



Research and Development Technical Report
ECOM-0090-F

AD

RELIABLE INTEGRATED WIRE TERMINATION DEVICES

FINAL REPORT

By

D. L. Pfendler

D. H. Gould

July 1973

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UNITED STATES ARMY ELECTRONICS COMMAND · FORT MONMOUTH, N.J.

CONTRACT DAAB07-71-C-0090

THE BENDIX CORPORATION
ELECTRICAL COMPONENTS DIVISION
SIDNEY, NEW YORK 13838

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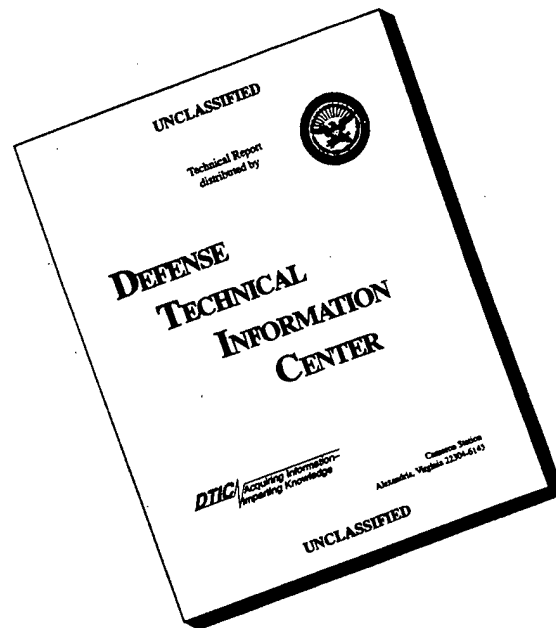
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July 1973

OSD - 1366

RELIABLE INTEGRATED
WIRE TERMINATION DEVICES

Final Report

January 1, 1971/January 31, 1973

Contract No. DAAB07-71-C-0090

DA Project No. 1F162203A 119 35 01

Prepared by

D. L. Pfendler and D. H. Gould

The Bendix Corporation
Electrical Components Division
Sidney, New York

FOR

U.S. ARMY ELECTRONICS COMMAND, FORT MONMOUTH, N. J.

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ABSTRACT

This final report covers an investigation into the design and evaluation of a single wire termination system capable of interconnection to various existing designs of multi-contact connectors. The devices utilizing this termination system were to be capable of assembly and maintenance with a common tool. In addition, the devices were to reliably withstand the environmental conditions encountered by ground and airborne Army equipment with emphasis on improvement for Army aircraft. The concept designed and evaluated makes waterproof connectors having crimp removable MS27491 series contacts practical to produce. However, to obtain sound insert moldings, minimum spacing between contact centerlines had to be established as follows:

Terminal Size	22D	20	16	12
Minimum Space	.090 in. (tentative)	.130 in.	.190 in.	.238 in.

It was found that the contact spacing of MIL-C-81511 connectors is inadequate for use with MS27491-22D contacts. Terminal insertion and removal tools were obtained, evaluated, and found useful. Terminal insertion and removal tips used for 22D contacts were mechanically weak. If the tip wall section must be increased, which is still to be determined, or if the dielectric wall thickness between contact cavities is inadequate for a reliable design, then the .090 in. spacing for this contact size may have to be increased.

FOREWORD

The work described in this report was authorized by the United States Army Electronics Command, under contract DAAB07-71-C-0090, DA Project 1F162203A119, Task 35, Sub-task 01.

This is the final report as prepared by The Bendix Corporation, Electrical Components Division, Sidney, New York with Mr. Elmer Godwin and Mr. Edward Ryan as ECOM Project Monitors.

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TECHNICAL REPORT

I. Introduction

This report has as its subject the development of reliable integrated termination devices. A definition of an integrated termination device can be given as a device that for any one electrical contact size (22, 20, 16, etc.) only one configuration of contact would be used. This one contact can then be assembled into a device such as an electrical connector, relay, switch, etc. that is interchangeable with specific devices currently available.

The purpose of this development was to limit the numerous designs of electrical contacts required at present in a user's stock to one single type which would replace all other crimp type contact designs now in use. In addition, accomplishing this purpose would simultaneously reduce the application tools required to one set. At the same time the performance capabilities, such as remaining sealed during water immersion, of fixed contact connectors and the conveniences of crimp insertable contact connectors were to be combined in the one device.

II. Detailed Report

A. Connector Assemblies

Initial layouts were made to document a number of concepts that could be used for an integrated termination system. The first layout made (Figure 1) shows that either a male or female electrical contact could be used as a terminal with the same basic retention mechanism (metallic or dielectric). A second layout was produced (Figure 2) to depict a number of possible methods of retaining an MS 27491 or MS 27493 type electrical contact used as a terminal. Items 2, 3, and 4 on this layout could be used in relays, switches, etc. which have large contact spacing and can utilize an exposed terminal. All other items in Figure 2 were rejected as being too expensive to produce, unproduceable, or unworkable. Connector assembly drawings for MIL-C-81511 intermateable type devices incorporating the metallic retention method illustrated in Figure 3 and the dielectric retention concept shown in Figure 4 were completed based on the following: (see Figures 5 through 8).

1. The standard MS 27491 socket contact would be used as the terminal. The choice of the socket contact was based on the following:
 - a. The electrical contacting surface of the socket contact is self protected with the usual steel sleeve. The mating pin is buried in the insulators and is thereby protected in comparison to being completely exposed to damage if the pin contact was chosen as the terminal.
 - b. The socket contact can continue to be manufactured by suppliers capable of producing a relatively complex part. The production of the relatively simple pin in the terminating device can be accomplished by manufacturers who may not have and would not need the capability of producing the socket contact.
 - c. If the socket contact is damaged it could be easily replaced if used as the terminal compared to replacing the socket in a wiring device.
 - d. The MS 27491 socket contact was the shortest in length and smallest in diameter available for use.

2. At one point in time it was thought that terminals with two or more ranges of engaging and separating forces (to lower electrical resistance through the contacts) and of a shorter length (to shorten overall connector length) should be evaluated. However, these ideas were rejected in light of the expected small effect on contact resistance and the increased loading required of the relatively weak contact insertion tools, with only a small decrease in overall length. Also, and more important, the introduction of a new contact which would add to the existing proliferation of contacts would defeat the purpose of the overall investigation.

The relatively weak contact insertion tools are caused by the fact that the width of the shoulder on the contact, used for contact/terminal retention, dictates the wall section of the insert tool. Review of the dimensions of the MS 27491, size 22D contact shoulder shows that .007 inch is the nominal width of the shoulder. The .007 inch must then be divided into clearance between the inside diameter of the tool and the contact crimp barrel and tolerance on inside and outside diameter of the tool. The result is a tool tip that is subject to deformation and damage during use. An increase in the shoulder width on the contact and, therefore, a proportionate increase in wall section of the tool for increased strength would also require a like increase in contact hole center-to-center distance.

A study of the detail component drawing and the mold drawing for the MIL-C-81511 intermateable prototype in the 18-85 arrangement, both dielectric and metallic retention, lead to less than 100% confidence in the ability of either retention system to meet all of the performance requirements. The extremely thin walls of the retention towers and the walls between the retention mechanisms in this size and arrangement results in thin walls in the molds and supports the less than 100% confidence. These thin walls required special time consuming machining procedures to be developed to produce the molds.

A layout was made (see Figure 9) to investigate the possibility of producing the MIL-C-81511, 18-85 arrangement, dielectric retention, by employing a contact with special diameters and lengths as compared to the MS 27491 series contact. The new contact would have a longer area to the rear of the retention shoulder to allow for the length required at the .040 inch diameter. The engaging end of the terminal would be a size 23. The idea was rejected due to the decision to use standard MS contacts as the terminals.

After an expenditure of considerable time and money to produce molds for the two inserts forming the dielectric retention mechanism section (Figures 10 and 11) a concentrated effort was made to mold the inserts. However, little or no success could be obtained in molding complete and useable inserts and accordingly experienced representatives of the manufacturer of the material used in the inserts were consulted. During a conference with ECOM representatives, Bendix-ECD's personnel, and the material manufacturer's representatives it was agreed that the .005 inch thick molded walls in these inserts were at that time beyond the state of the art capability, but were not considered impossible. The inability to fill the thin cavity in the molds was the basic cause of not obtaining complete and useable components. The walls that were produced were homogeneous and non-porous.

In addition to the Polymer 360 (Minnesota Mining and Manufacturing) molding compound used for dielectric terminal retention mechanisms, many other materials have been considered and/or evaluated in the past at Bendix-ECD. The materials and reason(s) for rejection are as follows:

<u>Item</u>	<u>Material</u>	<u>Reason(s) for Rejection</u>
1	Polycarbonate, GE Lexan	Non-resistant to various solvents.
2	Polyphenylen Oxide, GE, Grade 531	Non-resistant to various solvents.
3	Polysulfone, Union Carbide, P1700	Non-resistant to various solvents.
4	Nylon, 20% glass reinforced, LNP	Non-resistant to various solvents.
5	Tefzel HT2007-4, duPont	Lack of required mechanical properties (contact retention).
6	Tefzel 200, duPont	Lack of required mechanical properties (contact retention).
7	Tefzel HT2004-5, duPont	Lack of required mechanical properties (contact retention).
8	Tefzel HT2007-2, duPont	Lack of required mechanical properties (contact retention).
9	Polyethersulfone, Imperial Chemical Industries, P720	Non-availability of material (experimental material).

10	Glass reinforced polyester, Celanese X-917 (3300)	Lack of required mechanical properties (contact retention).
11	Trogamid T, Dynamit-Nobel	Non-resistant to various solvents.
12	Polyimidal, 15% glass filled, Raychem	Lack of required mechanical properties (contact retention).

Due to the lack of additional time and money in the contract, a decision was made with Bendix-ECD and USAECOM mutual concurrence to drop further development of the MIL-C-81511 intermateable, 18-85 arrangement, dielectric retention connector assemblies with the integrated wire termination concept.

Prototype MIL-C-81511 intermateable, 18-85 arrangement, metallic terminal retention samples were then tooled and produced and tested. Three basic failure modes were encountered during the testing. The three modes were not unexpected as the failures occurred in those areas that were new in the design of the connector. The three modes of failure were: (1) air leakage, (2) dielectric withstanding voltage breakdown and (3) terminal retention. The causes for failure were: (1) sealing of the fixed contact, (2) too thin insulation wall between contact cavities, and (3) faulty terminal retention mechanisms. The method of sealing the fixed contacts, the amount of insulation between contact cavities, and the stock thickness of the retention mechanism were all unique in this connector design.

As stated above, the results of testing the prototype MIL-C-81511, 18-85 arrangement metallic retention samples indicated that, except for the three failure modes, the connectors met the requirements of the specification. One area of interest is that of contact resistance because of the additional number of joints between contacts. Although the average contact resistance (one terminal end to other terminal end) is 50% more for 22 and 20 AWG wire and 25% more for 26 AWG wire for the integrated wire termination connector compared to the standard MIL-C-81511 connector, it still meets or is within the maximum limits set by the Military Specification. Also, the resistance (one terminal end to other terminal end) is no greater than a similar length of wire.

With corrective action taken for all three failure modes in effect, pre-production samples of MIL-C-81511, 18-85 arrangement, metallic terminal retention samples were fabricated and evaluated according to specific sections of Bendix-ECD test procedure L-15081-98, no revision, dated March 19, 1972. The corrective action was as follows:

- (1) inspection to insure round retention clips to improve contact retention,
- (2) grit blasting of bonding area between insert assembly and shell to improve seal and,
- (3) attempt to improve dielectric withstanding voltage capabilities between contact holes in the insert assembly.

The results of the testing are reported in Bendix-ECD Engineering Laboratory Report 12-5193 (see appendix). A copy of the test procedure is included in this report.

Because of the large number of dielectric withstanding voltage failures in the 18-85, MIL-C-81511 type samples tested, the test was discontinued by mutual agreement between USAECOM and Bendix-ECD. A program was then initiated to determine the capability to produce 18-85 metallic retention inserts which would pass the required dielectric withstanding voltage tests.

The capability study was accomplished as follows:

A dielectric withstanding voltage test fixture was fabricated which electrically stressed the dielectric walls in the insert by introducing a highly electrically conductive gas into the contact cavities and outside of the insert. The dielectric withstanding voltage test applies the test voltage between each contact cavity and all other adjacent contact cavities tied in common. The highly conductive gas is employed because the flash-over test voltage required is approximately one-fourth that required in air. Also the gas will permeate through semi-porous molded walls that air would not enter.

A number of different molding compounds were tried to obtain electrically good inserts. The mold fabricated for the 18-85 arrangement metallic terminal retention insert was utilized. The mold was used by production personnel on production equipment under Materials Laboratory personnel supervision to obtain the best combination of personnel and equipment available. All transfer molding was performed while the mold was under vacuum. The materials used, the condition, and the results of the dielectric withstanding voltage test with the previously described test fixture are as follows:

- a. Allied Chemical Epiall 1288BX-unheated preforms:
4 of 5 failed at 1300 VAC before bushing removal
1 of 1 failed at 1300 VAC after bushing removal
- b. Allied Chemical Epiall 1288BX-preheated preforms:
4 of 4 failed at 1300 VAC before bushing removal
4 of 4 failed at 1300 VAC after bushing removal
- c. Fiberite E3938C - unheated preforms:
4 of 4 failed at 1300 VAC before bushing removal
4 of 4 failed at 1300 VAC after bushing removal

- d. Fiberite E3938C - preheated preforms
4 of 4 failed at 1300 VAC before bushing removal
4 of 4 failed at 1300 VAC after bushing removal
- e. Allied Chemical Epiall 1961 - unheated preforms:
5 of 7 failed at 1300 VAC before bushing removal
1 of 2 failed at 1300 VAC after bushing removal
0 to 1 failed at 1300 and 1800 VAC after retention mechanism assembled.
- f. Allied Chemical Epiall 1908 - unheated preform:
1 of 6 failed at 1300 VAC before bushing removal
0 of 5 failed at 1300 VAC after bushing removal
0 of 4 failed at 1300 and 1800 VAC after retention mechanism assembled.

Note: One of the above inserts was damaged during retention mechanism assembly and, therefore, would not fit the test fixture for dielectric withstanding voltage testing. In all of the above inserts that failed the dielectric withstanding voltage test, the failure was due to porosity in the thin dielectric wall between terminal retention devices.

At the request of ECOM, drawings were made for devices utilizing the integrated wire termination system concept, intermateable with connectors in accordance with U.S. Army Materiel Command drawing number 11176551, 22-55 arrangement. These prototype assemblies with both metallic and dielectric retention mechanisms were evaluated according to a test program concurred on by USAECOM. A review of the test data indicated that, although both types of terminal retention mechanisms operated satisfactorily, the dielectric retention type seemed to be somewhat better than the metallic type in the area of terminal insertion and withdrawal. Since the dielectric terminal retention device is a full "collet" shaped mechanism, it seems to better "center" the terminal during insertion and withdrawal as compared to the metallic device which has the retention tines of the clip not directly opposite each other, thereby pushing the contact to one side. Note that, as expected, the same degree of difficulty in molding the dielectric retention mechanism component and the metallic retention component for the 22-55 arrangement devices was not present as in the 18-85 arrangement. This was due to the thicker walls of the dielectric between holes and the thicker walls of the retention towers because of the .130 inch center to center spacing.

Evaluation of the U.S. Army Materiel Command drawing 11176551/MIL-C-26482, 22-55 arrangement dielectric terminal retention pre-production samples according to Bendix-ECD test procedure L-15081-98, no revision, dated March 1972 was completed. The results of this testing is reported in Bendix-ECD Engineering Laboratory Report 12-5194 (see Appendix). Due to the unavailability of shells from the manufacturer, the insert assemblies were assembled in shells with MIL-C-26482 intermating dimensions for the evaluation of the termination method. The results of testing the prototype and pre-production connectors that are intermateable with connectors in accordance with U.S. Army Materiel Command drawing 11176551 indicate a capability to meet all the requirements of the test program.

