MIL-STD-2166
5 December 1984

MILITARY STANDARD

CONNECTIONS, ELECTRICAL, COMPLIANT PIN

FSC 5935

DEPARTMENT OF DEFENSE

Washington, DC 20363

Connections, Electrical, Compliant Pin

MIL-STD-2166

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: Commander, Naval Electronic Systems Command, ATTN: ELEX 8111, Department of the Navy, Washington, DC 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1. SCOPE

1.1 Scope. This standard is intended to be used in conjunction with other connector documents to verify the suitability of the compliant pin/printed wiring board interface. The applicable requirements specified herein are to be incorporated as part of the individual specification sheets in determining the additional tests to be conducted, the sequence of the tests, and the number of samples to be submitted.

1.1.1 Application. Compliant pins are designed for application in a plated-through hole in double-sided or multilayer printed wiring boards having thickness of .062 inch (1.57 mm) and .093 inch (2.36 mm) or larger as specified on the individual military connector specification sheet.

1.2 Classification. Compliant pins shall be of the following types:

Type I. Compliant pins which are not individually removable from the plated-through hole or the connector when the connector is installed on the printed wiring board.

Type II. Compliant pins which are individually removable from the plated-through hole. The pins may be used with or without a connector housing, but when used with a housing shall not depend on the housing for retention.

Type III. Compliant pins which are individually removable from the plated-through hole. The compliant pin shall be installed in a housing and shall partially depend on the housing for retention in the plated-through hole.

2. REFERENCED DOCUMENTS

2.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-13949 - Plastic Sheet, Laminated, Metal Clad (For Printed Wiring) General Specification For
MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)
MIL-P-55110 - Printed Wiring Boards

STANDARDS

MILITARY

MIL-STD-1344 - Test Methods for Electrical Connectors

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

INSTITUTE FOR INTERCONNECTING AND PACKAGING (IPC)

IPC-T-50 - Circuit, Electronic, Terms and Definitions, for Interconnecting and Packaging.
IPC-TM-650 - Test Methods Manual.

(Application for copies should be addressed to the Institute for Interconnecting and Packaging (IPC), 3451 Church Street, Evanston, IL 60202.)

2.3 Order of precedence. In the event of conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

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TABLES

FIGURES

3. DEFINITIONS

3.1 Terms and definitions. The definitions of all terms used herein shall be as specified in IPC-T-50.

4. GENERAL STATEMENTS OF REQUIREMENTS

4.1 Compliant pin terminations. Compliant pin terminations on a connector shall meet the requirements specified herein when tested as specified herein.

5. DETAILED STATEMENTS OF REQUIREMENTS

5.1 Printed wiring test board. Printed wiring test board requirements are as specified in 5.1.1.

5.1.1 Test board design. The test board shall be in accordance with table I for double-sided boards and table II for multilayer boards.

TABLE I. Double-sided boards.

Requirements	
Thickness	As specified individual connector specification sheet.
Grid pattern for plated-through holes	As specified individual connector specification sheet.
Inside diameter of finished plated-through hole	As specified individual connector specification sheet.
Laminate material	MIL-P-13949, type GF
Copper foil thickness	1 ounce per square ft.
Conductor spacing	0.008" min.
Conductor width	0.010" min.
Diameter of land surrounding plated-through hole	.020" greater than drilled hole
Drilled hole diameter	As specified in individual connector specification sheet.
Interconnections between plated-through hole	Figure 1
Tolerance on location of plated-through holes	Within .004 radius true position
Tolerance on diameter of finished plated-through hole	±0.003
Plating in plated-through holes	Copper 0.001 min plus tin-lead 0.0003 min
Conformal coating (both sides)	MIL-I-46058, type UR, 0.003 ±.002" thick

TABLE II. Multilayer boards.

