the description given here and in the enclosure to reference (d) and a few additional guide lines, a satisfactory safety analysis could be conducted. The additional guide lines deal with the method of starting the analysis and the following steps are recommended.

a. List phases in the manufacture to target sequence. Examples are assembly, handling, storage, transportation, check out and launch.

b. Subdivide phases if deemed necessary. An example would be subdivision of transportation into truck, rail, ship, or aircraft transportation.

c. List environments, conditions, and personnel actions which may occur in each phase or subphase concentrating on the unusual rather than the usual (the usual should be picked up in normal run throughs). Examples are application of excessive voltage during check out; bending a pin during connector mating; dropping the weapon during handling; overturning of the truck during transportation; weapon engulfed in fire in the storage area; etc.

d. Study the effects of each of the above circumstances on the safety of the system considering what safety remains and what additional circumstances would remove the remaining safety. This is a process of developing accident paths.

e. Discuss those accident paths judged to be most likely and how the system prevents these accidents through design or required procedures.

The purpose in identifying the most likely accident paths is that this permits a critical review of protection measures. Since the mechanisms of failure have been assumed, it also suggests ways to obtain better protection. The decision as to which paths are most likely is a matter of judgment. It would be desirable to express these paths in terms of probability of occurrence but the data necessary to do this are not available.

4.2 Explosive Component Safety

4.2.1 Since explosive components are by nature hazardous, they must be given special safety consideration. This discussion will concentrate on electroexplosive devices (EED's), i.e. explosive components which are electrically initiated.

4.2.2 It is generally accepted that initiation of explosives is a thermal process. The heat may be produced in a number of different ways. It may be the heating of the bridgewire, the normal mode of initiating an EED. It may be produced by shock, or by crushing, or by fire. From the system point of view the EED's must be adequately protected from these initiating stimuli, or they must be isolated so that premature initiation is not a safety problem. What constitutes adequate protection or isolation depends on the characteristics of the EED.

4.2.3 Two of the more dramatic safety problems encountered with explosive components involved extreme shock sensitivity and extreme electrical sensitivity. The extreme shock sensitivity developed in detonators in which azide combined with copper in the presence of moisture to produce a very sensitive explosive compound. This particular problem is well known and is avoided by choice of materials and component design. However there is always some chance that other undiscovered incompatibilities exist, particularly when a new material is placed in contact with, or in the vicinity of the explosive. Consequently the test programs of new explosive components place considerable emphasis on determining aging characteristics. With the time schedules available this must be done by accelerated tests and must accept the risks that the accelerated tests will give different results from long term aging.

4.2.4 Carbon bridge EED's accentuated the problems of extreme electrical sensitivity. These devices were designed to reduce power requirements in electronic fuzes. The first accidents occurred on the production line and were caused by static electricity. A series of special procedures for handling had to be developed. These EED's were then picked for use in other weapon components. This focused attention on their extreme susceptibility to initiation by RF energies. As a result of these safety problems, requirements were issued for use of insensitive EED's. The present requirement of MIL-I-23659 is a no-fire level not less than one ampere and one watt when applied for five minutes. This is not a complete solution for HERO problems but does make it easier to obtain the needed additional protection from shielding.

4.2.5 These examples of safety problems with explosive components were related to show the relation of their safety to system safety. Even though the known explosive-material combinations which may become highly shock sensitive are avoided, the system design should afford maximum practical protection to the components. Even though the extremely sensitive carbon bridge EED's are not employed the system design should effectively shield the circuits from radiated energy. Experience has indicated that explosive component evaluation programs of the types appearing in the appendices give adequate measures of characteristics, provided there has been the needed attention to protection of the explosive devices in system design. In this regard, the test programs submitted have been based on the assumption that the Torpedo Mk 48 Mod 0 and the Mobile Target Mk 27 Mod 0 afford protection to the explosive components which is similar to underwater weapons familiar to NOL personnel.

4.2.6 There is an aspect of explosive component safety which is less system oriented. Explosive components are frequently stored and handled apart from the weapon and installed at the last practical assembly point. The safety of personnel who handle, test, and install the components is a consideration. The fuze rough handling tests included in the test plans in the appendices are generally adequate to show that ordinary prescribed precautions for ordnance are sufficient to avoid personnel injury. This is not the only purpose of these tests. They serve also to show that the components possess an inherent ruggedness which is needed if the weapon system is to survive many of the possible accident situations.

4.2.7 Tests of explosive components have the following general safety purposes:

a. Current or voltage sensitivity tests: to determine susceptibility to initiation by stray energy and to explore circuit design problems.

b. Vibration: to detect any tendency for explosive to sift or parts to shift which changes characteristics.

c. Shock: to detect any excessive shock sensitivity.

d. Accelerated aging: to accelerate any chemical changes which would affect characteristics.

e. Jolt and jumble: to detect any handling problems and any tendency for explosive to sift and parts to break or shift.

f. Cook-off: to determine ignition level for system design considerations.

Information obtained from tests can often be used in system safety analyses because they give an indication of ways in which the components can be initiated by environments acting on the weapon.

5.0 Test Procedures and Guide Lines

5.1 Since explosive devices are expected to be inherently very reliable yct cannot be tested on a repetitive cycle, it is necessary to achieve the necessary confidence in the design and manufacturing techniques by utilizing special test procedures.

5.2 Environmental overtest methods are generally used in evaluation of explosive components. Overtesting is achieved by exposing samples to environmental stresses in excess of those expected in the normal life of a weapon component. If a device is safe to handle and performs reliably after environmental overtests, it can be reasoned that it will not be adversely affected during handling, stowage and use in the normal sequence of fleet use.

5.3 Penalty tests are also used to achieve quantitative reliability data. This method employs degradation of certain elements of the explosive train by known amounts and to determine on a statistical basis, the margin of input, output or sensitivity.

5.4 Exposure to both individual and combined environments is usually the practice since an explosive component may be exposed during its life to a variety of conditions. The degradation of a "non-testable" item in a weapon system due to stowage or handling can seriously reduce a weapon system performance.

5.5 The guide lines used are those that have been developed through the years for the testing of explosive components such as fuzes. Whenever possible, standard Joint Army-Navy-Air Force Military Standard tests are used. The evaluation consists of specific types of tests, namely:

a. Conformance to drawings and specifications
b. As received examination and check out
c. Shock
d. Vibration
e. Natural environment
f. Explosive safety
g. Performance firing tests

6.0 Evaluation Program

6.1 The evaluation programs for the nine explosive devices contained in the Torpedo Mk 48 Mod 0 and the Mobile Target Mk 27 Mod 0 are presented as Appendices A through I. The test descriptions for all of the programs have been consolidated and disclosed as Appendix J. The breakdown into separate appendices was done to simplify possible distribution of evaluation effort among several government activities and/or contractors.

6.2 The evaluation programs generated for the nine explosive devices are considered adequate to demonstrate safety and reliability if successful completion of each program is attained. Studies and investigatory tests have been omitted from the evaluation programs as it is assumed such actions would be taken by the design activity.

6.3 In determining what explosive devices were present in the Torpedo Mk 48 Mod 0 and Mobile Target Mk 27 Mod 0, it was discovered that no formal nomenclature had been assigned to each explosive device. As a result, the only nomenclature used in these evaluation plans is reference to contractor drawings, specifications, or other identification numbers.

6.4 The hardware requirements for the evaluation test program are summarized in Table 6.1.

TABLE 6.1. HARDWARE REQUIREMENTS

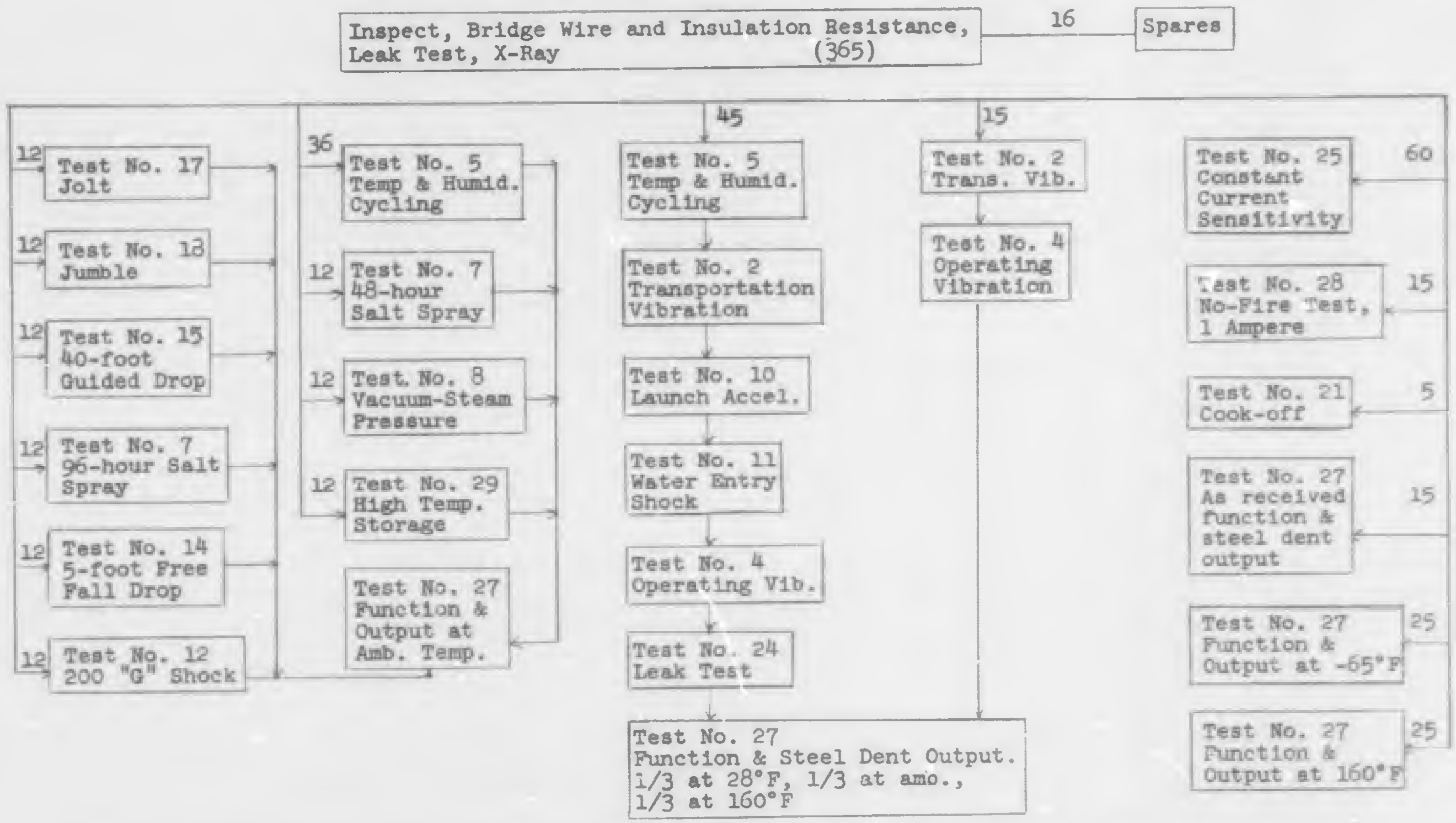
Item	Test Plan Appendix	Identification	Quantity Required	Additional Hardware Required
Detonator	A	Unidynamics Drawing 50-545	365	
Training Detonator	B	Unidynamics Drawing 50-675	250	
Arm and Detonate Device (Explosive Loaded)	C	Westinghouse Specification Drawing 949A308(R)	65	
Power Cartridge	D	Holex Identification Number 5411	175	1 - Start Valve 60 - Sets expendable start valve parts.
Igniter, Electric Primer	E, F	Holex Identification Number 5426	233	
Hot Gas Generator (Less Igniter)	F	Walter Kidde Drawing 893368	75	1 - Start Valve and plumbing from valve to generator. 58 - Sets expendable parts.
Igniter	G, H	Sundstrand Part Number 89328-2	239	
Gas Generator	H	Sundstrand Part Number 89328-1	75	1 - Combustor or mockup. 64 - Sets of expendable parts.
Generator, Gas Module Assembly	I	Unidynamics Drawing Number 50-463	175	