B. Dielectric Terminal Retention on the Terminals

Detailed component drawings for a size 22 terminal incorporating the concept of dielectric terminal retention as shown in Figures 12 and 13 were made. After considerable review of these details (see Figures 14 and 15) with Experimental and Production personnel, a conclusion was reached that due to the extremely small overall size of the retention clip and the undercut required on the inside, no attempt could be made to machine or mold the retention clip. It was then recommended to USAE COM by Bendix-ECD, and an agreement was reached, to evaluate this concept of terminal retention by evaluating a size 16 terminal with the dielectric retention mechanism on the contact. Detailed component drawings for this mechanism were made and components fabricated for a size 16 terminal (see Figures 16 through 18).

The construction of the dielectric terminal retention device on the terminal consist of a semi-flexible retention device that is captive in an undercut on the terminal (see Figure 19). When the terminal is inserted into a electrical device insert hole (.137 diameter) with a standard contact insertion tool, the retention device will collapse or reduce in size (this is allowed by the full length slot) thus requiring a rather low force for terminal insertion. When the insertion tool is removed the retention device will open up (increase in size due to its spring properties) and retain itself against the undercut shoulder in the insert hole. The terminal can be removed by inserting a removal tool that will reverse the above procedure. The results of the evaluation of this method of terminal retention are reported in Bendix-ECD report T-73-35 (see Appendix). These results show that the required force to insert and remove the terminal was well within the normal accepted limits. The terminal retention force at failure was more than twice the normal force required for a removable contact.

C. Terminal Insertion and Removal Tools

As the terminal in the basic integrated wire termination device is fully enclosed within a wiring device, there is no possible visual inspection that can be made to insure that the terminal is fully seated. One possible solution to the problem is an insertion tool, manufactured by the Burndy Corporation, which

incorporates a test feature to insure that the terminal is fully seated and locked. It incorporates a modification of the plastic insertion tool at its tip and in the handle portion are spring loaded jaws which grip the wire insulation well back of the terminal. Using this tool the terminal is inserted into the wiring device and as the tool is pulled out, the spring loaded jaws apply a force to the wire (4 pounds for a size 20 terminal) before it trips and the tool can be removed. If the terminal is not fully seated and locked in place, it will be pulled out of the wiring device as the tool is removed. A standard tool was also modified by Burndy Corporation for use with size 22D terminals and applying 2 pounds of trip-out force. The two tools, produced by the Burndy Corporation, one for size 20 terminals and one for size 22D terminals, were evaluated according to Bendix-ECD test procedure L-15081-92, revision A (as modified by Burndy letter of 11-24-72). The results of this test program are recorded in Bendix-ECD Engineering Laboratory Report 12-5204 (see Appendix). The test program consisted of evaluating the tool for its ability to insert terminals, the effect on various types and size of wire insulation, and general handling characteristics. The results of the testing indicate a general capability of the tool to perform according to the requirements of the test program.

D. Hard Conductive Coating

Bendix-ECD reviewed the technical report covering the development of the hard conductive coating ¹ for steel, aluminum, and magnesium for USA ECOM by Battelle Institute under contract DAAB07-69-C-0133. The coating is an electro-plated lusterless nickel plating. A review of the technical reports by Bendix-ECD plating personnel resulted in the following comments relative to the possible use of this coating for electrical connector assembly components.

1. The plating is adaptable only to flat surfaces.
2. Barrel plating is not possible. All parts would have to be rack plated, limiting the quantity that could be plated in a given time.
3. In order to plate round surfaces, the parts would have to be continually rotated in the plating bath.
4. The plating thickness used, .002 inch ² is entirely too thick for connector applications. All threads would have to be heavily undercut.

Reference 1 - Research and Development Technical Reports ECOM-0360-1, ECOM-0360-3, ECOM-0360-F.

Reference 2 - Research and Development Technical Report, ECOM-0360-F (Interim Final)

5. It would be doubtful that good adhesion, especially after thermal shock, would be obtained without having a zincate treatment prior to plating.
6. Its good abrasion and corrosion resistance is probably due to its heavy thickness.
7. Its lubricity is probably a result of the inclusion of carbon particles in the plating.
8. Problems would be encountered in plating blind holes, whether threaded or not.
9. In plating thicknesses common to connector parts (.0002 inch) plated parts probably would not pass corrosion resistance tests.

The above comments on the coating were transmitted to Battelle Institute by USA ECOM for review. The reply is contained in a letter from Battelle Institute dated March 17, 1972 (see Appendix). Since the above comments were made, ECOM personnel have shown Bendix-ECD personnel some round electrical connector components that were plated with this hard conductive coating that indicated the plating can be applied to round surfaces without continually rotating the parts. Also, it would appear that parts could be barrel plated rather than need to be rack plated only. In addition to the above, it is understood that further work is being performed at USAECOM in the refinement of this plating.

III. Conclusions and Recommendations

A. Connector Assemblies

Based on the initial guide lines reached during the contract; i.e., the use of the MS 27491 series socket contact as a terminal in electrical devices, the following conclusions and recommendations can be reached:

1. The concept that was designed and evaluated during the contract makes possible the use of a waterproof connector with crimp removable MS 27491 series contacts used as terminals.
2. Electrical connectors with the integrated wire termination method, utilizing MS 27491 series contacts as terminals, can be produced with the following combination of minimum center line to center line spacing and terminal size:

<u>Spacing</u>	<u>Terminal Size</u>
.090	22D
.130	20
.190	16
.238	12

Note: The .090 inch spacing for size 22D terminals is based on the use of insertion/removal tools that are mechanically weak. If improvements of the current tools can not be accomplished, it may be necessary to increase the spacing for size 22D terminals to allow an increase in tool wall-section.

3. The contact center line to center line spacing of MIL-C-81511 type electrical connectors (all contact sizes) is inadequate for either a metallic or dielectric terminal retention system from a standpoint of fabricating sound moldings. Within the time period and funding available during this contract, it was not possible to produce usable dielectric terminal retention components (see Figures 10, 11, and 20). The study program to determine the capability to produce electrically sound 18-85 arrangement metallic terminal retention inserts resulted in an overall yield of 20%. It is not economically feasible to produce any components on a 20% yield factor.
4. The plastic insertion removal tools for contact sizes 22, 22D, 22M (MIL-C-38999, MS 27491) and 23 (MIL-C-81511) are very weak due to the thin wall section of their tips making them difficult to use and subject to deformation during use. It is recommended that some improvements be made in the resistance to damage of the insertion-removal tools.
5. This termination concept would decrease substantially the large variety of contacts and application tools now required to be stocked by equipment and airframe contractors, including Military spare parts organizations.
6. The cost of the integrated wire termination devices would probably be higher than any comparable device now available. The increased initial cost, however, might be compensated by a reduced cost of installation due to changing from a solder operation to a machine controlled crimp termination.
7. No substitute has been found for the Polymer 360 (Minnesota Mining and Manufacturing trademark) molding compound for fabrication of the dielectric terminal retention mechanism regardless of the temperature at which the mechanism is to be used. No other material has the required combination of physical properties, temperature resistance, and resistance to solvents.
8. The dielectric terminal retention mechanism manufactured of Polymer 360 material can physically be the same part as used in conventional type connectors.
9. Based on the studies made by drawing layout and physically producing assemblies (see Figures 21 through 25) it is possible to produce electrical devices that are intermountable and intermateable with devices currently available. These studies have also shown that the devices would be generally longer on the termination end and therefore would weigh somewhat more.

10. Since the concept combines two methods of retaining contacts that are currently produced by a number of electrical connector manufacturers (sealed contacts and crimp removable contacts), the reliability of the concept should be on a high level.
11. Two methods of sealing the fixed contacts to their insert were considered - molding into place or separately sealed (or bonded) in a molded insert with contact holes. During the contract the latter method was used to reduce the use of skilled and expensive molding equipment operator labor for loading contacts into the mold. The experience gained during the contract has indicated that although to bond contacts into the insert is less expensive, the total labor for assembling the contacts into the inserts results in about the same total expense as loading contacts into a mold. From a performance viewpoint although both methods of producing fixed contact inserts would require a leakage test, less failures would probably occur with molded-in contacts. A potential manufacturer of electrical devices would require a review of both methods to determine the best choice to fit his operation at that time.
12. Within certain limitations, this termination concept is easily adaptable to provide glass sealed connectors, waterproof connectors, and filtered contact connectors all with crimp type wire terminations. The advantages of not requiring the application of heat (solder type wire terminations) which would affect waterproofness and hermeticity, or burn out filters on contacts are very evident.

B. Dielectric Terminal Retention on the Terminals

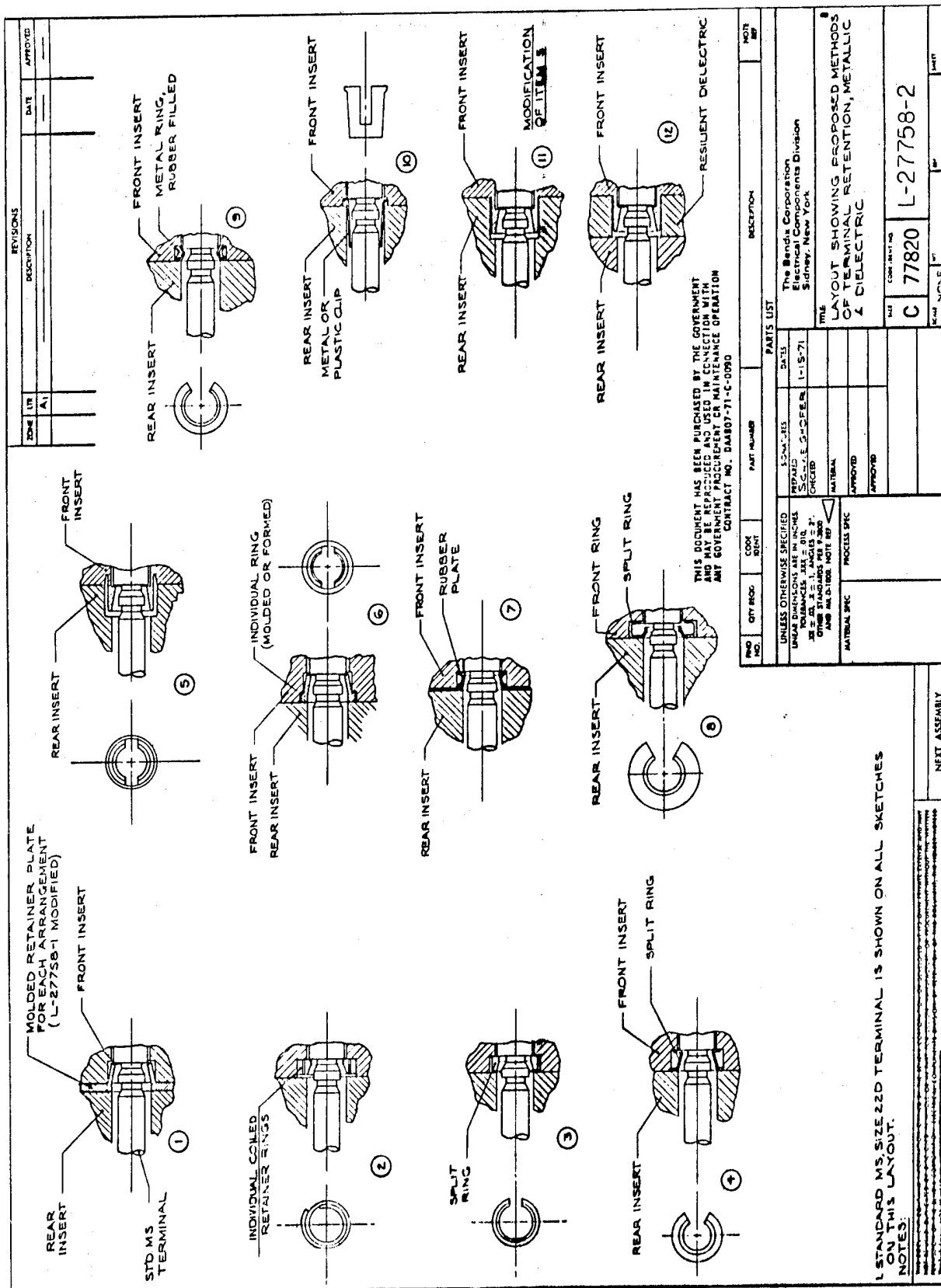
Based on a limited number of samples tested, the dielectric retention system on the terminal has a good potential. The terminal insertion, release, and removal forces were within the usual specification requirements. The displacement while under load is also within the normal electrical connector specification requirement. In addition, the terminal retention force at destruction shows a favorable 2 to 1 factor of safety over the usual minimum requirement for terminal (or contact) retention (see Figure 26).

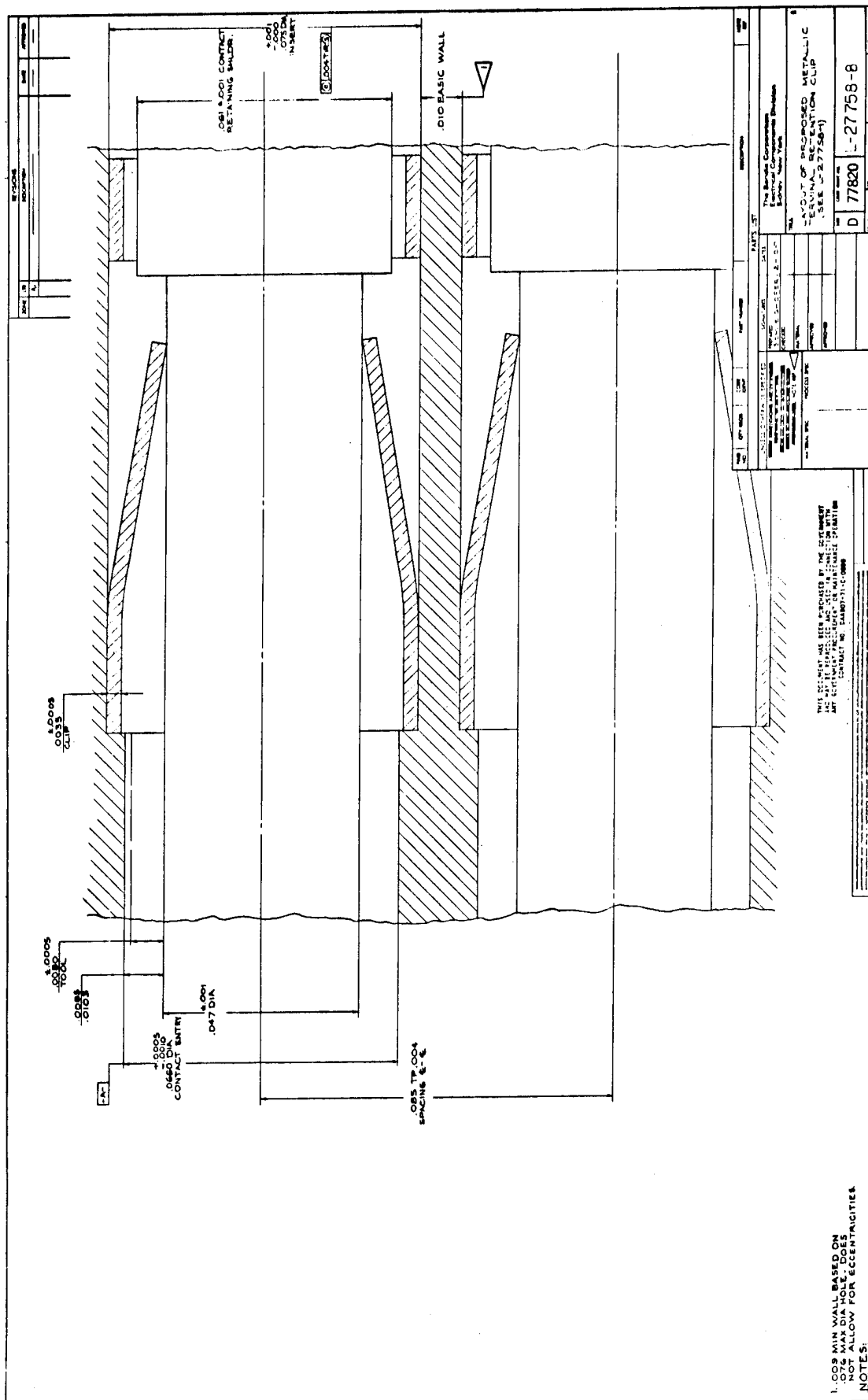
C. Terminal Insertion and Removal Tools

Evaluation tests of the two positive locking contact insertion tools, produced by the Burndy Corporation, showed that except for the smallest wire/insulation size, the tool performed as designed. The tools are capable of inserting and testing for seating of the contact (terminal) without damage to wire insulation or the contact crimp joint (see Figure 27).