Requirements	
Thickness	As specified individual connector specification sheet.
Grid pattern for plated-through holes	As specified individual connector specification sheet.
Inside diameter of finished plated-through hole	As specified individual connector specification sheet.
Drilled hole diameter	As specified individual connector specification sheet.
Laminate material	MIL-P-13949, type GF
Number of layers	10
Copper foil thickness	1 oz/ft^2
Conductor spacing	0.008" min
Conductor width	0.010" min
Diameter of land surrounding plated-through hole	.020" greater than drilled hole
Interconnections between plated-through holes	Figure 2
Tolerance on location of plated-through holes	Within .004" radius of true position
Tolerance on diameter of finished plated-through hole	±0.003
Plating in plated-through holes	Copper 0.001" min plus tin-lead 0.0003" min
Conformal coating (both sides)	MIL-I-46058, type UR, 0.003 ±.002" thick

5.1.2 Quality assurance. The compliant pin test boards shall be acquired in accordance with MIL-P-55110 and the specific requirements indicated on the individual connector specification sheet from a supplier who is certified to MIL-P-55110 for types 2 and 3 printed wiring boards fabricated from type GF material in accordance with MIL-P-13949. The qualifying activity for the individual connector specification sheet containing the compliant pin terminated connector shall, prior to initiation of testing, establish that the test board is in conformance with MIL-P-55110 and the individual connector specification sheet.

5.2 Performance requirement. Performance requirements are as specified in 5.2.1.

5.2.1 Initial insertion force (type I, II, and III). The force to initially insert the compliant pins in the plated-through hole in the printed wiring board shall not exceed 45 pounds for individual pins or 45 pounds maximum average for pins pre-assembled in connector housing.

5.2.2 Compliant pin retention. Compliant pin retention requirements are as specified in 5.2.2.1 through 5.2.2.3. The 5.0 pound retention force specified applies to compliant pins which do not contain solderless wrapposts. A 7.5 pound force applies when the compliant pins contain solderless wrapposts.

5.2.2.1 Type I retention. Type I retention requirements are as specified in 5.2.2.1.1 and 5.2.2.1.2.

5.2.2.1.1 Type I initial retention. After initial insertion of the compliant pins into the plated-through hole in a printed wiring board in accordance with 5.4.1.1, the minimum push or pull out force shall be 5.0 pounds per pin when tested in accordance with 5.4.2.1.1.

5.2.2.1.2 Type I conditioned retention. After conditioning in accordance with 5.4.3.1, the minimum push or pull out force shall be 5.0 pounds per pin when tested in accordance with 5.4.2.1.1.

5.2.2.2 Type II retention. Type II retention requirements are as specified in 5.2.2.2.1 and 5.2.2.2.2.

5.2.2.2.1 Type II initial retention. After initial insertion of the compliant pin into the plated-through hole in a printed wiring board in accordance with 5.2.1, the minimum push or pull out force shall be 5.0 pounds when tested in accordance with 5.4.2.2.1.

5.2.2.2.2 Type II conditioned retention. After conditioning in accordance with 5.4.3.2, the minimum push or pull out force shall be 5.0 pounds when tested in accordance with 5.4.2.2.2.

5.2.2.3. Type III retention. Type III retention requirements are as specified in 5.2.2.3.1 and 5.2.2.3.2.

5.2.2.3.1 Type III initial retention. After initial insertion of the compliant pins into the plated-through holes in a printed wiring board in accoardance with 5.4.1.3, the minimum push or pull out force shall be 5.0 pounds per pin when tested in accordance with 5.4.2.3.1.

5.2.2.3.2 Type III conditioned retention. After conditioning in accordance with 5.4.3.3, the minimum push or pull out force shall be a minimum of 5.0 pounds per pin when tested in accordance with 5.4.2.3.2.

5.2.3 Plated-through hole integrity. When tested in accordance with 5.4.4, plated-through holes containing compliant pins shall conform to the requirements specified in 5.2.3.1, and 5.2.3.2.

5.2.3.1 Hole deformation radius. The average hole deformation radius (deformation on board material) shall be no greater than 0.0015 inch (.038 mm) when measured from the drilled hole, based on a 10 hole microsection sample. The absolute maximum deformation radius shall not exceed 0.002 inch (.051 mm) (see figure 3).

5.2.3.2 Hole wall damage. When 10 holes are microsectioned in accordance with 5.4.4.1.2, the average copper thickness remaining between the compliant pin and the printed wiring laminate shall not be less than 0.0003 inch (.008 mm). In addition, there shall be no copper cracks or other interplane separations from the hole wall, barrel separations between the printed wiring board laminate and the copper barrel, separations between conductor interfaces or laminate to copper separations.

5.2.4 Electrical resistance, contact to printed wiring board. When the compliant pin contacts are tested as specified in 5.3.2.1, the resistance shall not exceed 2 milliohms for double-sided boards and 7 milliohms for multilayer boards.