APPENDIX A

A.0 Electric Detonator (Unidynamics Drawing No. 50-545)

A.1 The electric detonator is used in the arm and detonate device of the Torpedo Mk 48 Mod 0. A glass-Kovar plug is soldered to the case providing a hermetic seal. The bridge wire is 1.0 ± .1 ohms. The detonator contains 12 ± .5 mg of ignition mix per Unidynamics procedure N9072, 75 ± 5 mg. of lead azide, and 165 ± 20 mg. of RDX. It is designed to meet the one ampere, one watt NO-FIRE requirement of MIL-I-23659. Figure A.1 presents the recommended pilot production test plan. A total of 365 detonators will be required for the program.

A.2 The plug, bridge wire and ignition charge of the detonator are identical to that of the training detonator. For convenience and economy, the constant current sensitivity test will be covered by this program, and the capacitor discharge sensitivity test will be covered by the training detonator program. It is assumed that all of the tests measuring input sensitivity will apply to both detonators.



Notes: (1) Bridge wire and insulation resistance will be measured after each environmental test.
(2) Functioning and output after the safety tests (jolt, jumble, 40-foot drop, 96-hour salt spray) is not a requirement. However, if successful, it will add to the confidence in the reliability.
(3) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for the individual tests of the factory to target sequence.
(4) Appendix J contains test explanations.

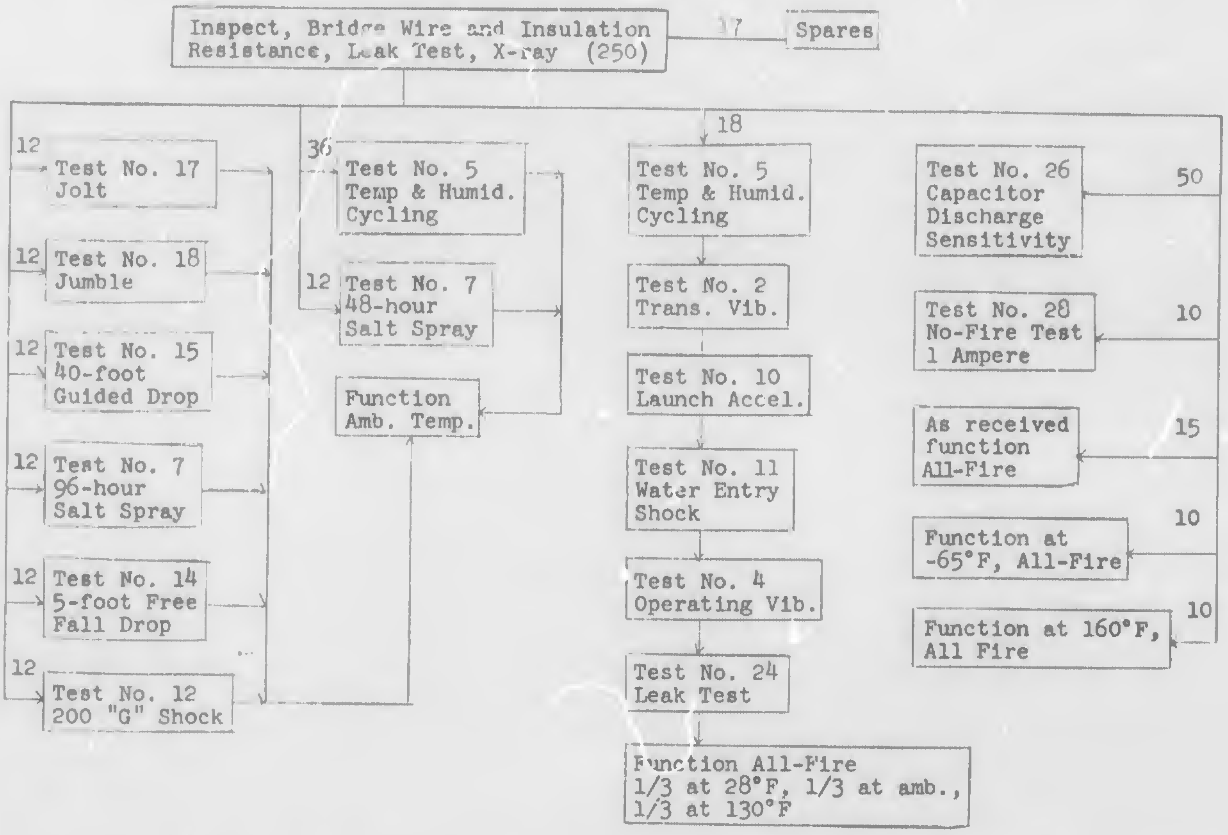
Fig. A.1 - Detonator, Unidynamics Drawing No. 50-545
Pilot Production Test Program

APPENDIX B

B.0 Electric Training Detonator (Unidynamics Drawing 50-675)

B.1 The electric training detonator replaces the electric detonator in the training version of the Torepdo Mk 48 Mod 0. It has an identical glass-Kovar hermetic seal, plug, bridge wire (1.0 ± .1 ohms), and ignition mix (12.0 ± 1.0 mg per Unidynamics procedure N9072). The base charge has been changed to lead styphnate and reduced to 20.0 ± 1.0 mg. Figure B.1 presents the recommended test plan. A total of 250 training detonators will be required for the program.

B.2 Because of the similarity of the plug end of the two versions of the electric detonator, it is assumed that all tests measuring input sensitivity will apply to both detonators.



Note: (1) Bridge wire and insulation resistance will be measured after each environmental Test.
(2) Functioning after safety tests (jolt, jumble, 40-foot drop, 96 hour salt spray) is not a requirement. However if successful, it will add to the confidence in the reliability.
(3) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for individual tests of the factory to target sequence.
(4) Appendix J contains test explanations.

Fig. B.1 - Training Detonator, Unidynamics Drawing No. 50-675
Pilot Production Test Program