D. Hard Conductive Coating

Although a conclusion has been reached by Bendix-ECD Plating Engineering Personnel that the hard conductive electro-plated lusterless nickel coating is not suitable at this time for use on electrical connector components, further investigation of the use of the coating on connector components should be made. The further investigation should in part include a visit of Battelle Institute personnel, with USA ECOM personnel, to an electrical connector manufacturer's plating facilities with discussion to conclude the differences in opinion on the suitability of the coating on connector components.





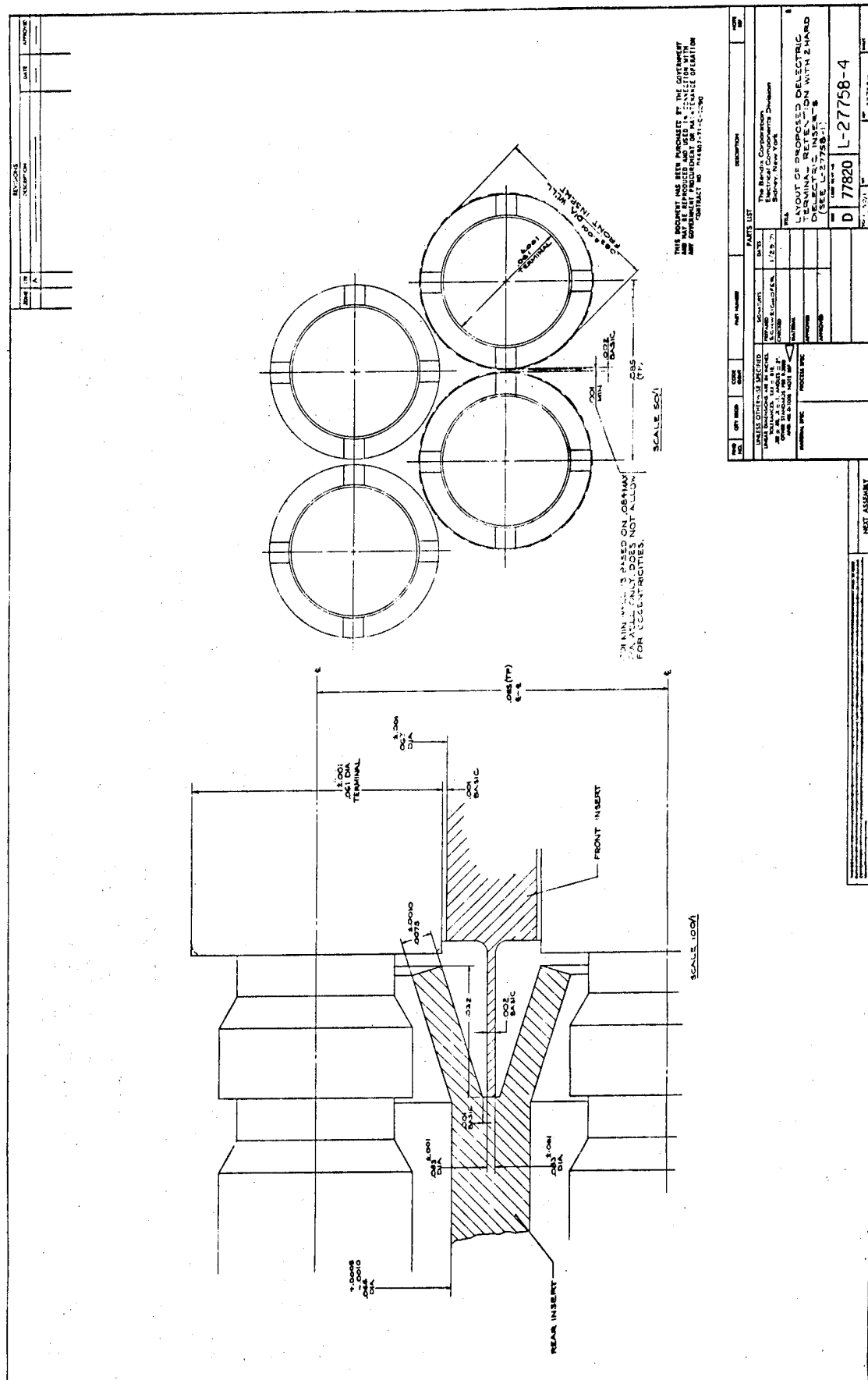
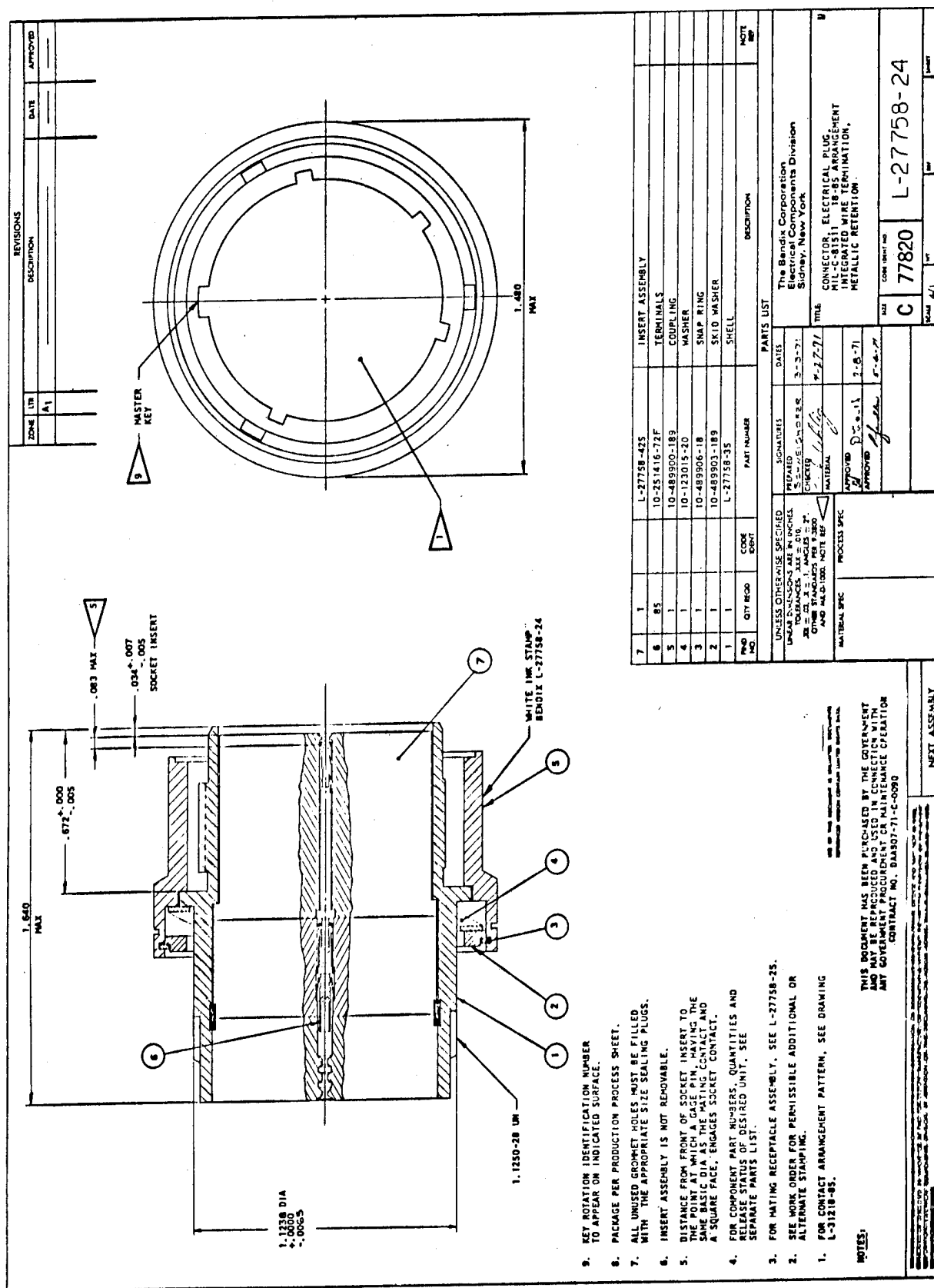


Figure 4.



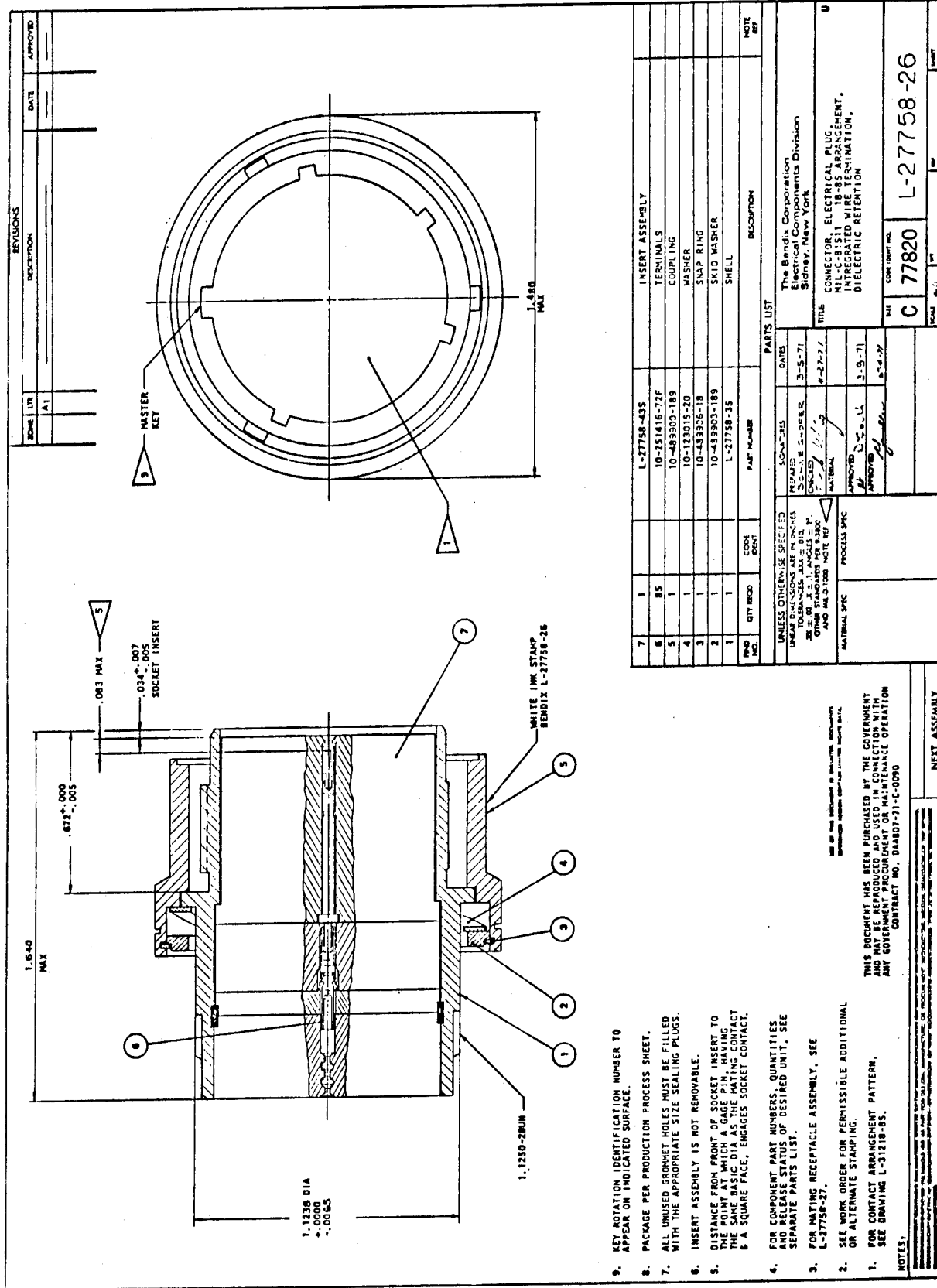


Figure 7.