5.2.4.1 Low-level contact resistance. When the compliant pin contacts are tested as specified in 5.3.2.2, the resistance shall not exceed 2 milliohms for double-sided boards and 7 milliohms for multilayer boards.

5.2.5 Humidity/moisture resistance. After testing as specified in 5.5.1, the compliant pin contact shall conform to 5.2.4.

5.2.6 Temperature cycling/thermal shock. After tested as specified in 5.5.2, the compliant pin contact shall conform to 5.2.4.

5.3 Methods of inspections. Methods of inspections are as specified in 5.3.1 through 5.3.2.2.

5.3.1 Visual and mechanical inspection. The compliant pin contact shall be inspected to determine that the material, design, construction, physical dimensions, and workmanship are in accordance with the applicable requirements.

5.3.2 Electrical testing. Electrical testing requirements are as specified in 5.3.2.1 and 5.3.2.2.

5.3.2.1 Electrical resistance, contact to printed wiring board (see 5.2.4). The compliant pin contacts when installed in the test board shall be tested in accordance with method 3004 of MIL-STD-1344 while connected in accordance with the test set-up depicted on figure 1 (double-sided boards) and figure 2 (multilayer boards). The following details shall apply:

a. Method of connection: See figures 1 and 2.

b. Test current: Fully rated current as specified in the individual specification sheet.

5.3.2.2 Low-level contact resistance (see 5.2.4.1). The compliant pin contacts when installed in the test board shall be tested in accordance with method 3002 of MIL-STD-1344 while connected in accordance with the test set-up depicted on figure 1 (double-sided boards) and figure 2 (multilayer boards).

5.4 Mechanical testing. Mechanical testing requirements are as specified in 5.4.1 through 5.4.4.

5.4.1 Mechanical testing of initial insertion force. Mechanical testing of initial insertion force requirements are as specified in 5.4.1.1 through 5.4.1.3.

5.4.1.1 Mechanical testing of type I initial insertion force (see 5.2.1). The compliant pin contacts (complete complement of contacts) pre-assembled in the connector housing as normal method of installation shall be inserted into the plated-through holes in the printed wiring test board. The force to insert the complete complement of contacts into the plated-through holes shall be determined.

5.4.1.2 Mechanical testing of type II initial insertion force (see 5.2.1). Compliant pin contacts not pre-assembled in the connector housing as normal method of installation shall be inserted into the plated-through holes in the printed wiring test board. Compliant pin contacts shall be inserted into each plated-through hole in the test board and the force to insert shall be determined for each compliant pin.

5.4.1.3 Mechanical testing of type III initial insertion force (see 5.2.1). The compliant pin contacts (complete complement of contacts) pre-assembled in the connector housing as normal method of installation shall be inserted into the plated-through holes in the printed wiring test board. The force to insert the complete complement of contacts into the plated-through holes shall be determined.

5.4.2 Mechanical testing of compliant pin retention. Mechanical testing of compliant pin retention requirements are as specified in 5.4.2.1 through 5.4.2.3.

5.4.2.1 Mechanical testing of type I retention (see 5.2.2.1). Mechanical testing of type I retention requirements are as specified in 5.4.2.1.1 and 5.4.2.1.2.

5.4.2.1.1 Mechanical testing of type I initial retention (see 5.2.2.1.1). After the initial insertion of the compliant pins into the plated-through holes in the printed wiring test board in accordance with 5.4.1.1, the force to simultaneously push or pull out all compliant pins inserted in the plated-through holes in the axial direction opposite of insertion shall be determined.

5.4.2.1.2 Mechanical testing of type I conditioned retention (see 5.2.2.1.2). After conditioning of the plated-through holes in accordance with 5.4.3.1, the specified axial push or pull force shall be applied simultaneously to all conditioned compliant pins inserted into the plated-through holes in the test board in the axial direction opposite of that of insertion.

5.4.2.2 Mechanical testing of type II retention (see 5.2.2.2). Mechanical testing of type II retention requirements are as specified in 5.4.2.2.1 and 5.4.2.2.2.

5.4.2.2.1 Mechanical testing of type II initial retention (see 5.2.2.2.1). After initial insertion, compliant pin contacts shall be tested in accordance with method 2007 of MIL-STD-1344. An axial push or pull force shall be applied to the compliant pin contact in a direction opposite to that of its insertion in the plated-through hole and the force determined.

