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EQUIPMENT, LEAK DETECTION, HELIUM, FOR CHEMICAL MUNITIONS

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FOREWORD

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Technical Director, U.S. Army Edgewood Research, Development and Engineering Center, Attn: SCBRD–ENE (STD/SPECS/PKG), Aberdeen Proving Ground, MD 21010–5423, by using the self–addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. This standard is approved for use by all Departments and Agencies of the Department of Defense in the selection of equipment to determine leaks in chemical munitions.

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1. SCOPE

1.1 Scope. This standard covers various types and classes of helium leak detection equipment for use in testing the inert components of chemical munitions for leaks, and also the final closure containing the chemical fill.

1.2 Classification. Helium leak detectors covered by this standard shall be of the following types and classes:

Type I	–	New leak detectors built for specific applications
Type II	–	Rebuilt Government–furnished leak detectors, modified for specific applications
Class 1	–	For heavy–walled munitions
Class 2	–	For thin–walled munitions
Class 3	–	For final closure of all munitions in the filling line
Class 4	–	Sniffer type to locate leaks to be reworked

2. APPLICABLE DOCUMENTS

(Not applicable to this document)

3. DEFINITIONS

3.1 Definitions of Technical Terms.

3.1.1 Mass spectrometer – A mass spectrometer is an instrument used to separate and determine the relative abundance of ions of different mass to charge ratio. Operation of the mass spectrometer depends on the deflection of ionized components of elements, compounds or mixtures, created by bombarding a sample in the gas phase with a beam of high–energy electrons. The high–energy electrons knock one electron from a sample molecule, producing a singly charged positive ion referred to as the parent ion. This ion in turn fragments to form a variety of other fast–moving positive ion fragments, mainly singly charged, which are stable only in the gas phase under the high–vacuum conditions used. These ions are directed through a magnetic field, which deflects their paths to an extent dependent upon their mass–to–charge ratios. The ions with the lowest mass–to–charge ratio are deflected the most. By varying the magnetic field, ions of any mass–to–charge ratio can be made to strike the detector. Since the ions are principally singly charged, the separation is primarily on the basis of mass. Taking into account the magnetic field and other characteristics of the instrument, the mass–to–charge ratio can be determined and hence the mass of each fragment. A mass spectrum is determined by (1) varying the magnetic field so that ions with progressively higher masses strike the detector, and (2) plotting the relative intensities (proportional to the numbers of ions of particular masses), as indicated by the detector, versus their mass–to–charge ratios. The mass–to–charge ratio of the parent ion is the molecular weight of the molecule. Therefore the mass spectrometer provides one of the best methods for obtaining very accurate molecular weights. More than that, however, the pattern of fragmentation and the masses of the parent ion and of each fragment ion provide an excellent "fingerprint method" for identifying the compound.

3.1.2 Helium leak detector. A helium leak detector is a mass spectrometer adjusted to detect helium gas. It can be used with a probe of helium to explore the outside of a system to detect a leak from inside a system, or it can be used inside a system to check for leaks from outside.

4. GENERAL REQUIREMENTS

4.1 Description. The equipment shall be capable of detecting helium leakage using a helium type mass spectrometer. The method used shall be placing the munition in a hood or chamber and evacuating either the interior of the munition or the chamber surrounding the munition. Helium shall be introduced into the space surrounding the munition or into the munition whichever is applicable. If any leaks are present, helium will be drawn through the leak into the evacuated space and then to the leak detector. The equipment shall be identified for acceptance or rejection in accordance with the requirements specified herein.

4.2 Construction. The equipment shall be ruggedly constructed for full time production operation. It shall be capable of three–shift operation, eight–hours per shift. Regardless of type, the pumps shall be of sufficient capacity to complete a test cycle which will satisfy the requirement of 5.1.10.

5. DETAILED REQUIREMENTS

5.1 Design criteria. The equipment described by this standard is intended to be used in production to screen components, determine leaks in filled munitions, and to conduct surveillance of existing stocks. The variety of components and the differences in the volumes and configurations of various munitions, dictate in part that pump–down time required will vary for each test cycle. There will be cases where the requirement of 5.1.10 cannot be met except at excessive costs for large pumps and other equipment. (See 6.2.1)

5.1.1 Equipment. The equipment shall be in sections: leak detector (mass spectrometer), pumping equipment, control panel, and a worktable with necessary manifolding and valves. The worktable is the only item to be specifically designed for the munition to be tested. The other items may be capable of being transferred from one operation to another. Vinyl tubing shall be used wherever flexible tubing is required. Rubber is not acceptable.

5.1.2 Leak detector. The leak detector shall be a helium mass spectrometer with a dynamic sensitivity of at least 10^{-7} cubic centimeters per second (cc/sec) at one atmosphere pressure differential with all external pumps running. In order to obtain this capability, the maximum sensitive capability will be approximately 10^{-9} cc/sec with all external pumps shut down. This sensitivity is required in order to obtain reliable readings at 10^{-6} cc/sec, which is the sensitivity required in production.

5.1.3 Pumping equipment. Evacuation of the items under test, or the chambers surrounding them, shall be accomplished with mechanical and/or diffusion vacuum pumps as necessary to reduce pressure to 20 microns of mercury or less.

5.1.4 Control panel. A control panel shall be provided, and will contain all switches, indicator lights, and gages except those specifically required on the worktable. The worktable shall be connected as closely as possible to prevent lag in readings and promote maximum sensitivity.

5.1.5 Worktable. The worktable portion of the helium leak detection system may be part of the production line. This section of the production line will be considered part of the helium leak detection equipment and if the latter is retained by the Government it will be part of the equipment retained. It shall also contain the required manifolding and valves.