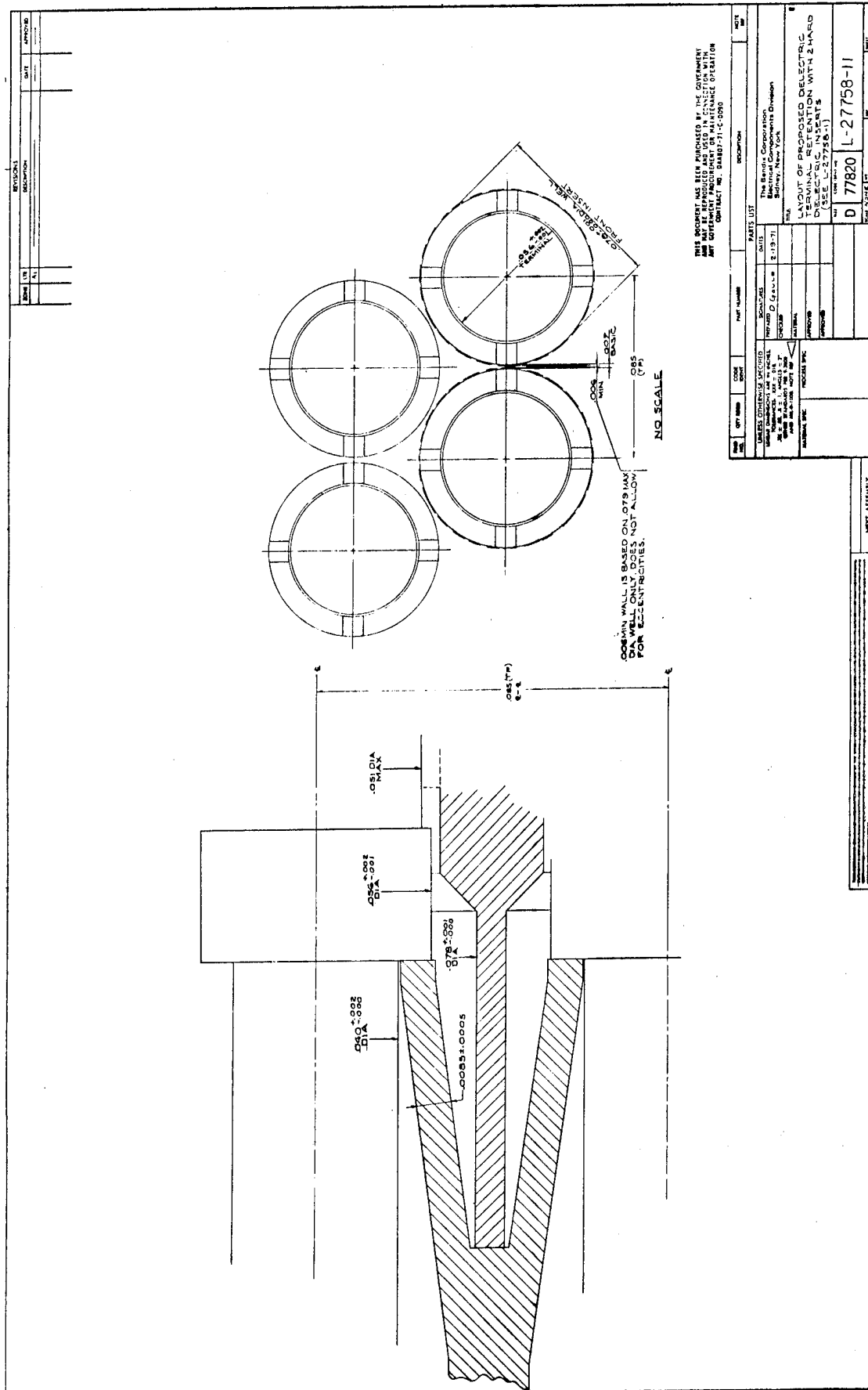
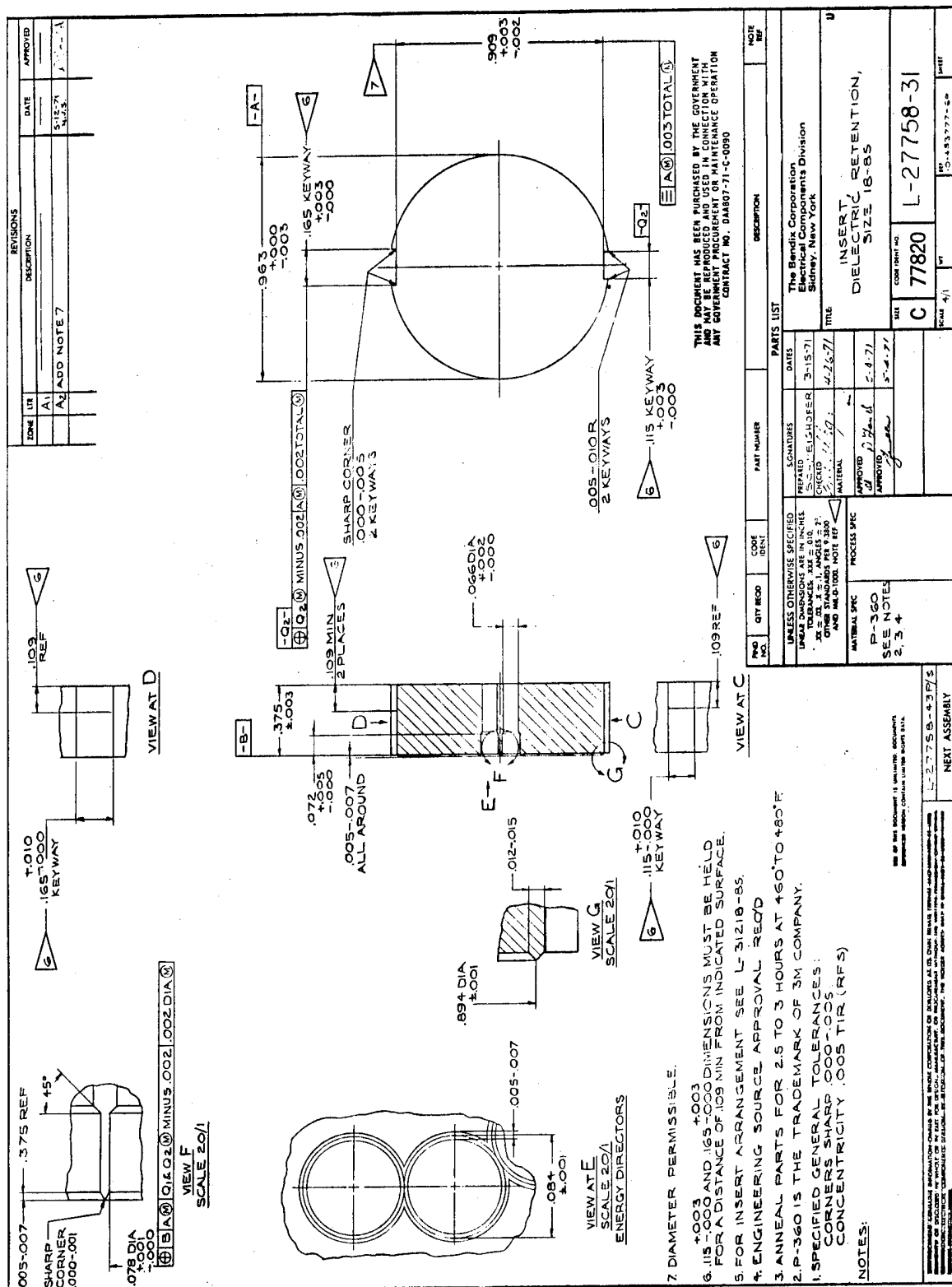
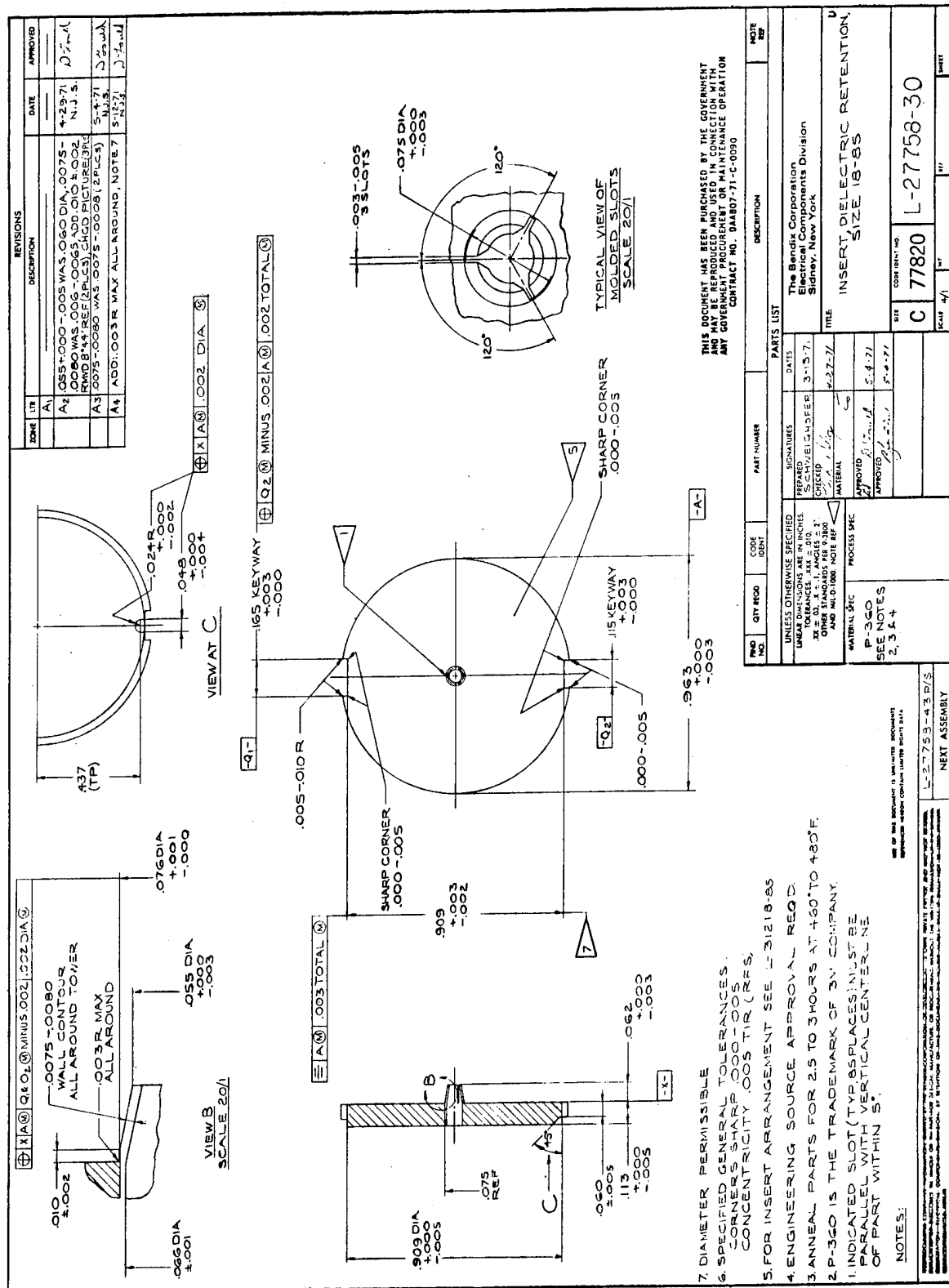
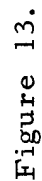


Figure 9.

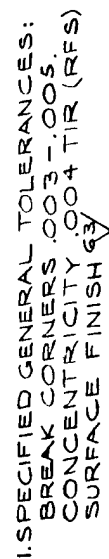






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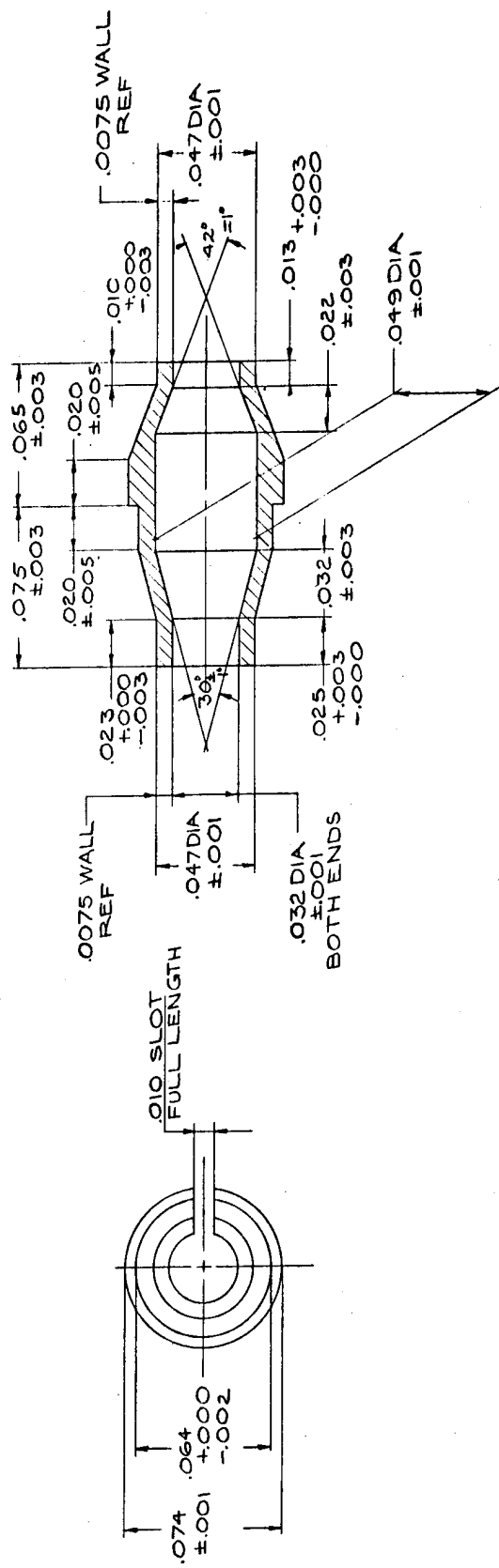
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		B		77820		
		SCALE 1/2" = 1"		WT		REF
				L-27758-40		
						SHEET

Figure 14.

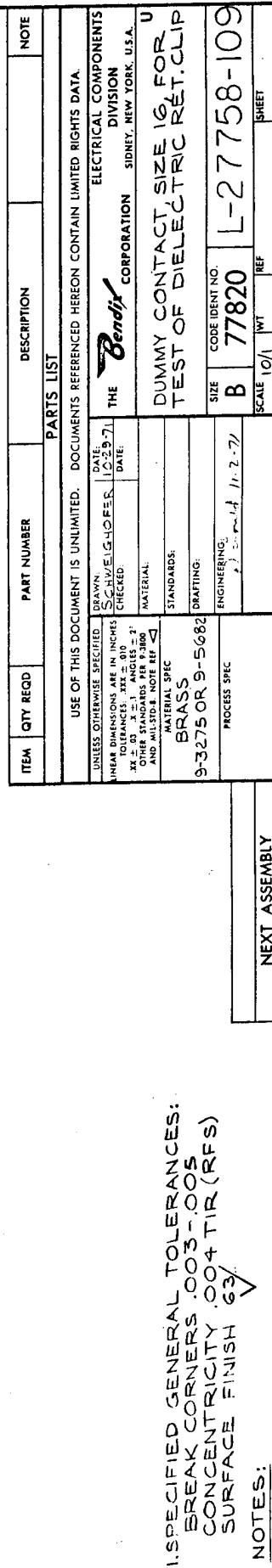
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CONTRACT NO. DAAB07-71-C-0090

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ALL CORNERS .000-.003R		DATE			
CONCENTRICITY .005 TIR (RFS)		DATE			
4. ENGINEERING SOURCE APPROVAL REQ'D.		DATE			
3. ANNEAL PARTS FOR 2.5 TO 3 HOURS AT 460° TO 480°F.		DATE			
2. P-360 IS THE TRADEMARK OF 3M COMPANY.		DATE			
1. SPECIFIED GENERAL TOLERANCES:		DATE			
ALL CORNERS .000-.003R		DATE			
CONCENTRICITY .005 TIR (RFS)		DATE			
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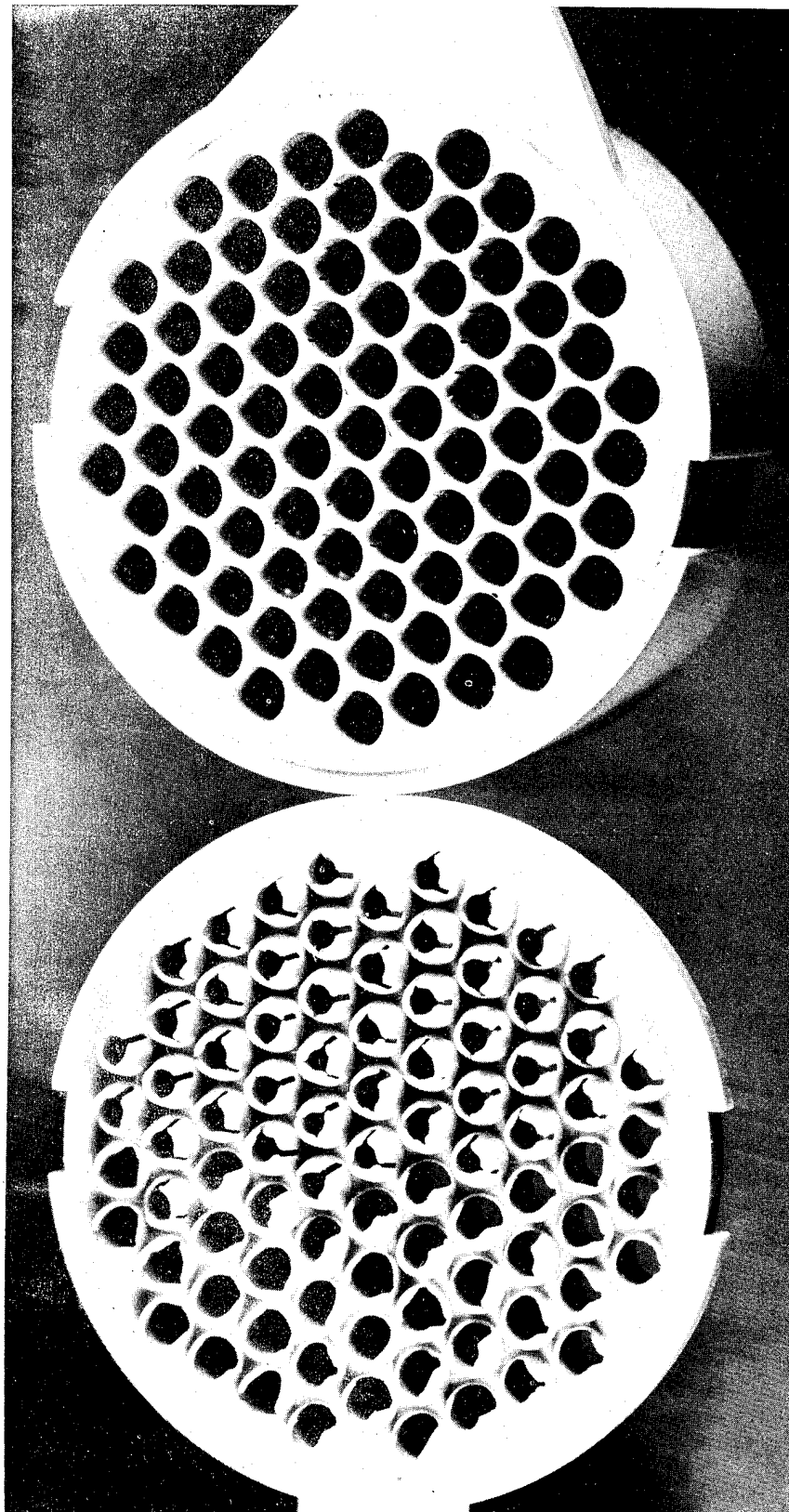


Figure 20. 18-85 Arrangement Dielectric Terminal Retention.



Figure 21. 18-85 Arrangement Metallic Terminal Retention.