APPENDIX C

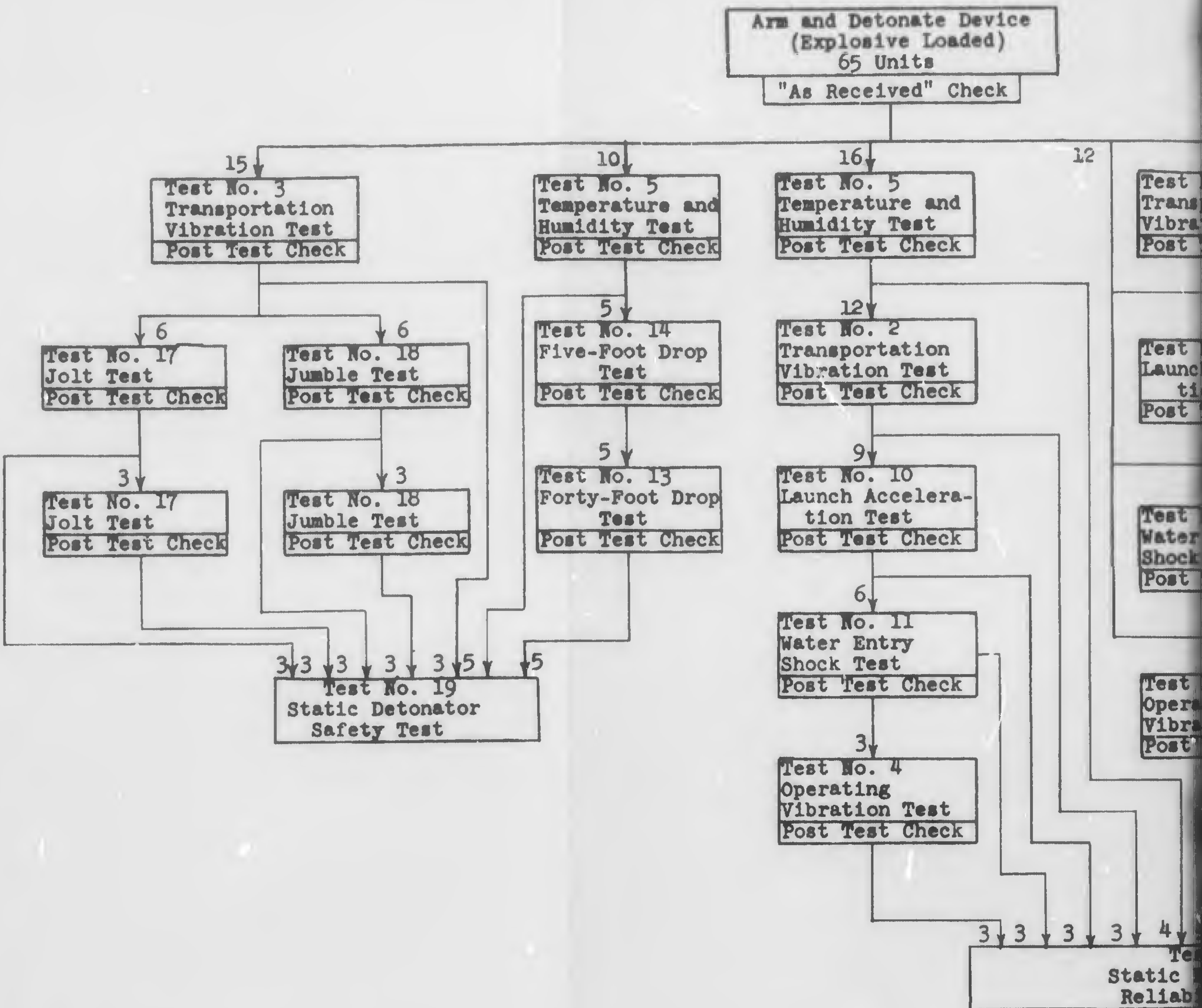
C.0 Arm and Detonate Device

C.1 The arm and detonate device is manufactured by Unidynamics under specification drawing 949A308(R). This device contains the explosive train for the Torpedo Mk 48 Mod 0 Warhead and is plugged into the base of the torpedo exploder. The explosive train consists of dual electric detonators, dual explosive leads and a high explosive booster. The arm and detonate device is cylindrical in shape i.e., 2½ inches in diameter and 4 inches long. The leads are located in a barrier plate and are misaligned with the detonators in the unarmed position. A rotary (Ledex type) solenoid is used to rotate the barrier plate to the armed position. In the process of arming the barrier plate, a shunt is removed from the electric detonators and the detonator circuits are armed. The barrier plate is locked in the unarmed position until an arming shaft is depressed. This shaft is depressed by the action of a hydrostatically activated safety pin device located within the exploder. Provision has also been made to lock the barrier plate in the unarmed position during handling and storage of individual arm and detonate devices.

C.2 A total of 65 arm and detonate devices are required to evaluate the safety and reliability of the explosive train. All devices shall be explosive loaded.

C.3 The evaluation plan for the arm and detonate device is presented in flow chart format as figure C.1. The tests indicated in this plan are described in detail in appendix J of the basic explosive device evaluation test program.

C.4 In developing the evaluation program for the arm and detonate device, it was assumed that the design had been adequately proven out in regard to detonator to lead, lead to booster, and booster to main charge transfer. By being adequately proven, it is meant that penalty testing in accordance with well known explosive test methods (i.e., NAVWEPS Report 7411, Varicomp, A Method for Determining Detonation-Transfer Probabilities, 30 June 1961) has been accomplished and adequate design margin has been demonstrated.



NOTES:

(1) Tests are described in appendix J. of the basic explosive device evaluation test program.

(2) The "As Received" and post test checks shall include:
- a. X-ray inspection. Check for irregularities, unsafety, etc.
- b. Bridge wire resistance measurements.
- c. Insulation resistance measurements.
- d. Visual inspection.
- e. Arming check (application of arm signal to unit).

Figure C.1

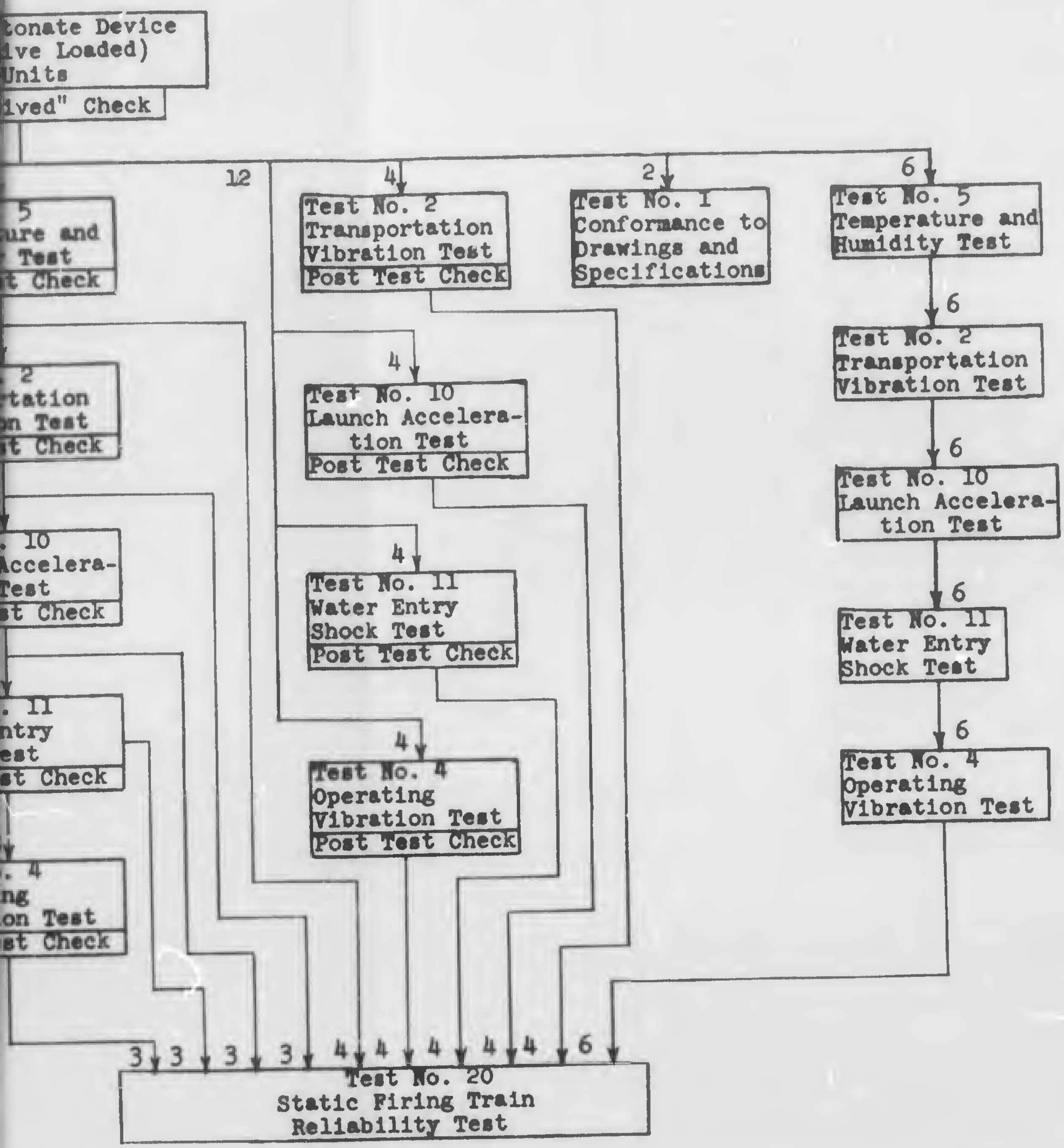


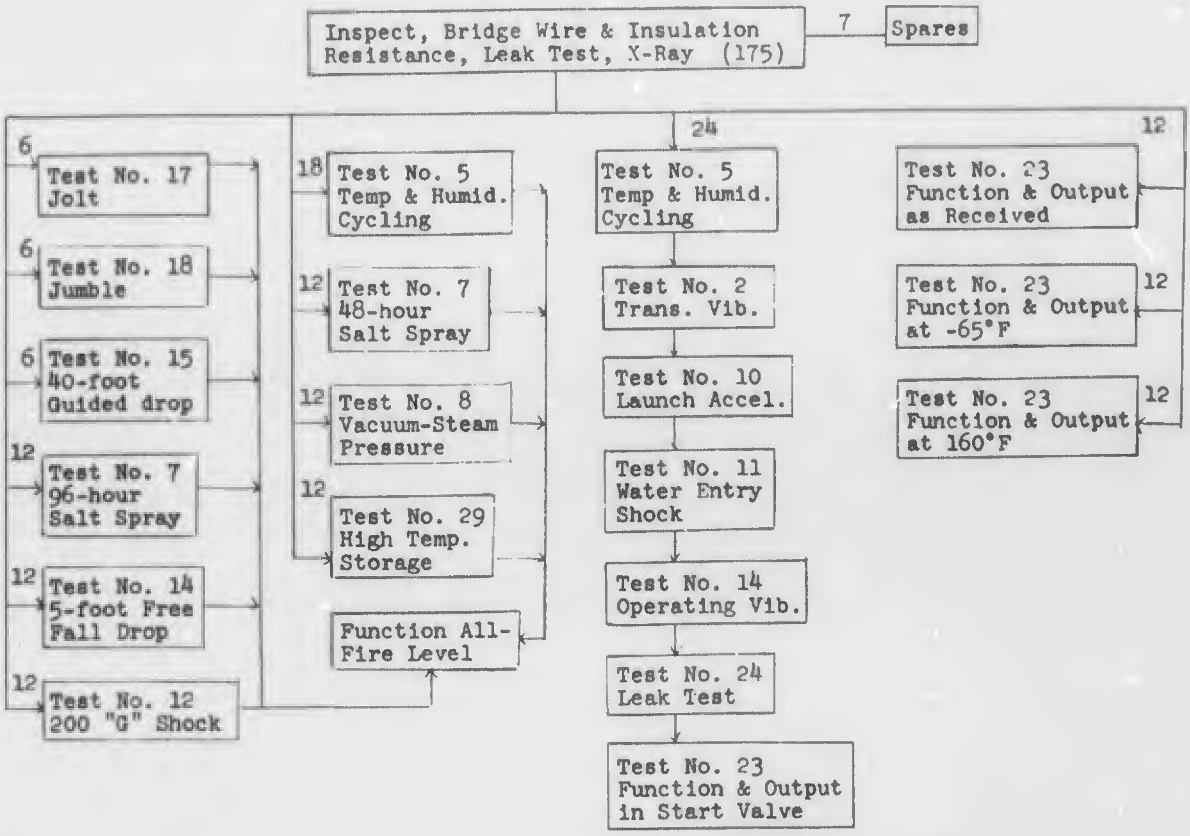
Figure C.1 Arm and Detonate Device Test Plan

APPENDIX D

D.0 Cartridge, Power (Holex Drawing No. 5411)

D.1 The power cartridge is used in the exercise version of the Torpedo Mk 48 Mod 0 during the recovery phase. When actuated it drives a plunger through a burst disc releasing nitrogen gas, which fills a double bladder and expels remaining fuel and sea water. The resulting buoyancy then causes the torpedo to rise to the surface to be recovered.