5.4.2.2.2 Mechanical testing of type II conditioned retention (see 5.2.2.2.2). After conditioning of the plated-through hole in accordance with 5.4.3.2, the specified push or pull force shall be applied to the conditioned compliant pin inserted in the plated-through hole in the axial direction opposite of that of insertion.

5.4.2.3 Mechanical testing of type III retention (see 5.2.2.3). Mechanical testing of type III retention shall be as specified in 5.4.2.3.1 and 5.4.2.3.2.

5.4.2.3.1 Mechanical testing of type III initial retention (see 5.2.2.3.1). After initial insertion of the compliant pins into the plated-through holes in the printed wiring test board in accordance with 5.4.1.3, the force to simultaneously push or pull out all compliant pins inserted in the plated-through holes in the axial direction opposite of insertion shall be determined.

5.4.2.3.2 Mechanical testing of type III conditioned retention (see 5.2.2.3.2). After conditioning of the plated-through holes in accordance with 5.4.3.1, the specified axial push or pull force shall be applied simultaneously to all conditioned compliant pins inserted into the plated-through holes in the test board in the axial direction opposite of that of insertion.

5.4.3 Mechanical testing, plated-through hole conditioning. Mechanical testing of conditioning plated-through hole requirements are as specified in 5.4.3.1 through 5.4.3.3.

5.4.3.1 Mechanical testing, plated-through hole conditioning, type I. The plated-through compliant pin termination holes in the printed wiring board shall be conditioned by using connectors of the same design as specified on the individual connector specification sheet for the compliant pin connector. The holes shall be conditioned by the insertion and removal of the compliant pins of a connector whose compliant pins have not previously been inserted in a plated-through hole (virgin pins). Following the initial insertion, the pins installed in the connector housing shall be removed from the plated-through holes and virgin compliant pins installed in a second connector housing shall be inserted into the plated-through holes. The second connector's pins shall be removed from the plated-through holes and virgin compliant pins installed in a third connector housing shall be inserted into the plated-through holes.

5.4.3.2 Mechanical testing, plated-through hole conditioning, type II. The plated-through compliant pin termination holes in the printed wiring board shall be conditioned by using pins of the design as specified on the individual connector specification sheet for the compliant pin connector. The hole shall be conditioned by the insertion and removal of a virgin compliant pin followed by the insertion and removal of a second virgin compliant pin in the same hole. A third virgin compliant pin shall then be inserted in the hole.

5.4.3.3 Mechanical testing, plated-through hole conditioning, type III. The plated-through compliant pin termination holes in the printed wiring board shall be conditioned by using connectors of the same design as specified on the individual connector specification sheet for the compliant pin connector. The holes shall be conditioned by the insertion and removal of the compliant pins of a connector whose compliant pins have not previously been inserted in a plated-through hole (virgin pins). Following the initial insertion, the pins installed in the connector housing shall be removed from the plated-through holes and virgin compliant pins installed in a second connector housing shall be inserted into the plated-through holes. The second connector's pins shall be removed from the plated-through holes and virgin compliant pins installed in a third connector housing shall be inserted into the plated-through holes.

5.4.4 Mechanical testing of type I, II, and III plated-through hole integrity (see 5.2.3). After plated-through hole conditioning in accordance with 5.4.3.1 for type I, 5.4.3.2 for type II, and 5.4.3.3 for type III, the compliant pins types I and III shall be cut and separate from the housing between where the pin emerges from the plated-through hole in the printed wiring board and where the pin enters the housing. The plated-through hole containing the compliant pin for type II and cut compliant pins for types I and III shall be microsectioned as specified in 5.4.4.1.

NOTE: For types I and III, potting shall be done before cutting away connector to eliminate the possibility of the cutting operation affecting the compliant pin to plated-through hole interface.

5.4.4.1 Microsectioning. The plated-through holes containing the compliant pins shall be microsectioned in accordance with IPC-TM-650, method 2.1.1. The examinations and measurements shall be at a magnification of 100X. Referee examinations shall be accomplished at a magnification of 200X.

5.4.4.1.1 Double-sided printed wiring boards. Plated-through holes containing compliant pins shall be microsectioned parallel to the board surface and examined for conformance to 5.2.3.1 and 5.2.3.2. At least two different levels of hole depth shall be viewed and measurements shall be taken at the entrance to the hole (just below the annular ring) and half-way down the compliant section. It is not mandatory that the same hole be viewed at both levels.