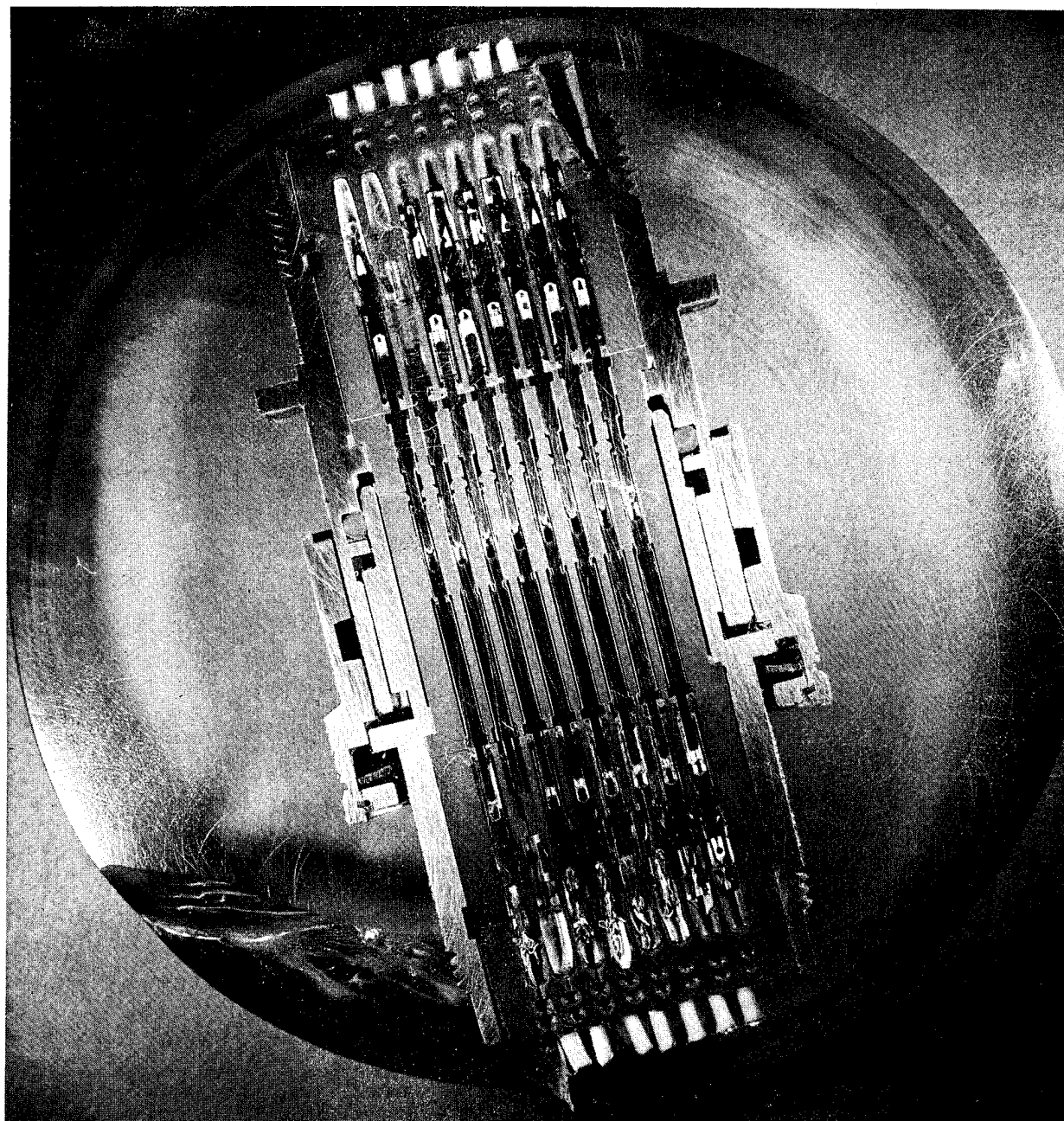


Figure 22.
18-85 Arrangement
Metallic Retention
Assembly Cutaway.



Figure 23. 22-55 Arrangement Dielectric Retention Assembly.

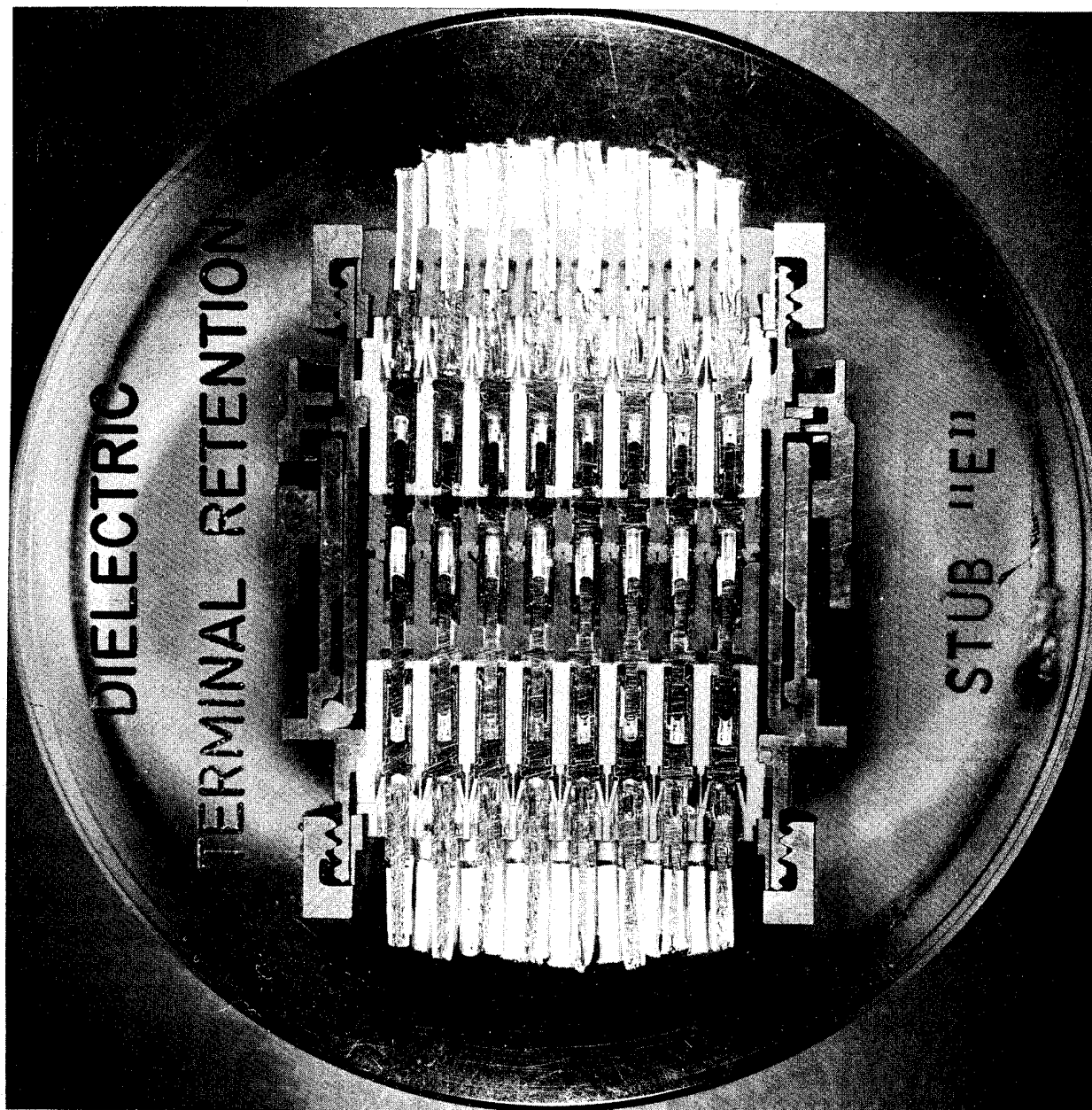


Figure 24.
22-55 Arrangement
Dielectric
Retention Cutaway

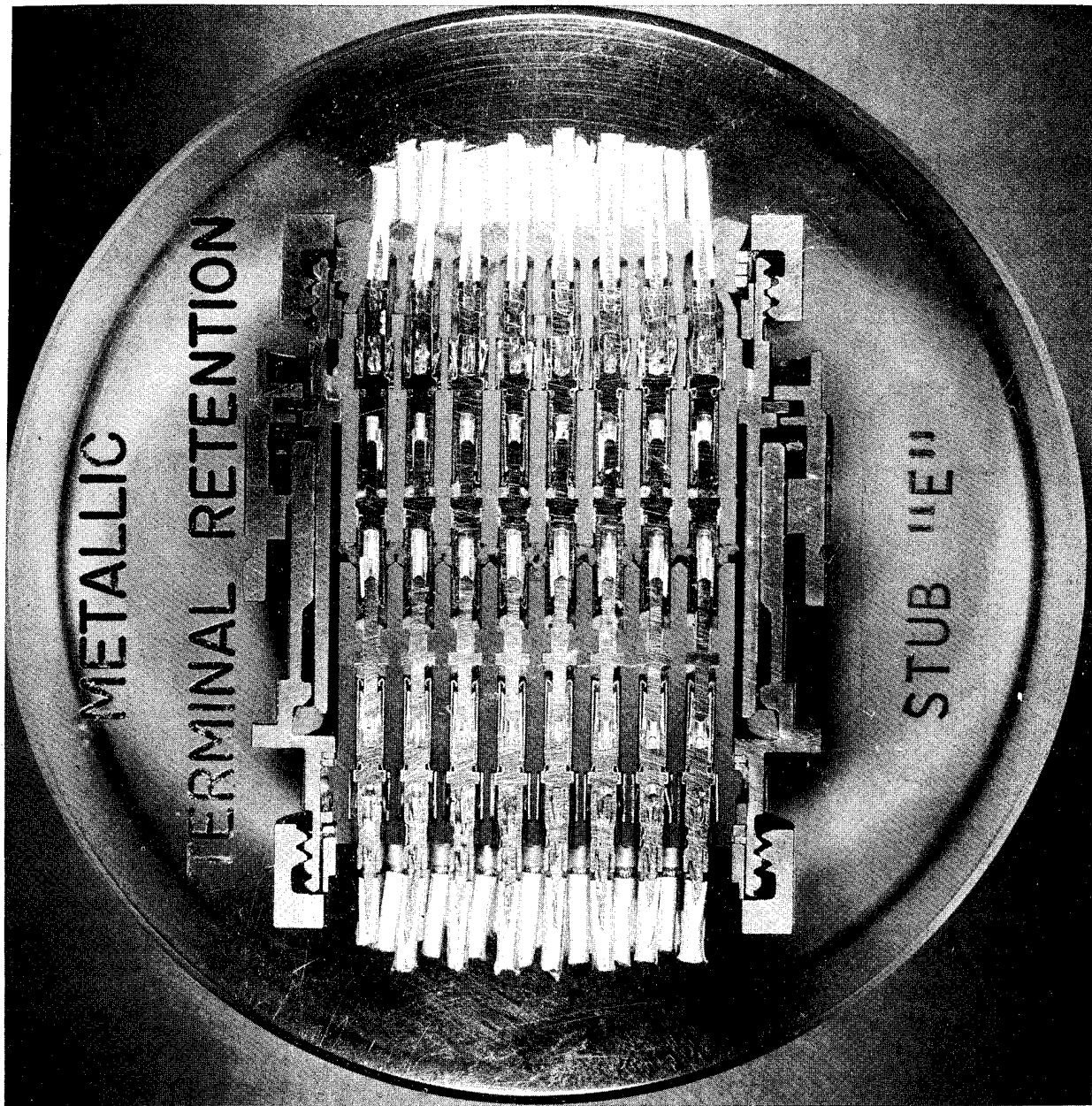


Figure 25.
22-55 Arrangement
Metallic
Retention Cutaway.

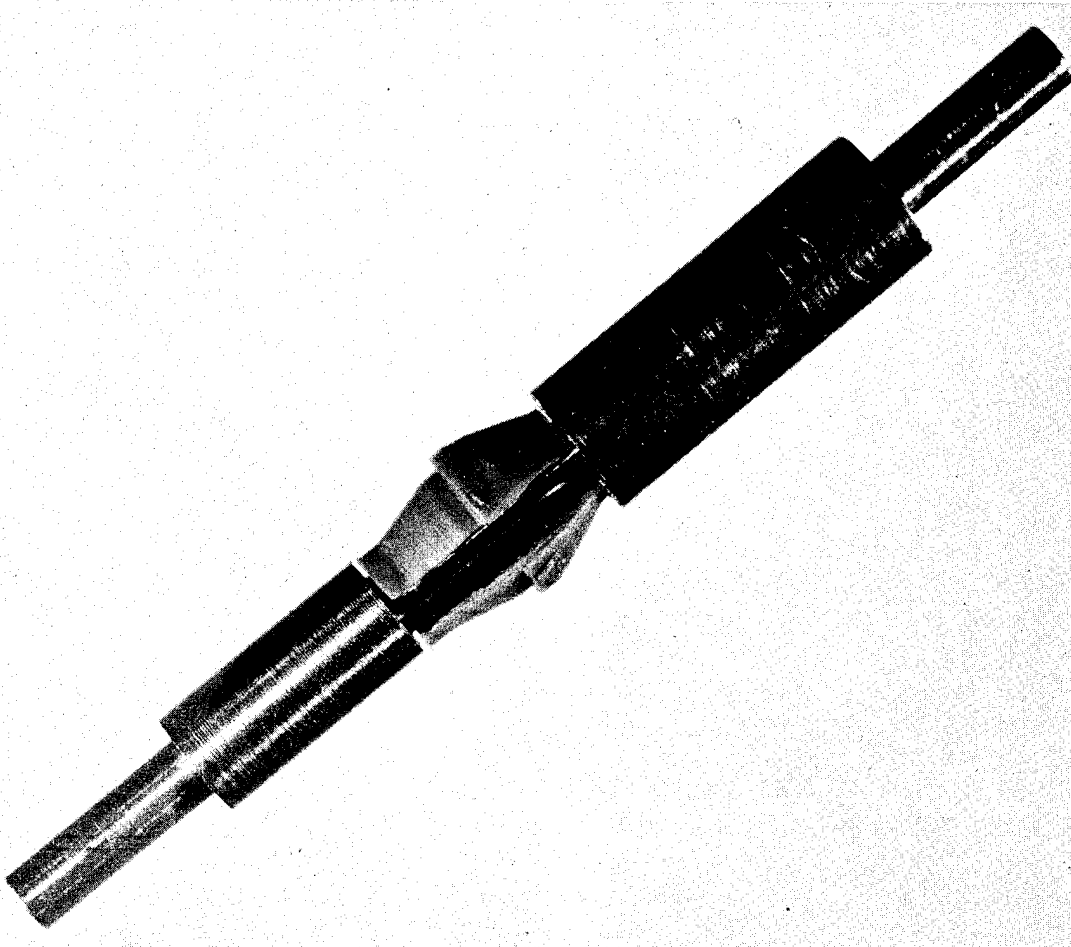


Figure 26. Enlarged View - Contact with Dielectric Retention.