D.2 The cartridge is approximately 1.85 inches long X .87 inches in diameter. It contains a primer with a dual bridge wire of 2.10 ± .25 ohms resistance per circuit. The NO-FIRE current is 0.1 amperes and the ALL-FIRE current is 1.0 amperes. The primer contains 285 mg. of No. 72 Hercules Hi-Temp powder. Figure D.1 presents the recommended pilot production test plan. A total of 175 cartridges, 60 sets of non-reusable parts for the start valve, and one start valve will be required for the program.



Notes: (1) Bridge wire and insulation resistance will be measured after each environmental test.

(2) Sixty sets of expendable parts and one start valve will be needed for the output tests.

(3) Functioning is not a requirement after the safety tests (40-foot drop, jolt, jumble and 96-hour salt spray). However, if successful additional confidence in the reliability is obtained.

(4) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for individual tests of the factory to target sequence.

(5) Appendix J contains the test descriptions.

Fig. D.1 - Cartridge, Power (Holex Drawing No. 5411) Pilot Production Test Program

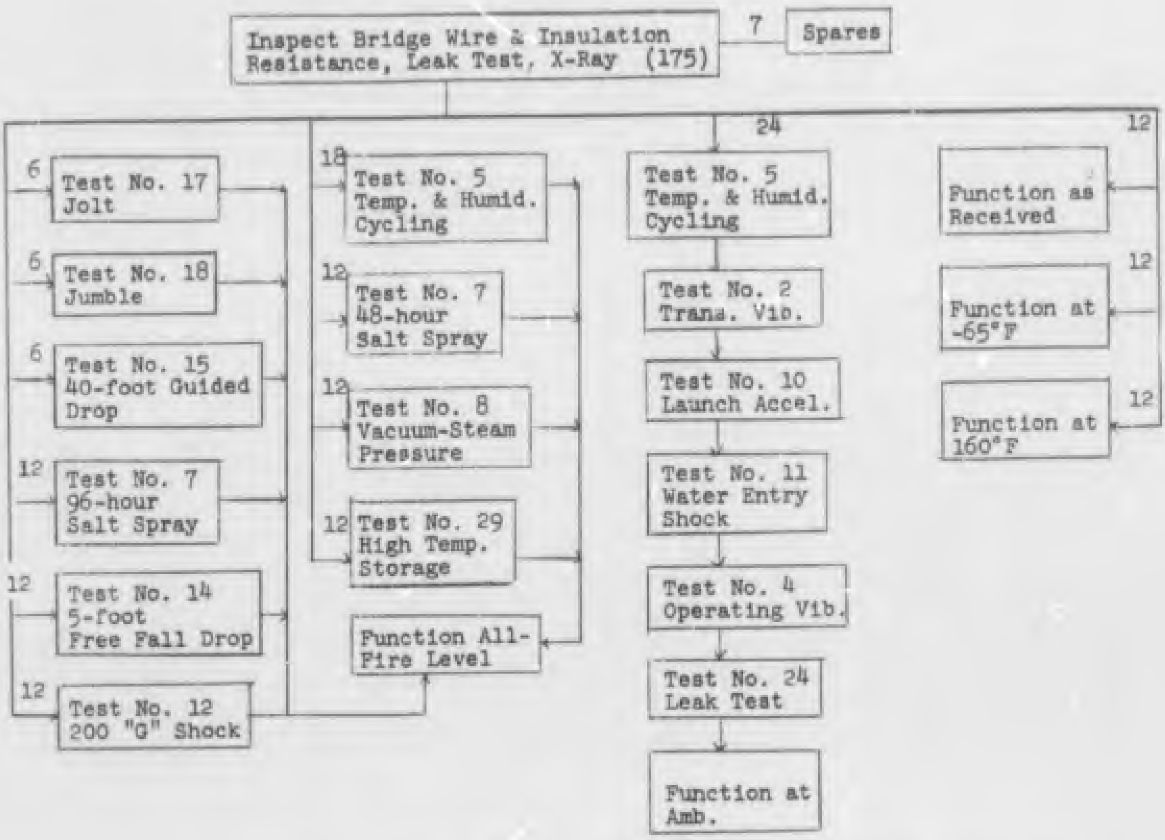
APPENDIX E

E.0 Igniter, Electric Primer (Holex Drawing No. 5426)

E.1 The igniter, electric primer, is used in the exercise version of the Torpedo Mk 48 Mod 0 during the recovery phase. When actuated it ignites a gas generator which supplements a container of nitrogen gas and is used to inflate a double bladder. All remaining fuel and sea water are expelled by the bladder, thus increasing the buoyancy of the torpedo and causing it to rise to the surface. The gas generator is needed for deep water recovery only. In shallow water the nitrogen bottle alone provides enough pressure to inflate the bladder.

E.2 The igniter is approximately 1.60 inches long X .87 inch in diameter. It contains a primer with a dual bridge wire of 2.10 ± .25 ohms per circuit. The NO-FIRE current is 0.1 amperes and the ALL-FIRE current is 1.0 amperes. The primer contains 285 mg. of No. 72 Hercules Hi-Temp powder. Figure E.1 presents the recommended pilot production test plan. A total of 175 igniters will be required for the program.

E.3 Due to the similarity of the igniter, electric primer, to the power cartridge (Appendix D), the test plans are essentially the same except that no output tests are scheduled for the igniter. The gas generator program (Appendix F) will test 58 igniters and generators under various conditions and will provide output characteristics of the igniter.



Notes: (1) Bridge wire and insulation resistance will be measured after each environmental test.
(2) Functioning is not a requirement after the safety tests (4C-foot drop, jolt, jumble and 96-hour salt spray). However, if successful additional confidence in the reliability is obtained.
(3) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for individual tests of the factory to target sequence.
(4) Appendix J contains the test descriptions.

Fig. E.1 - Igniter, Electric Primer (Holex No. 5426)

APPENDIX F

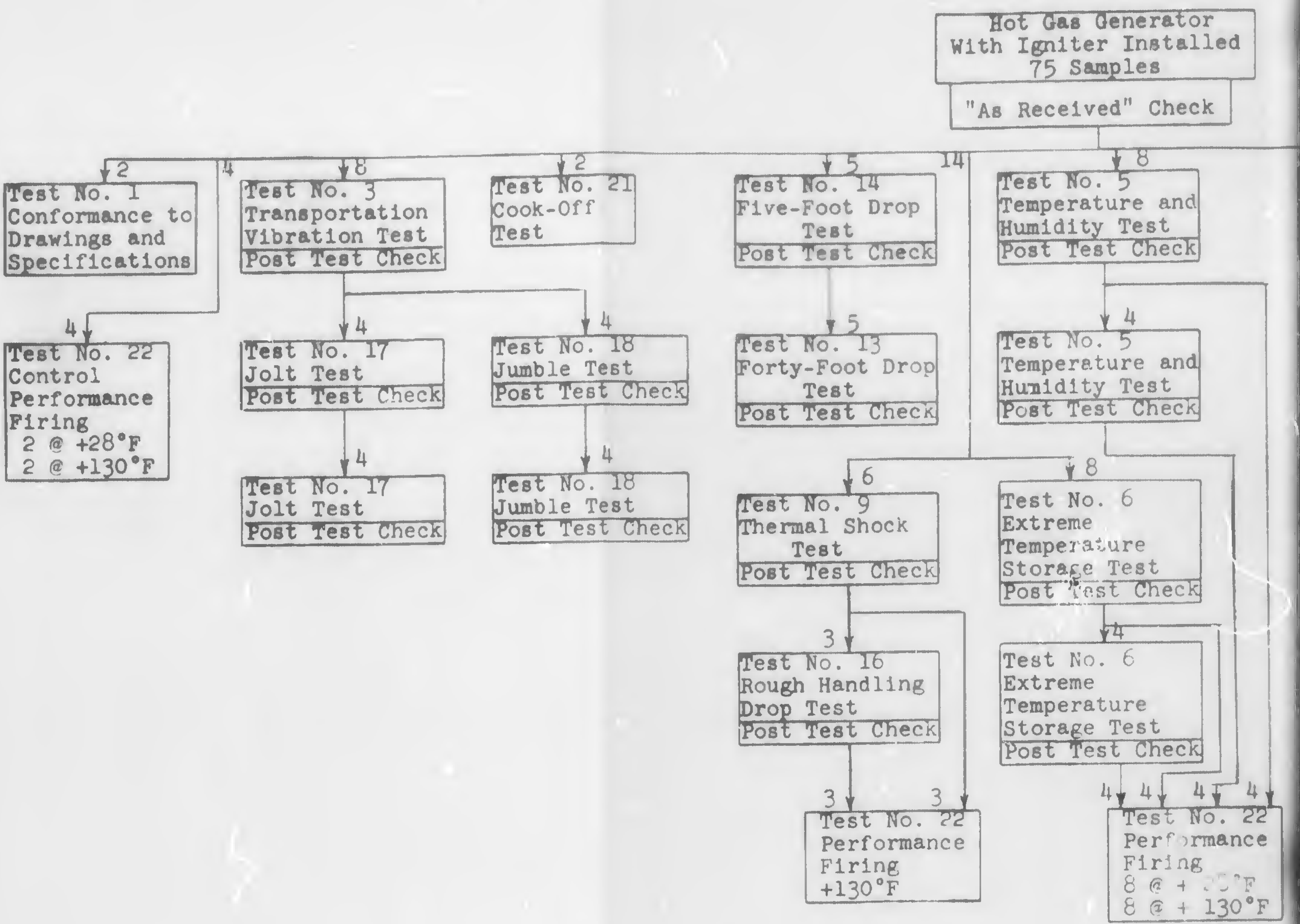
F.0 Hot Gas Generator

F.1 The hot gas generator is manufactured by Walter Kidde and Company Inc., under drawings 893368 and 291162 with Holex the vendor for the igniter (Holex Identification No. 5426) and Amoco Chemicals the vendor for the propellants (Amoco drawing No. 31657 Rev B.) The hot gas generator consists of a nickel-plated steel case approximately 5 inches in diameter and 7 inches long including hemispheric ends, one of which is a removable cover for insertion of the grain assembly. The igniter and a gas outlet fitting are installed in the removable cover. The propellant grain is a perforated cylindrical grain inhibited along its outer cylindrical walls only. A booster consisting of pellets of propellant is fastened to the inside of the cover directly under the igniter. The gas generator supplements a compressed gas container for deep recovery missions only. This augmentation provides heat energy and supplemental gas required to achieve Mk 48 Torpedo boyancy at maximum recovery depth.