5.4.4.1.2 Multilayer printed wiring boards. Plated-through holes containing compliant pins shall be microsectioned parallel and perpendicular to the board surface. In both planes, the microsectioned sample shall be examined for conformance to 5.2.3.1 and 5.2.3.2. In the sections parallel to the board surface at least two different levels of hole depth shall be viewed and measurements shall be taken at the entrance to the hole (just below the annular ring) and half-way down the compliant section. Also, in the perpendicular plane, the sample shall be viewed to ensure that no copper cracks, separations between conductive interfaces, or laminate-to-copper separations have occurred.

5.5 Environmental testing. Environmental testing requirements are as specified in 5.5.1 and 5.5.2.

5.5.1 Humidity/moisture resistance (see 5.2.5). The connector with the compliant pin terminations inserted into the plated-through holes in the printed wiring board shall be subjected to the humidity/moisture resistance test specified in the connector specification.

5.5.2 Temperature cycling/thermal shock (see 5.2.6). The connector with the compliant pin terminations inserted into the plated-through holes in the printed wiring board shall be subjected to the temperature cycling/thermal shock test specified in the connector specification.

5.6 Tests to be conducted during qualification. Tests to be conducted during qualification shall be as specified in table III.

5.6.1 Test specimens. Six connectors or more, assuring the minimum number of compliant pin terminations required in table III, shall be subjected to the tests indicated in table III in the order shown using a test board in accordance with 5.1.1.

5.7 Requirements to be specified on individual connector specification sheet. The following requirements shall be specified on the individual connector specification sheet:

a. Finished plated-through hole diameter (see tables I and II).

b. Drilled hole diameter (see tables I and II).

c. Grid of hole pattern in test board (see tables I and II).

d. Sequence of test and number of samples as shown in table III.

e. Thickness of board (see tables I and II).

f. Type I, II, or III (see 1.2).

TABLE III. Qualification testing requirements.

Inspection	Requirement paragrpah	Method paragraph	Number of specimens	
			Double-sided boards	Multilayer boards
Group I			3	3
Visual and mechanical inspection	5.3.1	5.4	1/	1/
Initial insertion force (type I, II, and III)	5.2.1	5.4.1	2/	2/
Low-level contact resistance	5.2.4.1	5.3.2.2	3/	3/
Rated contact resistance	---	---	3/	3/
Retention	5.2.2	5.4.2	2/	2/
Subgroup I			1	1
Conditioning (PTH)	---	5.4.3	2/	2/
Low-level contact resistance	5.2.4.1	5.3.2.2	3/	3/
Retention	5.2.2	5.4.2	2/	2/
Plated-through hole integrity	5.2.3	5.4.4	4/	3/
Subgroup II			1	1
Temperature cycling/thermal shock	5.2.6	5.5.2	1/	1/
Low-level contact resistance	5.2.4.1	5.3.2.2	3/	3/
Shock-mechanical	5.4	5.4.1 thru 5.4.4	1/	1/
Retention	5.2.2	5.4.2	2/	2/
Subgroup III			1	1
Vibration	---	---	1/	1/
Humidity/moisture resistance	5.2.5	5.5.1	1/	1/
Low-level contact resistance	5.2.4.1	5.3.2.2	3/	3/
Retention	5.2.2	5.4.2	2/	2/

1/ All contacts.

2/ Type I - all contacts, Type II - 20 contacts, Type III - 20 contacts minimum.

3/ 20 contacts each.

4/ 10 contacts.

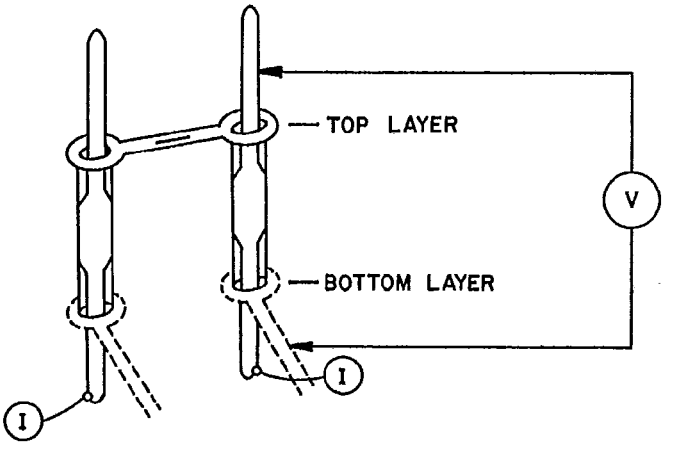

FIGURE 1. Double-sided boards.