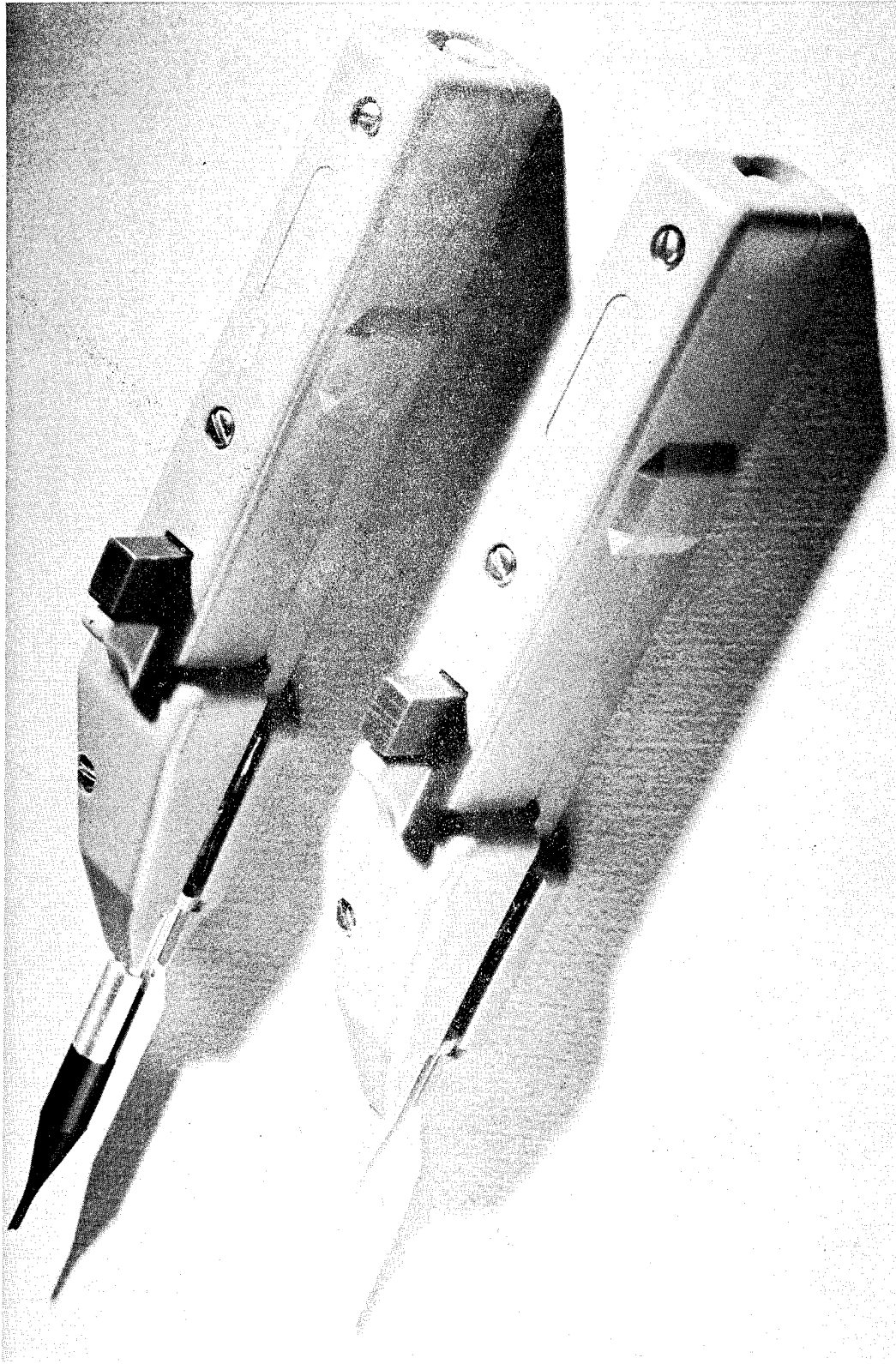


Figure 27. Burndy Contact Insertion Tools.

APPENDIX

Engineering Laboratory Report 12-5193

Engineering Laboratory Report 12-5194

Engineering Laboratory Report 12-5204

Internal Memorandum T73-35

Battelle Letter to USAECOM March 17, 1972

Distribution List

Form DD 1473

Engineering Laboratory Report

12-5193

PRE PRODUCTION TESTING, BENDIX PROTOTYPE
MIL-C-81311 TYPE, INTEGRATED WIRE
TERMINATION DEVICES

DATE OF TESTS: 6 JUNE 72 TO 5 JULY 72

DATE OF REPORT: 2 February 1973

REPORTED BY: *Walter E. Remy*

APPROVED BY: *Lewis J. Armitage*

APPROVED BY: *David C. Baker*

NOTED BY: *Donald W. Gould*

NOTED BY: *Donald L. Pfendler*



**Electrical
Components
Division**

Sidney, N. Y. 13838

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I PURPOSE

To qualify Bendix L-27758-24/25 MIL-C-81511 type electrical connectors, modified for inclusion of the Integrated Wire Termination system. This evaluation was made for assurance that this termination system would meet the applicable requirements of MIL-C-81511B as was set forth by the USAECOM Contract DAA807-71-C-0090.

II CONCLUSIONS

1. The submitted connectors did not meet the requirement set forth in L-15081-98 specification.
2. Only minor discrepancies were noted in the initial examination such as excessive RTV filler, chipped inserts and poor alignment of the interfaces.
3. Five of the six connector pairs submitted for testing had two or more circuit failures during the initial dielectric withstanding voltage test.
4. One retention mechanism in each of two connector halves failed to retain the special test contact within the .012 inch displacement requirement while at load.
5. High insertion and removal forces were encountered during the maintenance aging test, therefore, causing tool problems and grommet sealing web destructions.

III RECOMMENDATIONS

1. A fixture should be made to pre-electric test all connector components and sandwich assemblies. This would eliminate the loss of the fully assembled connectors and could help to pinpoint the cause of the failures.
2. More care should be taken in the assembling of the connectors to cut down the excessive amount of RTV filler compound.

IV ACTION TAKEN

The assemblies containing failures occurring during contact retention and dielectric withstanding voltage tests were disassembled to determine the cause of failure with the following observations and corrective action.

1. OBSERVATIONS

A. Contact Retention

- a. One contact retention failure (terminal retention) (receptacle 58-24/5) was due to a burr on the rear of the clip that did not allow the clip to "seat" properly in its undercut.
- b. The second contact retention failure (terminal retention) was due to a porous molded rear shoulder in the clip retaining undercut in the insert.

2. DIELECTRIC WITHSTANDING VOLTAGE

- a) All of the dielectric withstanding voltage test failures were through a porous area between two adjacent holes at the undercut in the insert that retains the terminal retention clip.

B. CORRECTIVE ACTION

1. Contact Retention

- a) The corrective action for the one contact retention failure due to the burr on the clip would be equipment to cut off the clips from the selvage to eliminate the burr that may have occurred when the clips were broken off the selvage.
- b) The corrective action for the contact retention failure caused by the porous molding that failed to retain the contact retention clip can only be to improve the quality of the moldings.

2. DIELECTRIC WITHSTANDING VOLTAGE

- a) During a conference attended by USAECOM and Bendix-ECD personnel, it was decided that a separate program would be started to investigate thoroughly the capability to produce mechanically and electrically sound inserts. The best of production techniques in molding procedures are to be employed. Also, additional molding compounds are to be investigated if necessary. The results of the program will be reported at a later date.

Donald K. Gould

Donald Gould
Connector Engineering

V DETAILED REPORT

A total of six mating pairs of L-27758-24 plug and L-27758-25 receptacle connectors were submitted for this test program. The connectors were individually numbered and divided into three groups. Group I consists of receptacles 1,2 and plug connectors 1,2. Group II consists of receptacles 3,4 and plug connectors 3,4. Group III consists of receptacles 5,6 and plug connectors 5,6. All these connectors had metallic retention mechanisms. All connectors were tested in accordance with Bendix test procedure L-15081-98, a copy of which is attached.

The connectors were subjected to the tests in the following sequence, in the order listed.

<u>TEST</u>	<u>PARAGRAPH</u>	<u>TEST SAMPLE NUMBERS</u>
Examination of Product	6.1	1,2,3,4,5,6
Operating Torques	6.3	1,2,3,4,5,6
Insulation Resistance	6.4	1,2,3,4,5,6

<u>TEST</u>	<u>PARAGRAPH</u>	<u>TEST SAMPLE NUMBERS</u>
Dielectric withstanding Voltage	6.5	1,2,3,4,5,6
Contact Retention (Fixed and Removable)	6.6	1,2,3,4,5,6
Maintenance Age	6.7	1,2
Contact Retention (Removable)	6.6.1	1,2
Thermal Shock	6.8	1,2,3,4
Vibration	6.9	1,2
Shock	6.10	1,2
Moisture Resistance	6.11	1,2
Dielectric withstanding Voltage (Altitude)	6.12	3,4
Insulation Resistance (Elevated Temperature)	6.13	3,4
Air Leakage	6.14	3,4
Water Immersion	6.15	3,4
Contact Resistance	6.16	1,2,3,4
Salt Spray	6.17	3,4
Operating Torque	6.3	1,2,3,4
Contact Resistance	6.16	3,4
Contact Retention	6.6	3,4
Durability	6.18	5,6
Temperature Life	6.19	1,2
Fluid Immersion (Lube Oil)	6.20.1	1,2
" " (Hydraulic Fluid)	6.20.2	3,4
Operating Torques	6.3	1,2,3,4,5,6
Insert Retention	6.21	1,2
Dielectric withstanding Voltage	6.5	5,6
Contact Retention	6.6	5,6
Insulation Resistance	6.4	5,6
Dielectric withstanding Voltage (Altitude)	6.12	5,6
Contact Resistance	6.16	5,6
Examination of Product	6.22	1,2,3,4,5,6

Each socket termination was crimped to a three foot length of Teflon insulated wire and installed into the insert cavities. Samples 1,3,5 were wired with 28 gage MS21985 wire having an OD of approximately .038 inch. Samples 2,4,6 were wired with 22 gage MS 21985 wire having an OD of approximately .052 inch. The socket terminations were crimped to the wire's using the M22520/2-01 crimp tool.

EXAMINATION OF PRODUCT - Para 6.1 (ALL SAMPLES)

All connector halves, and components were visually examined for conformance to the applicable Bendix assembly drawings, identification and general quality of workmanship. Some minor discrepancies such as excessive RTV filler, chipped insert edges, poor interface alignment and small nicks in grommets were noted, but no major discrepancies were noted during the visual examination.

All the minor defects could be and should be easily remedied.

OPERATING TORQUES - Para. 6.3 (ALL SAMPLES)

Each plug was coupled and uncoupled with its counterpart receptacle at a slow uniform rate. The peak torques were measured using a torque wrench and appropriate fixture. All torques, both coupling and uncoupling, were within the specification limits. Maximum torque was 15 1/2 in. lbs. and the minimum force was 7 3/4 in. lbs. Precise data is on the included data sheet ECL0540A4.

INSULATION RESISTANCE - Para. 6.4 (ALL SAMPLES)

The insulation resistance of the mated connectors was measured between each of twelve contacts and all other contacts and shell tied electrically in common. Six of the contacts were adjacent to the shell. The measurements were made at a test potential of 500 Volts DC and the electrification time did not exceed 2 minutes per circuit. All insulation resistance measurements exceeded the 5,000 megohms minimum allowed by the specification. Precise data can be obtained from the included data sheet ECL0540A-5 thru 10.

DIELECTRIC WITHSTANDING VOLTAGE - Para. 6.5 (ALL SAMPLES)

The mated connectors had potential of 1300 Volts AC/RMS 60 Hz applied between each contact and all the contacts and shell tied electrically in common for a time period of 2 seconds per circuit. Any electrical breakdown, flashover or leakage in excess of 1 ma was considered failure. Five of the six mating pairs of connectors had two or more circuit failures. Further testing disclosed that the failures were not restricted to either the plug or receptacle.

Upon completion of the test program, the cause of the dielectric withstanding voltage failures was further investigated. It was found that in most cases the failures occurred between contacts in the thin wall section of the insert. This wall thickness being only .008 inch between contacts. Precise data can be obtained from the included data sheet ECL0540A-11-12.

CONTACT RETENTION - Para. 6.6 (ALL SAMPLES)

Removable contacts

Fifteen contacts, randomly selected, were removed and replaced with a specially made test contact for contact retention. The special contact incorporated its own retention member release sleeve and had a "tail" long enough to allow the load to be applied.

A load (tensile) of 10 lbs. was applied at a rate of 1lb. per second and monitored for a time period of 5-10 seconds. Two retention mechanisms failed to hold the special contact during the load application. One failure was cavity 35 in receptacle #1, and cavity 22 in receptacle #5.

FIXED CONTACTS

Fifteen fixed contacts, same contact numbers used above, in each connector half, had a load of 10 lbs. applied to their mating ends at a rate of approximately 1 lb. per second and monitored for a period of 5 to 10 seconds. None of the contacts displaced more than the .012 inch allowable by the specification. Maximum displacement was .008 inch. Precise data can be obtained from the included data sheets, ECL0540A-17 thru 25.

MAINTENANCE AGE - Para. 6.7 Group I

Each removable contact was removed from and re-inserted into the individual insert cavity using the 11-8674 insertion tool and 11-8675 removal tool. The fifteen contacts, previously used in contact retention test, was subjected to an additional 9 more insertions and removals. The forces required to insert and remove these contacts was measured on the 1st and 9th insertion and removal.

Although there is no specification limit, it was felt that the initial inserting and removal forces were too high. This caused tool problems which in turn damaged the sealing webs in the grommet. The MS 27509A22M and MS 27509R22M plastic insertion and removal tools would spread under the force and slip over the contact shoulders. The 11-8674 and 11-8675 metal tools would also spread and slip over the shoulders of the contacts which in turn would damage the sealing area of the grommets.

The forces were 2-4 lbs. higher than the forces obtained in the preliminary evaluation. Precise data can be obtained from the included data sheets ECL0540A-13 thru 16.

CONTACT RETENTION - Para. 6.6.1 (GROUP I)

Removable Contacts

The fifteen contacts, subjected to maintenance ageing were again subjected to the contact retention test. A load of 10 pounds was

again applied to the special test contact, previously described, and held for a time period of 5 to 10 seconds. All retention mechanisms retained the special contact except for cavity #35 in receptacle #1, which had previously failed. This cavity, although not holding the special contact, does function mechanically with the standard contact and was used for further testing. Precise data can be obtained from the included data sheets ECL0540A-26-27.

THERMAL SHOCK Para. 6.8 Group I and II

The unmated connectors were subjected to 5 continuous cycles of temperature shock. Each cycle consisted of 30 minutes at -65°C [-85°F] followed by 30 minutes at +175°C [+349°F] with less than 2 minutes elapsing between temperature extremes. Visual examination did not disclose any cracking or detrimental effects to the connectors or components.

By agreement between the Engineering Department of the Bendix Corporation and Mr. Ryan of the USAECOM, all testing on this type of connector was stopped due to the poor test results obtained. It was felt that due to the high amount of circuit failures in the dielectric withstanding voltage test, the high forces obtained in inserting the contacts and the destruction of the grommets due to the tool problem caused by these high forces, no further testing would be of any value.

<u>REFERENCES</u>	CLT 3128	05971-02	and 74535
	L-15081-98	NO REVISIONS	
	MIL-C-81511		
	MIL-C-38999		
	MIL-STD-202		
	ECL0540 and ECL0540A		

Walter Denny
dl

APPENDICES A
L-15081-98

L-15081-98

PRE-PRODUCTION TESTING OF
INTEGRATED WIRE TERMINATION
SYSTEM ELECTRICAL CONNECTORS
FOR USAECOM

THE BENDIX CORPORATION
ELECTRICAL COMPONENTS DIVISION
SIDNEY, NEW YORK

1.0 Scope

The purpose of this test procedure is to establish the samples and test methods to be used in pre-production testing of MIL-C-81511B and "Stub-E" (Ordinance Document 11176551) type electrical connectors which are modified for inclusion of the Integrated Wire Termination System.

The test methods and limits contained herein were chosen as being applicable for these connector designs. They are derived essentially from the two documents referenced above.

2.0 Test Agency

All tests herein described will be performed at and by the Engineering Laboratory, Electrical Components Division, The Bendix Corporation, Sidney, New York 13838.

3.0 Standard Test Conditions

Unless otherwise specified, tests and examinations specified by this procedure will be conducted under any combination within the ranges below:

Temperature	68°F to 95°F
Relative Humidity	10% to 80%
Barometric Pressure	24" to 31" Hg

4.0 Test Samples

A total of 12 mating connectors will be required for this test program. They are identified as follows:

<u>Test Sample No.</u>	<u>Type</u>	<u>Bendix Part No.</u>	<u>Shell Config.</u>	<u>Retention</u>
1,2,3,4,5,6	81511	L-27758-24	Plug	Metallic
"	"	L-27758-25	Receptacle	"
7,8,9,10,11,12	Stub"E"	L-27758-104	Plug	Dielectric
"	"	L-27758-105	Receptacle	"

The MIL-C-81511 connectors have 85 Size 22D contacts, (18-85 arrangement), and the Stub "E" connectors have 55 Size 20 contacts (22-55 arrangement).