F.2 A sample size of 75 units including igniters is required to evaluate the hot gas generator. In addition, one start valve and necessary plumbing from the valve to the generator will be required for conducting performance firing tests. A total of 58 sets of expendable start valve parts will be required to refurbish the start valve after each firing test.

F.3 Figure F.1 describes the evaluation test plan in flow chart format. All tests in the flow chart are described in appendix J. of the basic explosive device evaluation test program.

F.4 In order to determine whether a gas generator will produce adequate output energy following environmental conditioning, it is necessary to subject the unit to a performance firing test. This type of test can vary from conducting actual systems tests in a torpedo to simplified laboratory firing tests. The disadvantages of systems tests are obvious i.e., cost, complexity, time. As a consequence, a study must be made of parameters which can be easily measured and can be translated into performance capability. In reviewing the gas generator in this respect, successful functioning is predicated upon producing gaseous products with sufficient energy (temperature and pressure per specified time) to adequately assist existing compressed nitrogen in driving fuel and water from the torpedo tankage sections. If the pressure-time and temperature-time envelopes for successful torpedo recovery are experimentally determined over the operating temperature range, then these parameters can be measured on gas generators in the laboratory and the results will be meaningful in terms of performance capability.



NOTES:

(1) Tests are described in Appendix J. of the basic explosive device evaluation test program.

(2) The "As Received" and post test check shall include:
   a. X-ray inspection @ 70±5°F. Take grain measurements off X-ray for evidence of gra
      Inspect for cracks or other irregularities.
   b. Bridge wire resistance measurements.
   c. Insulation resistance measurements.
   d. Visual inspection
   e. Weight measurement. Determine H_2O increase in grain if any. Use data to compare
      firing to determine amount of material consumed.

(3) One start valve and plumbing from valve to gas generator along with 58 sets of expendab
    parts will be required to conduct performance firings.

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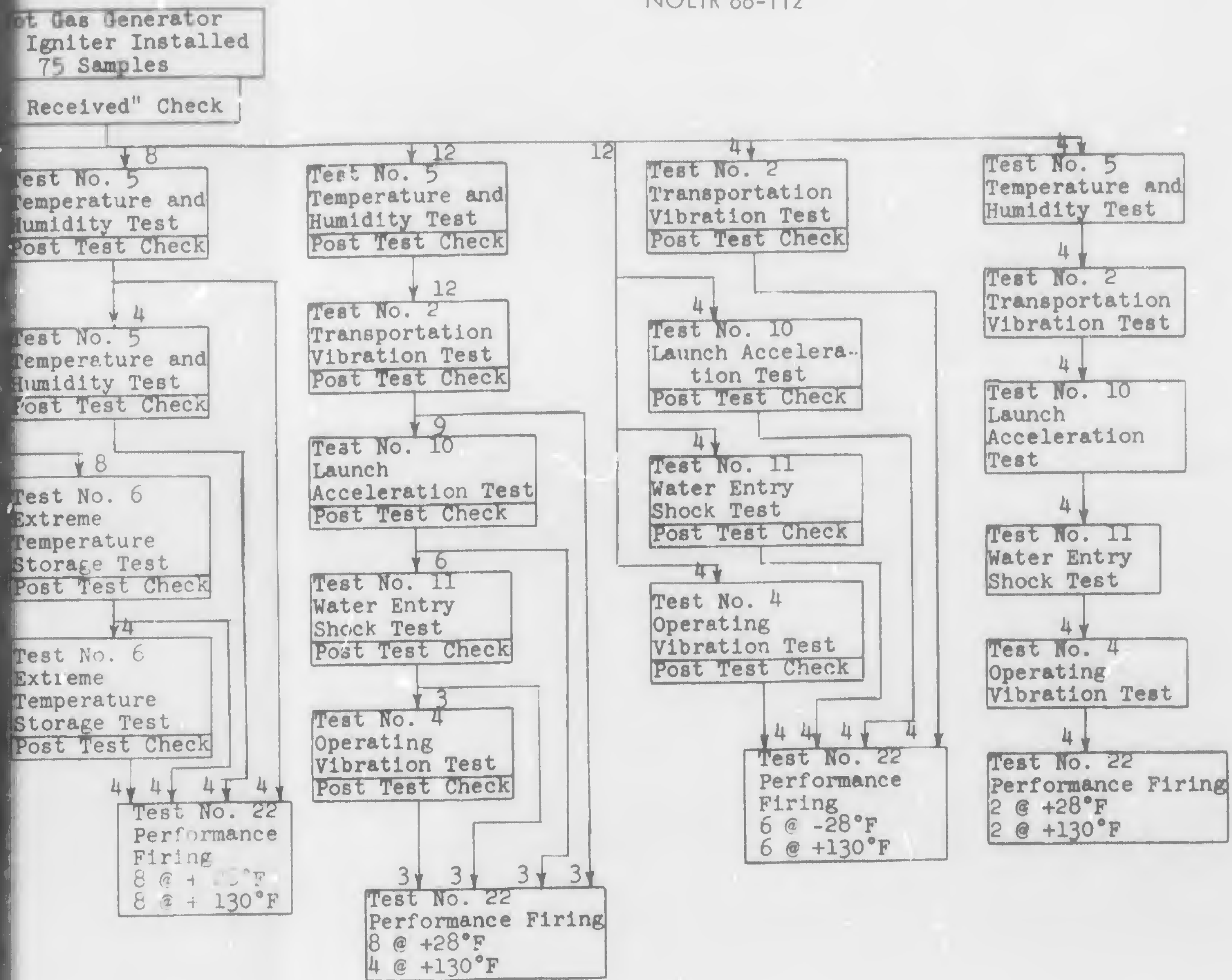


evaluation

ay for evidence of grain growth or shrinkage.

. Use data to compare with weight after

th 58 sets of expendable start valve

Figure F.1 Hot Gar Generator Test Plan

2

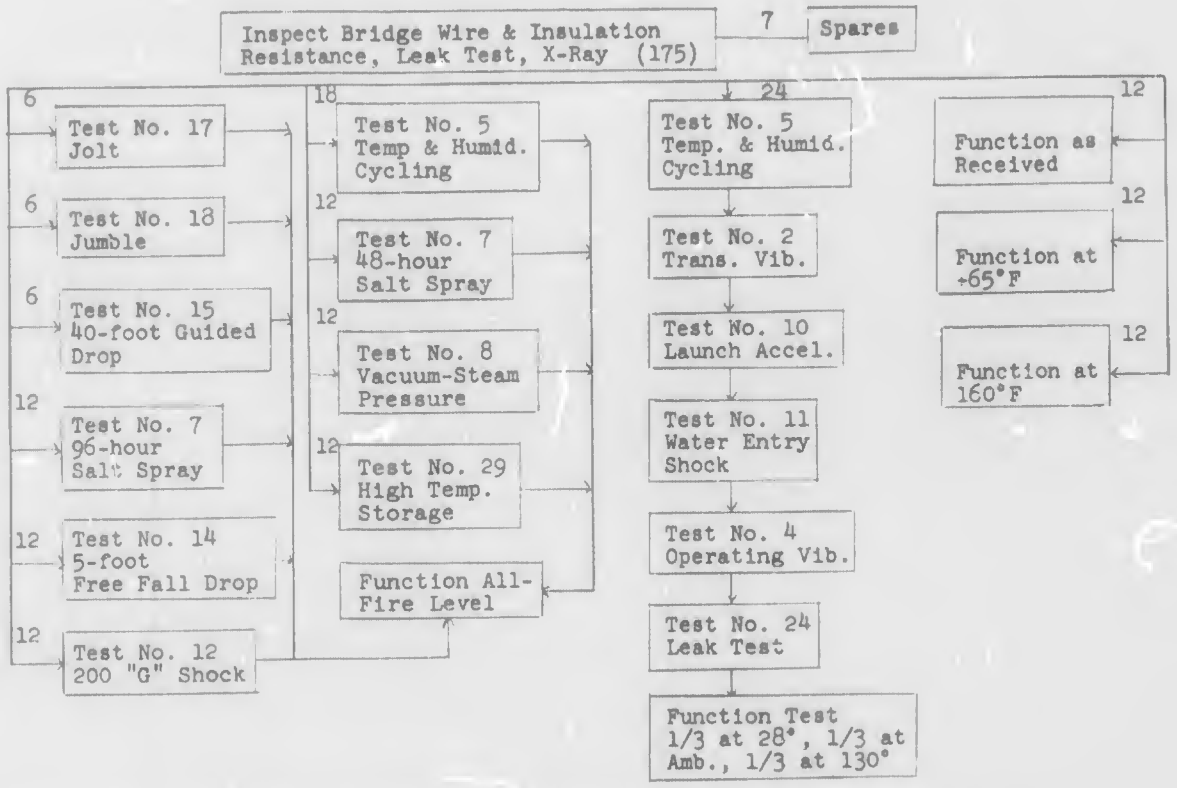
APPENDIX G

G.0 Igniter, Start Grain (Talley Industries Drawing No. 20348)

G.1 The igniter, start grain, is used to ignite the gas generator which starts and maintains the main power plant of the Torpedo Mk 48 Mod 0.

G.2 The igniter is approximately 3 inches long X .75 inch in diameter. It contains a four-pin dual bridge wire plug and undetermined amounts of ARI-18 ignition mix, ARI 18 propellant, and ARI 19 booster pellets. Each bridge wire is 1.35 ± .2 ohms. The NO-FIRE current is .50 amperes and the ALL-FIRE current is 1.0 amperes. Figure G.1 presents the recommended pilot production test plan. A total of 175 igniters will be required for the program.

G.3 No output tests are listed in Figure G.1. Output characteristics of the igniter will be determined from 64 firings of the gas generator (Appendix H).