5.1.6 Circuitry. The programming and control portion may consist of electronic equipment or electromechanical equipment. With the exception of start–stop switches and the master power switch, the sequential operation of the equipment shall be fully automated. (Fully automatic handling of test items is not necessarily implied here.) However, each step in the operation cycle shall be capable of being held by a manual override switch. The leak detector shall provide for automatic indication in case of current failure to the spectrometer portion of the detector, and shall be so interlocked that tests cannot be conducted in the event of such failure. Munitions which have a leak rate of 10^{-6} cc/sec or greater, or in which a leak is so gross as to prevent evacuation to a pressure of 20 microns of mercury shall be indicated by a red light on the control panel. Munitions which do not have a leak as great as 10^{-6} cc/sec shall be indicated by a green light on the control panel. A yellow indicator light shall remain on until the start of the next test. Any munition which exceeds the leakage limit shall be automatically marked, or in some manner identified in order to prevent its inclusion in the regular lot.

5.1.7 Monitoring. The equipment shall be checked for sensitivity and accuracy by means of a "calibrated glass leak", permanently attached to the vacuum system. It shall be in the order of magnitude of 10^{-6} atmospheric cc/sec. The sensitivity check shall be made at the start of each shift, and every 2 hours thereafter. Should an out–of–calibration condition be found, the items checked prior to this finding shall be rechecked in reverse order back to the last known acceptable item.

5.1.8 Handling. The contractor shall provide the mechanical equipment which will accomplish the required handling of the test items immediately before, during, and immediately after the execution of helium leak test. This handling shall not damage the test items; nor shall it alter their appearance or condition in any way which may affect the intended use of the items.

5.1.9 Contamination prevention. The mass spectrometer shall have a built–in cold trap for trapping water, oil vapors and condensable gases. It shall also have an external cold trap to prevent condensable vapors from entering the master equipment. The helium equipment shall be placed in a closed area to prevent contamination. The test items must be clean both inside and outside to prevent contamination of the test equipment. Small amounts of contamination not visible to the eye may cause wear of the pumping units which will cause a shut–down. The venting of the helium detection equipment and the munitions will be to a space outside the closed area, preferably outdoors.

5.1.10 Production requirement. The mass spectrometer must be able to detect leaks at a rate at least 30 percent greater than the anticipated production rate.

5.1.11 Detection cycle. The time of exposure of the item to the helium leak test shall be in accordance with the instruction manual furnished for the test equipment. The pressure in the space being tested for the presence of helium shall not exceed 20 microns of mercury prior to the beginning of the detection cycle. During the cycle, the helium used shall be at a pressure differential of not less than one atmosphere. The "helium atmosphere" shall contain not less than 95 percent helium during the detection cycle, except for Class 4. This requirement may be obtained by purging.

5.1.12 Instrumentation. The instruments which indicate directly for the operator must respond quickly enough to keep the operator fully informed of the progress throughout the test cycle.

5.1.13 Cleaning. The manifolding and other equipment shall be so constructed and arranged as to facilitate cleaning where contaminates collect on the interior surfaces.

5.1.14 Safety of personnel. All exposed moving parts of the equipment, such as drive belts, etc., shall be equipped with safety guards, and any other potentially dangerous conditions shall be also labelled.

5.1.15 Finish and name–plate. The finish shall be commercial standard for this type of equipment. The name–plate shall contain as a minimum, the power requirements and the vacuum capacity.

5.2 Manuals. Each piece of new equipment and each piece of modified equipment shall be provided with new operating and maintenance instruction manuals. They shall contain complete information for installation, operation and maintenance, and shall also include technical literature from the supplier of components. The manuals shall list the items that the equipment is capable of testing, and the production rate for each item. The number of manuals to be provided shall be specified in the contract.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard contains requirements for the design of a helium leak detector to be used to determine whether a chemical munition is leaking.

6.2 Submission for approval. The concept of the design or design changes must be submitted to the Technical Director, U.S. Army Edgewood Research, Development and Engineering Center, Attn: SCBRD–ENE, Aberdeen Proving Ground, MD 21010–5423 for approval prior to construction or alteration of equipment within 30 days after award of the contract. A schematic diagram with the following details shall be included:

(a) Make and type of pumps
(b) Make and type of valves
(c) Pipe and wire sizes
(d) Make and type of electric and electronic equipment, such as switches, etc.
(e) Assembly technology
(f) Materials
(g) Chamber design
(h) Method of operation
(i) Position in the production line of the end item to be tested
(j) Spare parts list required for the completion of the contract for the end item

6.2.1 Excessive cost of equipment due to production requirements. The exceptional cases cited in 5.1. will be resolved by the contracting officer or his technical representative.

6.3 Shipment and storage. Instructions for preservation, packaging, packing and marking shall be provided by the contracting officer.

6.4 Technical assistance. Should the contractor require technical assistance during the design of leak detection equipment, the contractor may contact the Contracting Officer, Procurement and Production Directorate, U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, MD 21010–5423.

6.5 Subject term (key word) listing.

Mass Spectrometer
Helium Leak Detector

6.6 Changes from previous issue. Changes to this document were made to update the format, separate design factors from general contractual information, and to define technical terms.

CONCLUDING MATERIAL

CUSTODIANS:

ARMY – EA

PREPARING ACTIVITY:

ARMY – EA

PROJECT NO. 4925–0056

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER MIL-STD-1441A (EA)

2. DOCUMENT DATE (YYMMDD) 940628

3. DOCUMENT TITLE EQUIPMENT, LEAK DETECTION, HELIUM, FOR CHEMICAL MUNITIONS

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(If applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY

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c. ADDRESS *(Include Zip Code)* TECH DIRECTOR, ERDEC SCBRD ENE S ES027 5232 FLEMING RD, APG MD 21010	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	