5.0 Test Sequence

The connectors shall be subjected to the tests in the following sequence in the order listed:

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Test	Para.	Test Samples		
		1,2,7,8	3,4,9,10	5,6,11,12
Examination of Product	6.1	X	X	X
Wire & Prepare	6.2	X	X	X
Operating Torques	6.3	X	X	X
Insulation Resistance	6.4	X	X	X
Dielectric Withstanding Voltage	6.5	X	X	X
Contact Retention (Remov. & Fixed)	6.6	X	X	X
Maintenance Age	6.7	X		
Contact Retention (Remov. Only)	6.6.1	X		
Thermal Shock	6.8	X	X	
Vibration	6.9	X		
Shock	6.10	X		
Moisture Resistance	6.11	X		
Dielectric Withstanding Voltage (Alt.)	6.12		X	
Insulation Resistance (Elev. Temp.)	6.13		X	
Air Leakage	6.14		X	
Water Immersion	6.15		X	
Contact Resistance	6.16	X	X	
Salt Spray	6.17		X	
Operating Torques	6.3	X	X	
Contact Resistance	6.16		X	
Contact Retention (Remov. & Fixed)	6.6		X	
Durability	6.18			X
Temperature Life	6.19			X
Fluid Immersion - Lube Oil	6.20.1	X		
Fluid Immersion - Hydr. Oil	6.20.2		X	
Operating Torques	6.3	X	X	X
Insert Retention	6.21	X		
Dielectric Withstanding Voltage	6.5			X
Contact Retention	6.6			X
Insulation Resistance	6.4			X
Dielectric Withstanding Voltage (Alt.)	6.12			X
Contact Resistance	6.16			X
Final Examination of Product	6.22	X	X	X

6.0 Test Descriptions

Following are the descriptions of how each individual test will be performed.

6.1 Examination of Product

The individual connectors will be inspected for conformance to the applicable Bendix assembly drawings and for general quality of workmanship.

6.2 Wire and Prepare

Each connector half shall be permanently marked (etched) with its own test number, (ref. Para. 4.0). Each removable socket termination shall be crimped to a three foot length of teflon insulated wire and installed into the insert cavities. The Stub "E" connectors shall all be wired with nominal diameter 20 gage wire. Samples 1, 3 & 5 (81511) shall be wired with minimum diameter wire while 2, 4 & 6 shall be wired with maximum diameter wire.

6.3 Operating Torques

Each plug shall be coupled to its counterpart receptacle and uncoupled at a slow uniform rate. The peak torques shall be measured using a torque wrench and appropriate fixturing. The torques shall be within the following limits:

Connector	Torque - Lb. In.	
	Max. Eng. & Disengaging	Minimum Disengaging
MIL-C-81511	28	4
Stub "E"	25	-

6.4 Insulation Resistance

The insulation resistance of the mated connectors shall be measured between each of 12 contacts and all other contacts and shell tied electrically in common. Six of the contacts shall be adjacent to the shell. The measurements shall be made at a test potential of 500 VDC $\pm$ 10% and electrification time shall not exceed 2 minutes. All values shall be greater than 5,000 megohms.

6.5 Dielectric Withstanding Voltage

The mated connectors shall have an AC potential applied between each contact and all other contacts and shell tied electrically in common for a period of 2 seconds per circuit. Leakage current shall not exceed 1 ma. The applied voltage shall be as follows:

<u>Connector</u>	<u>Potential-A.C. RMS</u>
81511	1300
Stub "E"	1500

6.6 Contact Retention

6.6.1 Removable Contacts

Fifteen contacts shall be removed and replaced with a specially made test contact for contact retention. This contact shall incorporate its own retention member release sleeve and have a "tail" long enough to allow a load to be applied. With this fixture in each contact cavity to be tested, a load will be applied at a rate of approximately 1 lb/sec. and monitored for a period of 5-10 seconds without being displaced by more than 0.012 in. while under load. The loads to be applied are:

<u>Connector</u>	<u>Load-Lbs.</u>
81511	10
Stub "E"	15

6.6.2 Fixed Contacts

Fifteen fixed contacts in each connector half shall have a load (see 6.6.1) applied to their mating ends at a rate of approximately 1 lb/sec. and monitored for a period of 5 to 10 seconds without being displaced by more than 0.012 in. while under load.

6.7 Maintenance Age

Each removable contact shall be removed from and reinserted into its individual insert cavity using appropriate insertion and removal tools. The fifteen contacts already subjected to contact retention shall be removed and reinserted an additional 9 times. The forces to insert and remove these contacts shall be measured on the 1st and 9th cycles.

6.8 Thermal Shock

The unmated connectors shall be subjected to 5 continuous cycles of temperature shock. Each cycle shall consist of 1/2 hour at -65 +0° C followed by 1/2 hour at +175 +3° C

-5°

-0°

with no more than 5 minutes elapsing between temperature extremes. There shall be no damage detrimental to the operation of the connector after being subjected to this conditioning.

6.9 Vibration

The mated connectors shall be rigidly mounted on a vibration exciter using a suitable vibration test fixture and their normal mounting means. A minimum of 8 inches of wire shall be unsupported on both ends of the connector. The connector shall be subjected to a vibration level of either 0.06 inch d.a. or 20G peak, whichever is less. The vibration frequency shall be varied logarithmically between 10 and 2000 Hz and back to 10 Hz in a period of 20 minutes. The vibration sweep shall be applied 12 times (4 hours) in each of 3 mutually perpendicular axes. Each 4 hour period shall be conducted 1 hour at -65°C, 2 hours at room temperature and 1 hour at 175°C. During the vibration, the series wired contacts shall be monitored for discontinuities at a direct current of 100 ma. Discontinuities of 1 microsecond or greater will constitute a failure.

6.10 Shock

The mated connectors shall be rigidly mounted on a shock test machine using a suitable test fixture and their normal mounting means. A minimum of 8 inches of wire shall be unsupported on both ends of the connectors. The connectors shall be subjected to one shock pulse in each direction of each of the three mutually perpendicular axes. Each pulse shall be of approximately half-sine waveform, 50G peak and 11 milliseconds duration. The series wired contacts shall be monitored for discontinuities at a direct current of 100 ma. Discontinuities of 1 microsecond or greater shall constitute failure.

6.11 Moisture Resistance (81511 Only)

The mated 81511 type connectors shall be subjected to the moisture resistance test of MIL-STD-202, Method 106, with step 7b vibration excluded. After a minimum of 3 hours after completion of the final cycle, while the connectors are still subjected to high humidity, the insulation resistance shall be measured as specified in 6.4 except that it shall be 500 megohms or greater.

6.12 Dielectric Withstanding Voltage at Altitude (81511 only)

The mated 81511 type connectors shall be tested as specified in 6.5 except that they shall be placed in a vacuum chamber and evacuated to a simulated altitude of 110,000 feet for 1/2 hour and then subjected to a test potential of 1000V AC RMS.

6.13 Insulation Resistance at Elevated Temperature

The insulation resistance of the mated connectors shall be measured as in 6.4 except that they shall have been subjected to a temperature of 175°C for 30 minutes prior to making the measurements. All measurements shall be in excess of 200 megohms.

6.14 Air Leakage

The unmated plugs and receptacles shall be mounted on a test fixture suitable for application of a pressure of 30 psig to the mating face. The assembly shall be soaked at a temperature of -65°C and then pressurized to 30 psig. The leakage rate shall not be more than 1 in ³/hour.

6.15 Water Immersion (81511 only)

The mated 81511 type connectors shall be immersed in tap water to a depth of 6 ft. for a period of 48 hours. They shall then be removed from the water and insulation resistance will be measured as specified in 6.4 except that all measurements shall be in excess of 100 megohms.

6.16 Contact Resistance

The resistance of 25 contact sets of each mated connector shall be measured. The four wire method of MIL-C-23216C (Figure 4) shall be used. The voltage drop across a 6 in. length (contact set approximately in the middle) shall be measured at the following test currents:

Connector Type	Contact Size	Wire Size	Test Curr. Amps. DC	Maximum Potential Drop M.V.	
				Initial	After Temperature Life & Salt Spray
81511	22D	24	3	55	65
81511	22D	28	1 1/2	35	45
Stub"E"	20	20	7 1/2	60	70

6.17 Salt Spray (81511 only)

The unmated 81511 type connectors shall be subjected to the salt spray test as specified in MIL-STD-202, Method 101, Test Condition B. The salt concentration shall be 5%. Following the exposure the connectors shall be washed off with tap water and dried in a circulating air oven at a temperature of 38° ± 3°C for 12 hours maximum, after which they shall be removed and inspected. The connectors shall be mated and unmated one cycle to insure mateability and to remove free salt deposits.

6.18 Durability

The mating 81511 type connectors shall be subjected to 500 cycles of mating and unmating at a maximum rate of 300 cycles per hour. The Stub "E" connectors will be similarly subjected to 200 cycles. The coupling mechanism will be operated in a manner to simulate actual service operation. The connectors shall show no mechanical or electrical defects detrimental to the operation of the connector.

6.19 Temperature Life

The mated connectors shall be subjected to a temperature of 175°C for a period of 1000 hours. At the end of 1000 hours, while at 175°C, the insulation resistance shall be measured as specified in 6.4 except that all measurements shall be in excess of 200 megohms.

6.20 Fluid Immersion

6.20.1 Hydraulic Oil MIL-H-5606

The unmated connectors shall be immersed in the hydraulic oil at room temperature for 20 hours. The parts shall be allowed to drain for 1 hour at room temperature prior to being subjected to the subsequent tests.

6.20.2 Lubricating Oil MIL-L-23699

The unmated connectors shall be tested as in 6.20.1 except that MIL-L-23699 lube oil shall be used.

6.21 Insert Retention (81511 only)

The inserts in the 81511 type connector shells shall have axial loads applied to their mating faces at a rate of approximately 10 lb/sec until a load equivalent to 75 psig is reached. This load shall be retained for a period of 10 to 15 seconds without becoming dislodged.

6.22 Final Examination of Product

At the completion of testing, the connectors shall be examined for general condition and damage considered to be abnormal for the tests to which the connectors have been exposed.

7.0 Test Report

A test report shall be written at the completion of testing which is to include all pertinent test information, copies of original test data and conclusions. The report shall be written in standard Bendix/ECD Engineering Laboratory Report format. Three copies of this report will be supplied to USAECOM, Fort Monmouth, New Jersey.

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8.0 Equipment List

The following equipment or suitable equivalent will
be used in performing the foregoing tests:

Torque Fixture	Sturtevant	ICF-100-I
Torque Wrench	Sturtevant	M-5-1S
Torque Wrench	Sturtevant	M-25-1S
Torque Wrench	Sturtevant	M-50-1S
Megohm Bridge	General Radio	1644A
Automatic Connector	Bendix	F-1680
Tester		
High Voltage A.C.	Bendix	L-9947-25
Supply		
Universal Testing	Instron	TTC
Machine		
Thermal Shock Machine	Blue-M	WSP109C-3
Vibration Test System	M-B	C-20
Shock Test Machine	Consol. Vac.	3" Hyge
Humidity Chamber	Blue-M	FR-386
Circulating Air Oven	Blue-M	POM-206C
Cold Chamber	Murphy & Miller	LTF-4-120
Constant Current	Kepeco	KS-18-10M
Power Supply		
Digital Voltmeter	Hewlett Packard	3450A
Ammeter	Weston	931
Salt Spray Chamber	Ind. Filter &	411-1C
	Pump Co.	
Connector Durability	Bendix	44-76531
Machine		

Lewis A. Armitage
Engineering Laboratory

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APPENDICES B

DATA SHEETS

LABORATORY TEST SHEET						DATE OF TESTS 6-21-72		REPORT NUMBER 12-5193	
TEST <u>OPERATING TORQUES</u>						TEMP 74°		R.H. 36%	
TEST SPECIMEN(S) L. 27758-24 PLUGS MATED						LT. 31X8		ECL 0540.A-Y	
WITH L. 27758-25 RECEPTACLES						SPEC. 1-18081-98		PARA. 6.3	
TEST EQUIPMENT STURTEVANT TORQUE WRENCH				CAL. DATE 5-24-72	DUE DATE 8-7-72	SPEC. LIMITS MAX - 28 1/16 INCHES MIN - 4 1/16 INCHES			
						TEST CONDITIONS Room AMBIENT INITIAL			
MATED CONNECTOR PAIR #1									
MATING FORCE		UNMATING FORCE							
12 1/2 LB-INCHES		15 1/2 LB-INCHES							
MATED CONNECTOR PAIR #2									
MATING FORCE		UNMATING FORCE							
7 3/4 LB-INCHES		10 LB-INCHES							
MATED CONNECTOR PAIR #3									
MATING FORCE		UNMATING FORCE							
10 3/4 LB-INCHES		15 LB-INCHES							
MATED CONNECTOR PAIR #4									
MATING FORCE		UNMATING FORCE							
11 1/2 LB-INCHES		12 LB-INCHES							
MATED CONNECTOR PAIR #5									
MATING FORCE		UNMATING FORCE							
10 LB-INCHES		15 LB-INCHES							
MATED CONNECTOR PAIR #6									
MATING FORCE		UNMATING FORCE							
10 LB-INCHES		11 1/2 LB-INCHES							

REF.

Electrical Components Division

Sidney, New York 13838

TESTED BY
T.R. NAPOLITANO
APPROVED BY

WITNESSED BY

TEST				DATE OF TESTS		REPORT NUMBER	
INSULATION RESISTANCE				6-23-72		12-5193	
TEST SPECIMEN (S)				TEMP.	R.H.	ECL. 0540A-5	
L-27758-24 PLUGS MATED				74%	38%		
WITH L-27758-25 RECEPTACLES #1				LT.	SPEC. L-15081-98		
F.1514				8128	6.4		
TEST EQUIPMENT				CAL. DATE	DUE DATE	SPEC. LIMITS	
GENERAL RADIO MEGOHM BRIDGE 1644D				9-1-71	8-29-72	5,000 MEGOHMS	
SWITCHING FIXTURE BOX E-4306				Prior to Use	TEST CONDITIONS Room Ambient		
					INITIAL		
					Test Potential 500 volts Dc		
CONTACT INSULATION RESISTANCE							
1	3.2 x 10 ⁶	MEG OHMS					
4	1 x 10 ⁶	"					
8	1.1 x 10 ⁶	"					
18	1.7 x 10 ⁶	"					
22	2 x 10 ⁶	"					
29	2 x 10 ⁶	"					
35	1.2 x 10 ⁶	"					
41	1.8 x 10 ⁶	"					
48	2.4 x 10 ⁶	"					
57	2.2 x 10 ⁶	"					
60	1.4 x 10 ⁶	"					
72	2 x 10 ⁶	"					
75	1.5 x 10 ⁶	"					
82	2.2 x 10 ⁶	"					
85	4 x 10 ⁶	"					
REF.							
Bendix				Electrical Components Division			
Sithney, New York 11838				TESTED BY W.E. Denny			
				APPROVED BY			
				WITNESSED BY			

[illegible]

TEST				DATE OF TESTS		REPORT NUMBER	
INSULATION RESISTANCE				6-23-72		12-5193	
TEST SPECIMEN(S) L-27758-24 PLUG MATED				TEMP 74° F R.H. 38%		ECL 0540A-7	
WITH L-27758-25 RECEPTACLES #3				LT. 3128		SPEC. 1-15081-98	
TEST EQUIPMENT F-1514		CAL. DATE 9-1-72		DUE DATE 8-29-72		SPEC. LIMITS 5,000 megohms	
GENERAL RAPID MEGOHM BRIDGE 1644A				PRD. TO 1158		TEST CONDITIONS ROOM AMBIENT	
SWITCHING FIXTURE BOX 8 E-4306						INITIAL	
						Test Potential 500volts DC	
CONTACT INSULATION RESISTANCE							
1	3.2 x 10 ⁶	MEG OHMS					
4	2.2 x 10 ⁶	"					
8	2 x 10 ⁶	"					
18	6 x 10 ⁶	"					
22	3.5 x 10 ⁶	"					
29	2.5 x 10 ⁶	"					
35	12 x 10 ⁶	"					
41	13 x 10 ⁶	"					
48	12 x 10 ⁶	"					
57	2.5 x 10 ⁶	"					
60	12 x 10 ⁶	"					
72	12.6 x 10 ⁶	"					
78	13.6 x 10 ⁶	"					
82	4 x 10 ⁶	"					
85	15 x 10 ⁶	"					
REF.							
				Electrical Components Division		TESTED BY T.A. NAPOLITANO APPROVED BY WITNESSED BY	
Sidney, New York 13830							