Notes: (1) Bridge wire and insulation resistance will be measured after each environmental test.
(2) Functioning is not a requirement after the safety tests (40-foot drop, jolt, jumble and 96-hour salt spray). However, if successful additional confidence in the reliability is obtained.
(3) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for individual tests of the factory to target sequence.
(4) Appendix J contains the test descriptions.

Fig. G.1 - Igniter, Start Grain (Talley Industries Drawing No. 20348)

APPENDIX H

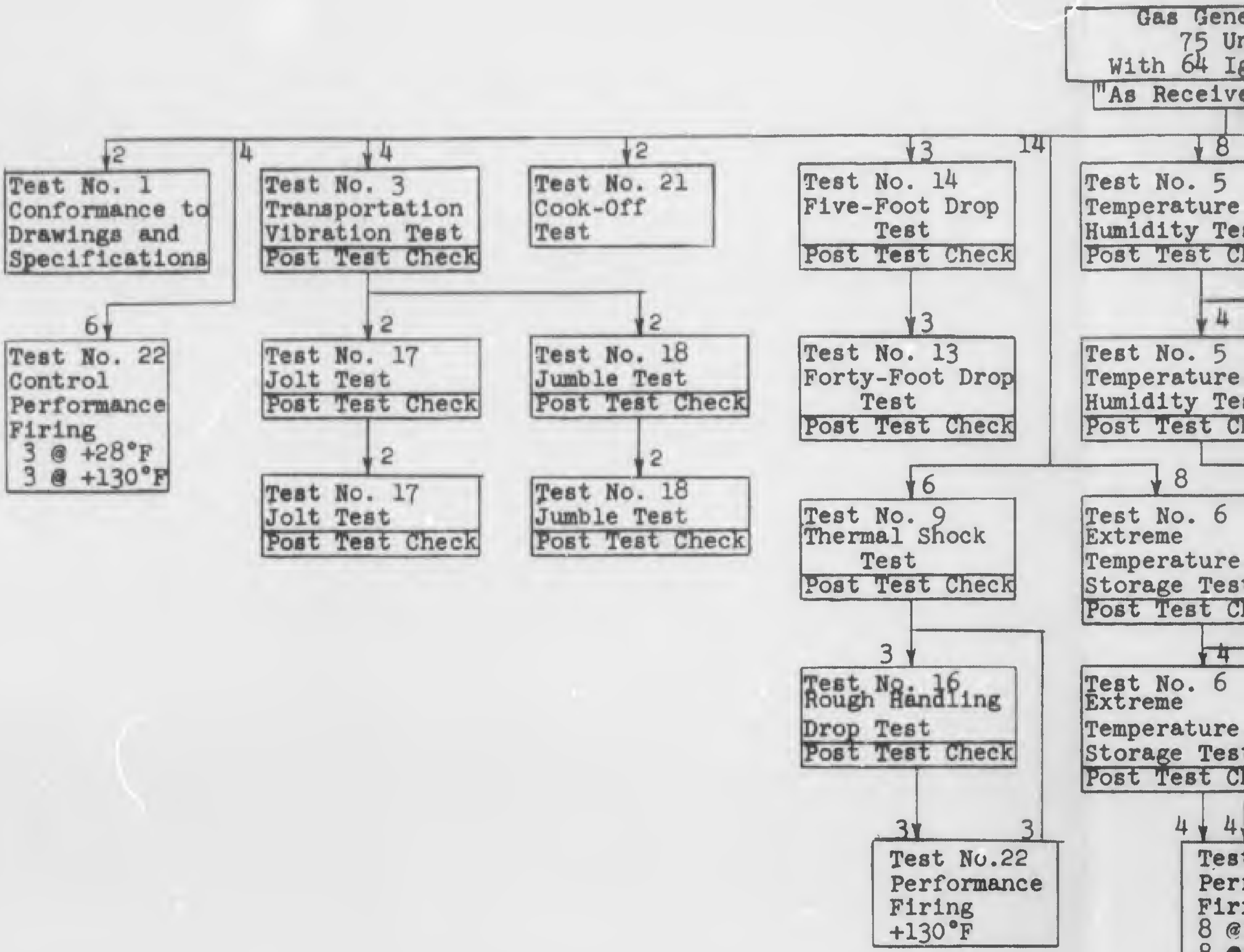
H.0 Gas Generator

H.1 The gas generator is produced by Sundstrand Aviation under part no. 89328-1 with Talley Industries the vendor for the gas generator grain and igniter. The gas generator grain is approximately 3 inches in diameter and 7 inches long. The grain is protected from moisture by a plastic bag surrounding the grain and is initiated by an igniter. The gas generator and igniter are housed in the Mk 48 Torpedo power plant combustor. The combustor assembly is a reaction chamber in which a liquid monopropellant (Otto fuel) is decomposed and burned, and the resultant gases diluted with sea water. The fuel is sprayed through a fuel nozzle into the reaction chamber where combustion is initiated and sustained. Initially, gas pressure from the hot gas generator drives a biliquid pump which pumps Otto fuel and water to the reaction chamber. Also, the temperature and pressure conditions necessary for the combustion of Otto fuel are initially provided by the burning gas generator. The temperature and pressure of the ignited fuel in the reaction chamber cause a continuous reaction. Sea water is supplied through a nozzle in the rear of the chamber to cool the combustion gases to approximately 1500°F. The cooled gases are then directed to the turbine inlet as motive power for the turbine. The combustor has an inner cylinder which houses the gas generator and within which actual fuel decomposition occurs. This inner cylinder is designed for easy refurbishment subsequent to each firing. Sea water flows between the inner and outer cylinder walls for cooling purposes prior to mixture with the Otto fuel.

H.2 A sample size of 75 gas generators and 64 igniters will be required for this evaluation program. In addition as a minimum, one combustor assembly or a suitable mockup will be required along with 64 sets of expendable parts, if any.

H.3 Figure H.1 describes the evaluation test plan in flow chart format. All tests in the flow chart are described in appendix J of the basic explosive device evaluation test program.

H.4 In order to determine whether a gas generator will produce adequate output energy following environmental conditioning, it is necessary to subject the unit to a performance firing test. This type of test can vary from conducting actual systems tests in a Mk 48 Mod 0 Torpedo to simplified laboratory firing tests. The disadvantages of systems tests are obvious i.e., cost, complexity, time. As a consequence, a study must be made of parameters which can be easily measured and can be translated into performance capability. The gas generator must supply sufficient energy to the turbine so as to pump Otto fuel and water into the combustor. Also, the hot gases from the gas generator must be sufficient to ignite the Otto fuel and support combustion until the reaction is self-sustaining. Parameters such as combustor internal temperature and pressure may be measured during successful system runs in order to obtain specifications for laboratory measurements on subsystems i.e., combustor assembly or suitable mockup. If possible, the laboratory performance firings should eliminate the need of Otto fuel and water. This may require the firing of identical gas generators in the complete power plant system both with and without the use of water and fuel while measuring temperature and pressure in the combustor. It is evident by the above discussion that the performance firing tests for this gas generator will be very difficult to firm up. As a result, the designer must continually work for a better method of testing gas generator output so that adequate specifications can be formulated in regard to performance testing without the need for systems tests.



NOTES:
(1) Tests are described in appendix J of the basic explosive device evaluation
(2) The Igniters will be exposed to the environmental conditioning along with e generator scheduled for performance firing.
(3) The "as received" and post test checks on the gas generators and igniters s
   a. X-ray inspection. Look for cracked propellant and other irregulariti
   b. Make physical measurements on grain to determine grain shrinkage or g
   c. Bridge wire resistance measurements.
   d. Insulation resistance measurements.
   e. Visual inspection.
(4) Additional hardware will be required for the performance firing. As a mini combustor assembly or suitable mockup will be required along with 64 sets o expendable parts, if any.

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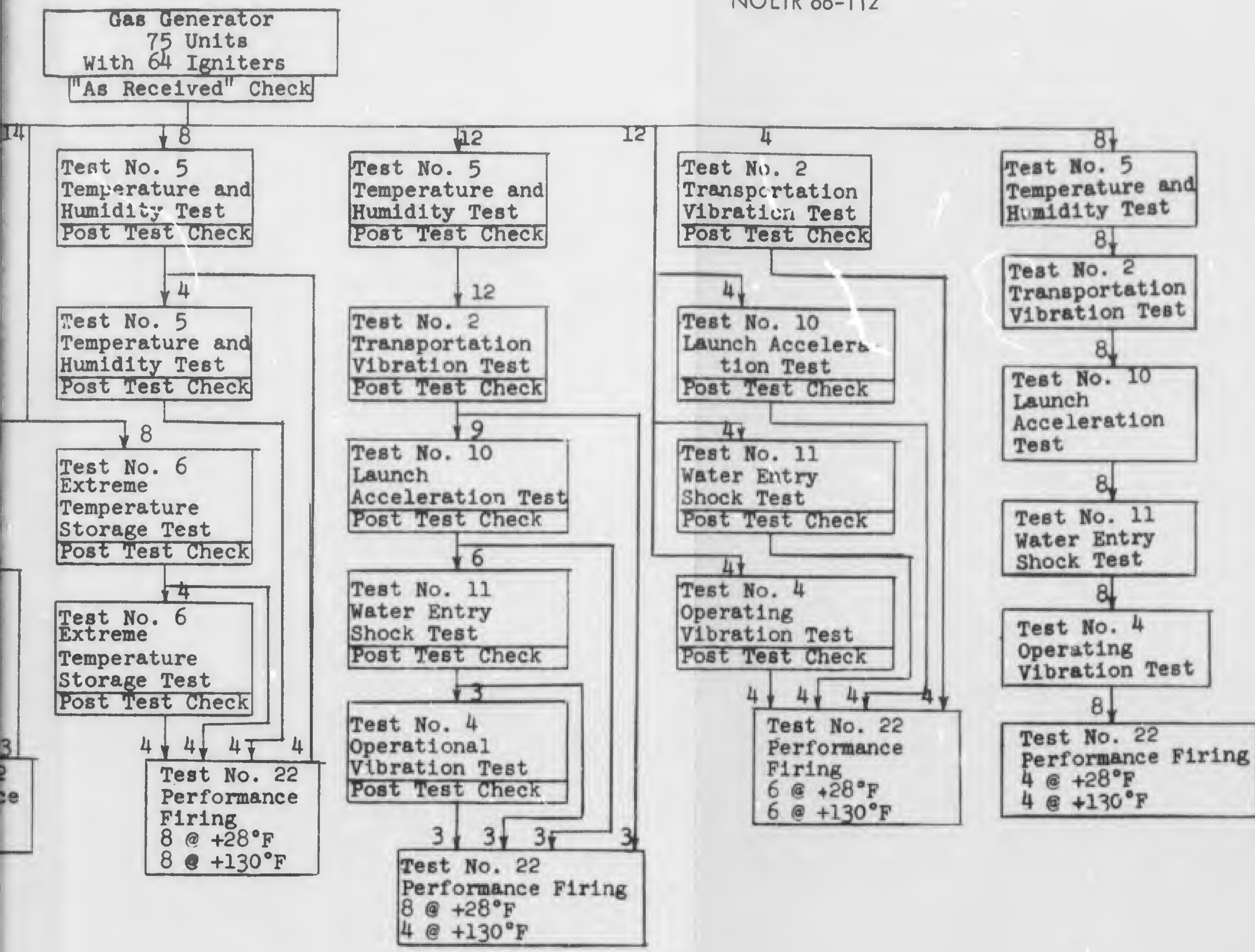