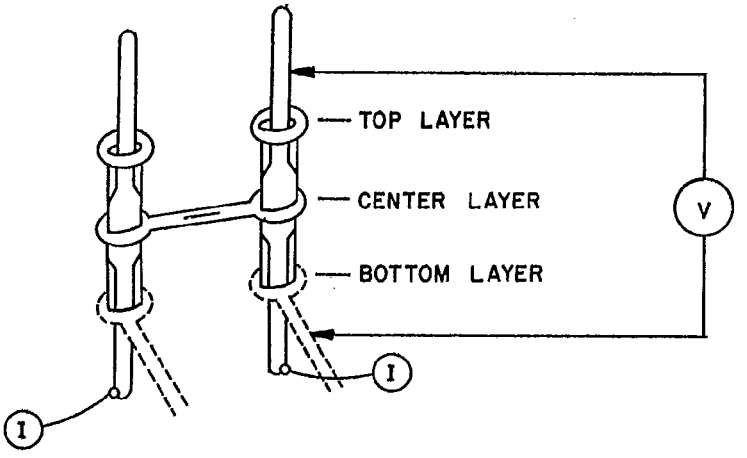

FIGURE 2. Multilayer boards.

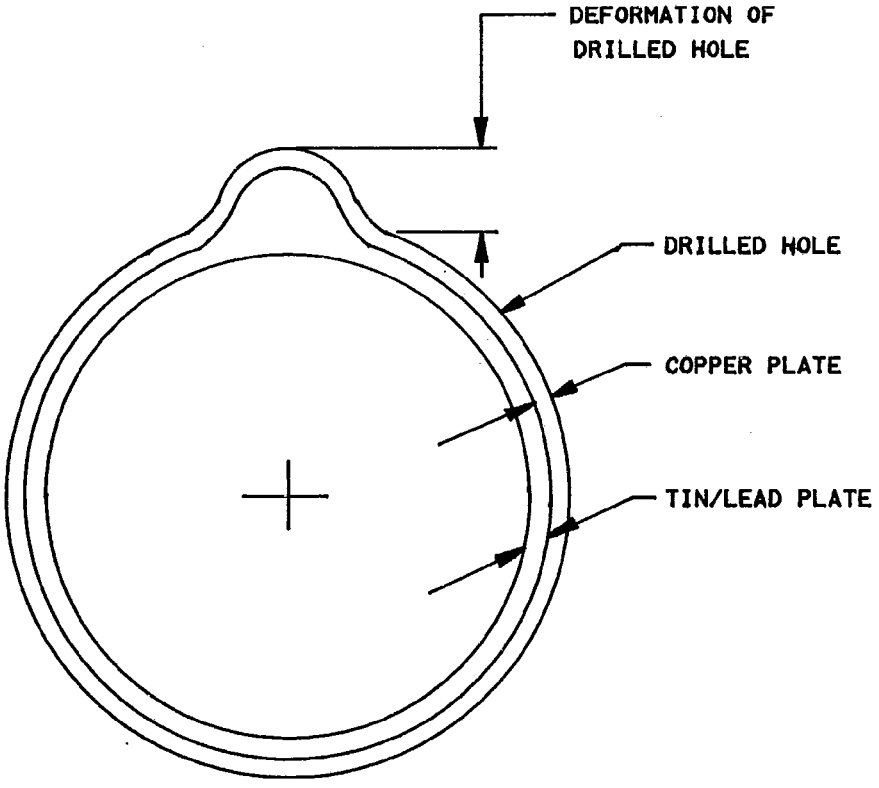

FIGURE 3. Hole distortion.

Custodians:
Army - CR
Navy - EC
Air Force - 17

Review activities:
Army - AR
Navy - AS, SH
Air Force - 11, 85, 99
DLA - ES

User activities:
Army - MI
Navy - CG, MC
Air Force - 19

Agent:
DLA - ES

Preparing activity:
Navy - EC

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