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Figure H.1 Gas Generator

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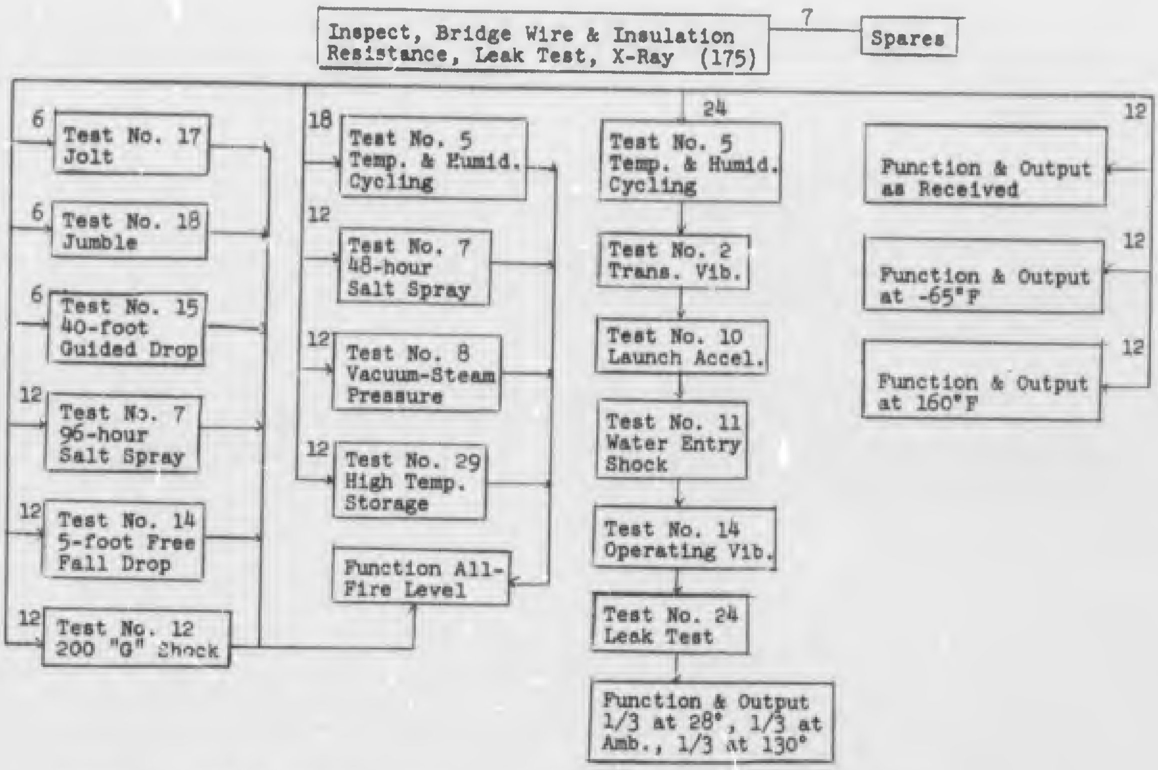
APPENDIX I

I.0 Generator, Gas Module Assembly (Unidynamics Drawing No. 50-463)

I.1 The generator, gas module assembly, is used in the exercise version of the Torpedo Mk 48 Mod 0 to deploy a radar reflector at the end of the run in order to locate the torpedo for salvage.

I.2 The generator is approximately .73 inch long X .2 inch in diameter. It contains an Atlas match M-103 of 1.3 ± .13 ohms bridge wire resistance, 400 ± 20 mg. of N-690 ignition powder, and 100 ± 10 mg. of SR4990 rifle powder. Figure I.1 presents the recommended pilot production test plan. A total of 175 generators will be required for the program.

I.3 There is not enough information at this time to define an output test. However Figure I.1 lists output tests where necessary assuming that detailed tests will be designed when the information is available.



Notes: (1) Bridge wire and insulation resistance will be measured after each environmental test.
(2) Sixty sets of expendable parts and one start valve will be needed for the output tests.
(3) Functioning is not a requirement after the safety tests (40-foot drop, jolt, jumble and 96-hour salt spray). However, if successful additional confidence in the reliability is obtained.
(4) After environmental tests all detonators will be subjected to a leak test (Test No. 24) except for individual tests of the factory to target sequence.
(5) Appendix J contains the test descriptions

Fig. I.1 - Generator, Gas Module Assembly (Unidynamics Drawing No. 50-463)

APPENDIX J

J.0 Test Descriptions For Explosive Devices in Torpedo Mk 48 Mod 0 and Mobile Target Mk 27 Mod 0

J.1 Test No. 1. (Conformance to Drawings and Specifications)

J.1.1 In evaluating ordnance items, it is necessary to assure that the items represent the latest design disclosures. Consequently, the items must be checked piece by piece to the drawings for dimensional and material conformance. Specification conformance must also be determined. In this case, environmental and performance test data can be obtained from evaluation test results.

J.2 Test No. 2. (Transportation Vibration Test)

J.2.1 Transportation Vibration Test - The test item is rigidly attached to the vibrator table with a fixture that transmits the desired vibration without introducing unrealistic resonances or restrictions that could keep the item from vibrating in its normal modes. If convenience or cost considerations dictate that the sub-assemblies should be vibrated in weapon hull sections, the hull sections should be considered as part of the test fixture and may be stiffened to meet the above requirements. Simple harmonic vibration is applied along each of the three mutually perpendicular axes for three hours. The total test duration is nine hours. The frequency range of 10 to 100 cps is covered by cycling at a logarithmic rate which does not exceed one-third octave per minute. Any portion of the frequency range may be covered by using discrete frequency steps of equal time duration which are spaced no more than one-sixth octave apart. The vibration amplitude is maintained at .060" ± .006" peak to peak or 3 g (peak), whichever is the lesser value. Where large test fixtures are used, the vibration amplitude should be limited to the test amplitude on any portion of the fixture.

J.2.2 The test items shall be both safe and reliable following this test.

J.3 Test No. 3 (Transportation Vibration Test)

J.3.1 The test items shall be tested and evaluated in accordance with the Military Standard Transportation Vibration Test (MIL-STD-303A).

J.4 Test No. 4. (Operating Vibration Test)

J.4.1 <u>Operating Vibration Test</u> - The test item is rigidly attached to the vibrator table with a fixture that transmits the desired vibration without introducing unrealistic resonances or restrictions that could keep the item from vibrating in its normal modes. If convenience or cost considerations dictate that the subsystems should be vibrated in weapon hull sections, the hull sections should be considered as part of the test fixture and may be stiffened to meet the above requirements. Wherever practical, test items should be in operation during the test. Test parameters for the various torpedo and target test items are shown in Table J.4. Simple harmonic vibration is applied along each of the three mutually perpendicular axes for equal periods of time. The applicable frequency range is covered by cycling at a logarithmic rate which does not exceed one octave per minute. The vibration amplitude is maintained to within 10% of the specified levels. Where large test fixtures are used, the vibration amplitude should be limited to the test amplitude on any portion of the fixture. Target test items which are expended during target operation or replaced after each operation should be subjected to one test cycle. All other target test items should be subjected to five test cycles to insure reliable operation during the repeated operation of the target.

J.4.2 The test items shall be both safe and reliable following this test.

J.5 <u>Test No. 5.</u> (Temperature and Humidity Test)

J.5.1 The test items shall be tested and evaluated in accordance with the Military Standard Temperature and Humidity Test (MIL-STD-304).

J.6 <u>Test No. 6.</u> (Extreme Temperature Storage Test)

J.6.1 The test items shall be stored for 28 days at a temperature of +160°F followed by an additional 28 days at -65°F. The relative humidity shall be uncontrolled and determined only by laboratory ambient humidity conditions. No protection shall be afforded to the test items while under extreme temperature storage conditions.

J.6.2 The test items shall be both safe and reliable following this test.

J.7 <u>Test No. 7.</u> (Salt Spray Test)

J.7.1 The test items shall be tested and evaluated in accordance with the Military Standard Salt Spray Test (MIL-STD-306).

TABLE J.4. OPERATING VIBRATION TEST PARAMETERS

APPLICATION	FREQUENCY RANGE (cps)	TEST AMPLITUDE (lesser of two values)		DURATION	
		Displacement inch (peak to peak)	Acceleration g (peak)	Per Axis (minutes)	Total (minutes)
Torpedo Test Items-Except Turbine Power Plant Items	10 to 500	.100	3	20	60
Torpedo-Turbine Power Plant Items	10 to 2000	.100	5	5	15
Target Test Items	10 to 500	.100	2	20	60 per cycle

J.8 Test No. 8. (Vacuum Steam Pressure Test)

J.8.1 The test items shall be tested and evaluated in accordance with the Military Standard Vacuum Steam Pressure Test (MIL-STD-305).

J.9 Test No. 9. (Thermal Shock Test)

J.9.1 Thermal Shock - The item to be tested shall first be placed within a test chamber wherein a temperature of 160°F is maintained. The item shall be exposed to this temperature for a period of four hours, at the conclusion of which, and within five minutes, the item shall be transferred to a chamber having an internal temperature of -65°F. The item shall be subjected to this temperature for a period of four hours. This constitutes one cycle which is repeated three times. At the conclusion of each of the first two cycles the test item is immediately, within five minutes, transferred to a chamber having an internal temperature of +160°F. At the conclusion of the third cycle, the item shall be removed from the test chamber, returned to a room temperature environment, and within a period of one hour inspected. The duration of exposure at each extreme temperature shall not be less than that specified and may be extended to overnight exposure to prevent interruption of the transfer sequence.

J.9.2 The test items shall be both safe and reliable following this test.

J.10 Test No. 10. (Launch Acceleration Test)

J.10.1 Launch Acceleration - The test item shall be attached to the shock tester table in mounts designed to simulate as realistically as possible the service installation. This mounting is to include any vibration or noise isolators if used. The item is oriented so that the resulting inertia force will be parallel to the longitudinal axis of the torpedo or target and directed toward the aft end of the torpedo or target. The item is accelerated so that a peak of 8 g is attained in 0.2 second; the total duration of the pulse is one second.

J.10.2 The test items shall be both safe and reliable following this test.

J.11 Test No. 11. (Water Entry Shock Test)

J.11.1 Water Entry Shock - The test item shall be attached to the shock tester table in mounts designed to simulate as realistically as possible the service installation. The mounting is to include any vibration or noise isolator if used. The test item is then subjected to three shocks, transverse vertical, transverse horizontal, and axial (i.e., axial is torpedo or target longitudinal axis.) The magnitudes of the shocks are presented below:

WATER ENTRY SHOCK TEST PARAMETERS

	Torpedo Mk 48	Mobile Target
Transverse	Approximate 1/2 sine, 60 g, 40 milliseconds duration	Approximate 1/2 sine, 90 g, 35 milliseconds duration
Axial	4 g, 0.5 second duration	3 g, 0.5 second duration

J.11.2 The test items shall be both safe and reliable following this test.

J.12 Test No. 12. (200 "G" Shock Test)

J.12.1 200 "G" Shock Test - Test items are to be mounted in the device of intended use or in a suitable test vehicle affording the same degree of support. The shock pulse shall be applied to the item's mounting points in both directions along each of three mutually perpendicular axes. The shape of each shock pulse shall approximate as nearly as possible a half sine wave. The amplitude of each shock pulse shall exceed 200 "g's" for 1.5 ± 0.4 millisecond and it shall exceed 65 "g's" for 9 ± 0.9 millisecond.

J.12.2 Test items shall be free from visible damage or leaks (if applicable) and shall perform satisfactorily in functional tests subsequent to this test. They shall be functionally tested at 70°F.

J.13 Test No. 13. (Forty-Foot Drop Test)

J.13.1 The unprotected test items shall be dropped forty feet free fall onto a nonyielding steel plate (3 inch armor plate, minimum). Impact orientations shall be chosen which are deemed most likely to cause failure. Each item will be dropped once only.

J.13.2 The test items shall be safe to handle and dispose of following this test.

J.14 Test No. 14. (Five-Foot Drop Test)

J.14.1 The unprotected test items shall be dropped five feet free fall onto a nonyielding steel plate (3 inch armor plate, minimum). Impact orientations shall be chosen which are deemed most likely to cause failure. Each item will be dropped once only.

J.14.2 The test items shall be safe to handle and use following this test i.e., not necessarily reliable.

J.15 Test No. 15. (Forty-Foot Guided Drop Test)

J.15.1 The test items shall be mounted in a test fixture and fastened to the carrier of the guided drop test apparatus. The drop test apparatus is comprised of three basic components as follows: (a) A rigidly supported, truncated cone shaped, hardened steel anvil having a minimum 6.0 inch diameter flat top, a minimum 36 inch diameter base, and a minimum height of 21 inches fixed to a concrete pad of minimum diameter 36 inches and minimum thickness of 60 inches. (b) A carrier to which the test fixture is fixed having a striking surface of hardened steel 6.0 inches in diameter and a minimum thickness of 3.0 inches. Separate carriers may be necessary for vertical, 45°, and horizontal positions. (c) A vertical guide which guides the carrier in its drop to the anvil. The guide design should allow as little friction as possible.

J.15.2 The test items shall be subjected to a forty-foot drop test in the apparatus described above. The items shall be unfired and safe to handle and dispose of following this test.

J.16 Test No. 16. (Rough Handling Drop Test)

J.16.1 Unpackaged test items shall receive a series of drops onto a nonyielding steel plate (3 inch armor plate, minimum). Each test item shall be dropped four times from 24 inches and eight times from 12 inches. A study of the test item geometry shall be made in order to choose impact orientations judged most likely to cause failure.

J.16.2 The test items shall be examined after each drop and shall receive a thorough post test check following the drop series. The significance of damage resulting from the rough handling drop test will be assessed on a per case basis. Unless obvious damage results which would prohibit use of the test items, it is considered that the items must remain safe to handle and use in order to pass this test.

J.17 Test No. 17. (Jolt Test)

J.17.1 The test items shall be tested and evaluated in accordance with the Military Standard Jolt Test (MIL-STD-300).

J.18 Test No. 18. (Jumble Test)

J.18.1 The test items shall be tested and evaluated in accordance with the Military Standard Jumble Test (MIL-STD-301).

J.19 Test No. 19. (Static Detonator Safety Test)

J.19.1 The test items shall be tested and evaluated in accordance with the Military Standard Static Detonator Safety Test (MIL-STD-315).

J.20 Test No. 20. (Static Firing Train Reliability Test).

J.20.1 The purpose of this test is to determine the reliability of arming device explosive trains. A minimum of ten arming devices shall be initiated with fully armed explosive trains. Of these, a minimum of four are to be initiated after a four hour soak at +130°F and four after a four hour soak at +28°F. A minimum of twenty-five arming devices shall be subjected to a Bruceton type test to determine the reliability of the explosive train at maximum tolerance conditions of detonator to lead misalignment. NAVORD Report 2101 (Statistical Methods Appropriate For Evaluation of Fuze Explosive-Train Safety and Reliability) shall be used as a guide as well as appropriate firing techniques described in MIL-STD-315 (Military Standard Static Detonator Safety Test). Of these, at least five arming devices shall be initiated after a four hour soak at +130°F and five after a four hour soak at +28°F. In all cases, only one detonator shall be initiated.

J.20.2 In assessing explosive train reliability, hardware deformation and/or break-up can be used by explosive experts to determine whether the train functioned high order or not. Another method of making this determination is by use of a steel witness plate. Initially, as a control, several boosters (one at a time) are placed against a steel witness plate and detonated high order by use of an Army Engineers Special Blasting Cap or equivalent. All future tests of the explosive train would then be made with boosters placed against an identical witness plate. By comparing the damage to the witness plate (dent) with the control witness plates, a decision can readily be made as to whether or not the device produced a high order detonation.

J.21 Test No. 21. (Cook-Off Test)

J.21.1 A cook-off test is performed to determine the resistance of the test item to elevated temperatures. This test can be accomplished in two basic manners depending upon the size of the test item. For small items with negligible heat sink i.e., detonators, a thermocouple can be placed on the skin of the item, the item placed in a suitable temperature chamber, and the temperature increased until the item autoignites. A temperature-time record is obtained whereby cook-off temperature is determined. If the test item has considerable mass (heat sink) such as gas generators, the following technique can be employed. Place the test item in a temperature chamber heated to +150°F. Maintain this temperature for a minimum of four hours and then raise the chamber temperature rapidly by 25°F and soak for an additional four hours. Repeat this procedure until the item auto-ignites. The accuracy of this technique is limited to within 25°F. If greater accuracy is required, a smaller temperature interval can be used.

J.22 Test No. 22. (Performance Firing)

J.22.1 This test consists of firing a gas generator and measuring key parameters to determine performance capability. These firings are to be made at the operating temperatures of +130°F and +28°F.

J.23 Test No. 23. (Power Cartridge Output Test)

J.23.1 The test items shall be mounted in the valve, identical to the torpedo valve configuration including all expendable parts. Functioning shall be at the All-Fire level.

J.23.2 The test items shall have functioned, causing the plunger to shear the burst disc.

J.24 Test No. 24. (Leak Test)

J.24.1 The test items shall be immersed in water in a suitable Bell jar and the pressure reduced to 4 ± 1 inches of mercury absolute. Visual evidence of bubbles shall be indication of a leaker.

J.24.2 Test items shall be safe and operable following this test.

J.25 Test No. 25. (Constant Current Sensitivity)

J.25.1 For this test an instrument capable of maintaining a constant current through the bridge wire of the test item, and a suitable safety chamber will be necessary. An appropriate starting level and step size are determined by trial and error. The Bruceton or "staircase" method of NAVORD 2101 "Statistical Methods Appropriate for Evaluation of Fuze Explosive Train Safety and Reliability" is used to determine the mean firing level, the 99.9% or All-Fire level, and the 0.1% or No-Fire level.

J.26 Test No. 26. (Capacitor Discharge Sensitivity)

J.26.1 For this test a suitable low loss capacitor, a low loss charging and switching system, and a suitable safety chamber will be necessary. An appropriate starting level and step size are determined by trial and error. The Bruceton or "staircase" method of NAVORD 2101 "Statistical Methods Appropriate for Evaluation of Fuze Explosive Train Safety and Reliability" is used to determine the mean firing level, the 99.9% or All-Fire level, and the 0.1% or No-Fire level.

J.27 Test No. 27. (Steel Dent Output Test)

J.27.1 The test items are mounted in a suitable fixture, confined by encasing in a heavy brass sleeve, and placed on a standard steel block. An appropriate safety chamber must be used. When initiated an indentation is formed in the block. The depth of the indentation is measured by a gauge capable of measuring to ± .001 inches. Limits are placed on the average depth of dents and on individual depth of dents.

J.27.2 Test items failing to provide a dent within the proper range will be classed as an output failure.

J.28 Test No. 28. (No-Fire Test)

J.28.1 The test items are pulsed for five minutes with the No-Fire current by an instrument capable of maintaining a constant current through the bridge wire. A suitable safety chamber must be used.

J.28.2 Test items that function will be classed as failures.

J.29 Test No. 29. (High Temperature Storage)

J.29.1 The test items are placed in a chamber at 160°F for a period of 28 days.

J.29.2 Following the test the items shall be reliable and safe to handle.

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2. Torpedoes - Exploders
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II. Stange, Richard H.
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