LABORATORY DATA SHEET

TEST				DATE OF TESTS		REPORT NUMBER	
INSULATION RESISTANCE				6-23-72		12-5193	
TEST SPECIMEN (S) L-27758-24 PLUG MATED				TEMP	R.H.	ECL	PM
				74°F	38%	05404-8	
WITH L-27758-25 RECEPTACLE #4				LT.	SPEC.		
				3128	L15081-98		
TEST EQUIPMENT F.1514				CAL. DATE	DUE DATE	SPEC. LIMITS	
GENERAL RADIO MCGRAW HILL BRIDGE 1644A				9-1-71	8-29-72	5000 megohms	
SWITCHING FIXTURE BOX R E-4306				Prior To Use	TEST CONDITIONS Room Ambient		
					INITIAL		
					Test Potential 500 volts DC		
CONTACT INSULATION RESISTANCE							
1	7.5 x 10 ⁶	megohms					
4	20 x 10 ⁶	"					
8	12 x 10 ⁶	"					
18	15 x 10 ⁶	"					
22	15 x 10 ⁶	"					
29	8 x 10 ⁶	"					
35	20 x 10 ⁶	"					
41							
48	7 x 10 ⁶	"					
57	10 x 10 ⁶	"					
60	15 x 10 ⁶	"					
72	6 x 10 ⁶	"					
78	5 x 10 ⁶	"					
82	17 x 10 ⁶	"					
85	20 x 10 ⁶	"					
46	20 x 10 ⁶	"					
* This contact failed Dielectric Withstanding Voltage, apparently due to carbon trace. Another contact was chosen.							
REF.							
Bendix				Electrical Components Division		TESTED BY	
						T.A. NAPOLITANO	
						APPROVED BY	
						XAL	
						WITNESSED BY	

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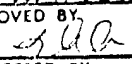
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LABORATORY DATA SHEET

TEST DIELECTRIC WITHSTANDING VOLTAGE		DATE OF TESTS 6-23-72		REPORT NUMBER 12-5193
TEST SPECIMEN(S) L-27758-24 PLUGS MATED		TEMP 74°	R.H. 38%	ECL 0540-A-12
WITH L-27758-25 RECEPTABLES		LT. 3128	SPEC. L-15081-98	PARA. 6.5
TEST EQUIPMENT AUTOMATIC CONNECTIC TESTER F-4680		CAL. DATE 6-1-72	DUE DATE 6-29-72	SPEC. LIMITS 1300 V AC RMS
		TEST CONDITIONS ROOM AMBIENT		
		INITIAL		

PLUG 58-24/1 mated WITH 58-25/4 RECEPTACLE			
CIRCUIT	FAILING VOLTAGE	FAILURE OCCURRED IN	
5	500	RECEPT.	
35	650	"	
65	500	"	
21	650	PLUG	
22	850	"	
23	400	"	
31	650	"	
32	1250	"	
33	400	"	
41	1250	"	
42	1000	"	
43	400	"	
52	400	"	
PLUG 58-24/5 mated WITH 58-25/5 RECEPTACLE			
ALL CIRCUITS PASSED DIELECTRIC WITHSTANDING VOLTAGE			
PLUG 58-24/6 mated WITH 58-25/6 RECEPTACLE			
CIRCUIT	FAILING VOLTAGE	FAILURE OCCURRED IN	
55	1150	RECEPT.	
64	400	"	
65	1150	"	
72	600	"	
41	750	PLUG	
51	800	"	

REF.	 Bendix Electrical Components Division Sydney, New York 13838	TESTED BY T.A. NAPALITANO APPROVED BY  WITNESSED BY
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LABORATORY DATA SHEET

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LABORATORY DATA SHEET						DATE OF TESTS		REPORT NUMBER			
TEST SPECIMEN (S)						TEMP.		R.H.			
TEST EQUIPMENT						SPEC.		ECL.			
CAL. DATE						DUE DATE		PARA.			
TEST CONDITIONS						SPEC. LIMITS		INITIAL			
RATE						114/second					
PLUG #4						RECEPTACLE #4					
CONTACT						LOAD					
DISPLACEMENT						CONTACT					
LOAD						DISPLACEMENT					
1						1					
4						4					
8						8					
18						18					
22						22					
29						29					
35						35					
41						41					
48						48					
57						57					
60						60					
72						72					
78						78					
82						82					
85						85					
2						2					
* DUE TO DAMAGED PIN #1, CONTACT #2 WAS SUBSTITUTED.											
REF.						TESTED BY					
Bendix						T. A. NAPOLITANO					
Electrical Components Division						APPROVED BY					
Solway, New York 11930						WITNESSED BY					

Engineering Laboratory Report

12-5194

PRE-PRODUCTION TESTING
BENDIX PROTOTYPE "STUB E"
INTERGRATED WIRE TERMINATION DEVICES

DATE OF TEST: 23 Oct 1972 to 20 Dec 1972

DATE OF REPORT: 2 February 1973

REPORTED BY: Randy A. Napolitano

APPROVED BY: W. A. Armstrong

APPROVED BY: W. B. Baker 2/2/73

NOTED BY: Donald H. Gould

NOTED BY: Donald L. Pfendler



Electrical
Components
Division

Sidney, N. Y. 13838

ENGINEERING LABORATORY REPORT 12-5194

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ENGINEERING LABORATORY REPORT 12-5194

I. PURPOSE

To qualify Bendix L-27758-80 and -81 Stub E (Ordinance Document 11176551) electrical connectors, modified for inclusion of the integrated wire termination system. This qualification was made for the acceptance of this termination system to the applicable requirements of MIL-C-81511B as set forth by the USAECOM Contract DAAB07-71-C-0090.

II. CONCLUSIONS

The submitted connectors successfully met all of the requirements of Bendix Test Plan L-15081-98 with the following exceptions:

1. Initial visual examination disclosed some minor discrepancies such as excessive RTV sealant, poor plating in socket barrels and distorted grommet holes. These discrepancies would not be detrimental to testing. No major discrepancies were noted.
2. Operating Torques exceeded the specification limits. This was due to the addition of the second waved washer which was needed to gain more mating depth.
3. Several circuit resistance readings exceeded the specification limit. Other readings were higher than normal. The reason for abnormal readings was the improper positioning of the insert in the shells, causing a minimal effective electrical engagement.
4. Receptacle #9 had air leakage in excess of 182 cubic inches per hour. The leakage appeared to be between the insert and the shell.
5. Operating Torques after Temperature Life were extremely high. This was caused by the drying and flaking of all lubrication during Temperature Life.
6. Visual examination after Temperature Life disclosed discoloration of the plug shells and the hard dielectric inserts.

III. RECOMMENDATIONS

1. Further investigation should be conducted for sealing of these connectors. The RTV filler is apparently inadequate as a sealant for this design.
2. Investigation for a better lubricant should be explored. The present lubricant is not sufficient for a Temperature Life test at elevated temperatures.

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III. RECOMMENDATIONS (Continued)

The present lubricant tends to dry and flake off, giving no lubrication to the coupling ramp mechanism. This causes extremely high operating forces.

IV. ACTION TAKEN

The assemblies containing various types of failures during the testing were inspected or disassembled and inspected to determine the cause of failure with the following observations and recommendations for corrective action.

- A. Connector assembly #11, circuit #1, was intermittent during contact resistance testing.

1. Observations

- a. The length of the fixed pin contact is shorter than required. It appears to have been machined too short.

2. Corrective Action

- a. Components must be machined to required dimensions.

- B. Receptacle assembly #9 had a leakage rate of 182 cubic inches per hour after exposure to the environments. Leakage appeared to be between the insert assembly and the shell.

1. Observations

- a. The assembly was disassembled to inspect the area between the insert assembly and the shell. It was observed that there was less than acceptable adhesion between the RTV sealant and the dielectric terminal retention insert.

2. Corrective Action

- a. In the recent past, at Bendix/ECD, a change has been made from RTV sealant per MIL-A-46146, Type I, to RTV sealant per MIL-A-46146, Type II. This is an improvement in adhesion to the P-360 (3M) material. If additional connector assemblies were to be made, the new sealant would be used.

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IV. ACTION TAKEN (Continued)

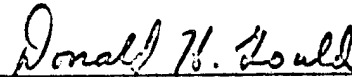
- C. Connector assemblies #11 and #12 turned a much lighter color (from a black color) during the Temperature Life test.

1. Observations

- a. The greatest color change was on the plug assemblies with both coupling nuts, plug shells and adapters changing color. It was the opinion of Bendix/ECD personnel that the thickness of plating on these components was thinner than required by the component drawing.

2. Corrective Action

- a. Although the color change of the plating is only cosmetic in nature (i. e. it did not cause any functional failures), the proper thickness of plating must be applied in the future.



Donald H. Gould
Connector Engineering

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V. DETAILED REPORT

A total of six mating pairs of connectors were submitted for this test program. The connectors were individually numbered and divided into three groups. There were identified as follows:

<u>Test Sample Number</u>	<u>Bendix Part Number</u>	<u>Shell Configuration</u>	<u>Group Number</u>
7, 8	L-27758-80	Plug	I
7, 8	L-27758-81	Receptacle	I
9, 10	L-27758-80	Plug	II
9, 10	L-27758-81	Receptacle	II
11, 12	L-27758-80	Plug	III
11, 12	L-27758-81	Receptacle	III

Due to the unavailability of Stub E shells from the manufacturer, the Stub E inserts were assembled in shells with MIL-C-26482 intermating dimensions.

All connectors were tested in accordance with Bendix Test Procedure L-15081-98, a copy of which is attached.

The connectors were subjected to the tests in the following sequence, in the order listed.

Test Sequence

<u>Test</u>	<u>Par</u>	<u>Test Sample Groups</u>		
		<u>I</u> <u>(7&8)</u>	<u>II</u> <u>(9&10)</u>	<u>III</u> <u>(11&12)</u>
Examination of Product	6.1	x	x	x
Wire and Prepare	6.2	x	x	x
Operating Torques	6.3	x	x	x
Insulation Resistance	6.4	x	x	x
Dielectric W/Stding Voltage	6.5	x	x	x
Contact Retention (Remov&Fixed)	6.6	x	x	x
Maintenance Age	6.7	x		
Contact Retention (Remov Only)	6.6.1	x		
Temperature Cycle	6.8	x	x	
Vibration	6.9	x		
Shock	6.10	x		

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V. DETAILED REPORT (Continued)

<u>Test</u>	<u>Par</u>	<u>Test Sample Groups</u>		
		<u>I</u> <u>(7&8)</u>	<u>II</u> <u>(9&10)</u>	<u>III</u> <u>(11&12)</u>
Insul Resistance (Elev Temp)	6.13		x	
Air Leakage	6.14		x	
Contact Resistance	6.16	x	x	
Operating Torques	6.3	x	x	
Contact Retention (Remov&Fixed)	6.6		x	
Durability	6.18			x
Temperature Life	6.19			x
Fluid Immersion, Hydraulic Oil	6.20.1		x	
Fluid Immersion, Lube Oil	6.20.2	x		
Operating Torques	6.3	x	x	x
Dielectric W/Stdng Voltage	6.5			x
Contact Retention (Remov&Fixed)	6.6			x
Insulation Resistance	6.4			x
Contact Resistance	6.16			x
Final Examination of Product	6.22	x	x	x

Examination of Product, Par 6.1

The individual connectors were visually inspected for conformance to the applicable Bendix assembly drawings and for suitability for evaluation of the design. Some minor defects were noted such as excessive RTV sealant, poor plating in socket barrels and distorted grommet holes. All of the defects noted would not be detrimental to the evaluation of the design.

Wire and Prepare, Par 6.2

Each removable socket termination was crimped to a three foot length of teflon insulated MIL-W-16878/4, 20 gauge wire, using an MS3198-1 (S/N 5781) crimp tool with an MS3198-9P positioner. The wired socket terminations were installed into the connector cavities using MS27509A20 insertion tools. All contacts were removed with MS27509R20 removal tools.

Groups I, II and III

Operating Torques, Par 6.3

Each plug was coupled to its counterpart receptacle and uncoupled at a slow, uniform rate. The initial peak force required to couple and uncouple the mating connectors was measured.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

All forces were within the specified 25 inch-pound limit. Recorded forces are included on Data Sheet 1.

Insulation Resistance, Par 6.4

The insulation resistance of the mated connectors was measured between each contact and all other contacts and shell tied electrically in common. The measurements were made at a test potential of 500 volts dc $\pm 10\%$ and the electrification time was less than two minutes per circuit. All circuits had an insulation resistance greater than 10,000 megohms. This test was conducted on the automatic connector tester F-1680 calibrated 10/10/72.

Dielectric Withstanding Voltage, Par 6.5

The mated connectors had a potential of 1500 volts ac rms at 60 Hz applied between each contact and all other contacts and shell connected electrically in common for a period of two seconds per circuit. Any leakage current in excess of one milliamperes was considered a failure. There were no electrical flashovers or breakdowns noted. The test was conducted on the automatic connector tester F-1680 calibrated 10/10/72.

Contact Retention, Par 6.6

Removable Contacts, Par 6.6.1

Fifteen contacts, randomly selected, were removed and replaced with a specially made test contact. This special contact incorporated its own retention member release sleeve and had a body long enough to allow the load to be applied. A load (tensile) of 15 pounds was applied at a rate of approximately one pound per second and monitored for a time period of 5-10 seconds. In all cases the retention mechanism tested held the special contact. The maximum displacement was .007". Precise data is on Data Sheets 2-7 attached.

Fixed Contacts, Par 6.6.2

Fifteen fixed contacts, the same contact numbers used for the Removable Contact Retention test, had a load of 15 pounds applied to their mating end at a rate of approximately one pound per second and monitored for a period of 5-10 seconds. The maximum displacement was .007". Precise load data and displacement can be obtained from attached Data Sheets 8-13.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

Group I Tests, Samples #7 and #8

Maintenance Age, Par 6.7

Each removable contact was removed from and reinserted into its individual insert cavity using MS27509A20 insertion and MS27509R20 removal tools. The 15 contacts already subjected to contact retention were removed and reinserted an additional nine times. The forces to insert and remove these contacts were measured on the first and ninth cycles. The maximum insertion force was 5-3/4 pounds initially and 3-1/2 pounds on the ninth cycle. The minimum removal force was 3/4 of a pound both initially and on the ninth cycle. Refer to Data Sheets 14-17.

Contact Retention, Removable Contacts, Par 6.6.1

The same 15 contacts which were previously tested were again removed and replaced with the special steel contact for contact retention. The test was performed in the same manner as previously described. All retention mechanisms held the special contact and the maximum displacement was .0055". Recorded data is on Data Sheets 18, 19.

Temperature Cycle, Par 6.8

The unmated connectors were subjected to five continuous cycles of temperature shock. Each cycle consisted of one-half hour at -65°C. (-85°F.) followed by one-half hour at +175°C. (+347°F.). The elapsed time between the temperature extremes was less than two minutes. At the end of the test, a visual examination disclosed no damage detrimental to the operation of the connectors.

Vibration, Par 6.9

During the series wiring of the Group I samples for vibration, a discontinuity occurred when the mated connectors were flexed. An investigation into this problem revealed the connectors were not fully mating. A second waved washer was added to the vibration samples to increase the mating depth.

Operating forces were measured after the addition of the second waved washer and the forces were increased by approximately 20 to 33 inch pounds mating and unmating. The forces, although increased, gave a more stable main joint and no further discontinuities were noticed.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

A later investigation disclosed improper positioning of the Stub E inserts in the MIL-E-26482 type connector shells. This caused a minimal electrical engagement of the main joint contacts. Recorded forces are on Data Sheet 20.

The mated connectors were rigidly mounted on a vibration exciter using a suitable vibration test fixture and their normal mounting means. A minimum of 8" of wire was unsupported on both ends of the connectors. The connectors were subjected to a vibration level of 20g peak. The vibration frequency was varied logarithmically between 10 and 2000 Hz and back to 10 Hz in a period of 20 minutes. The vibration sweep was applied 12 times (4 hours) in each of three mutually perpendicular axes. Each four-hour period was conducted at one hour at -65°C . (-85°F .), two hours at room temperature and one hour at $+175^{\circ}\text{C}$. ($+347^{\circ}\text{F}$.). During vibration, the series wired contacts were monitored for discontinuities at 100 milliamperes dc. There was no discontinuity of one microsecond or greater. Refer to Data Sheets 21, 22.

Shock, Par 6.10

The mated connectors were rigidly mounted on a shock test machine using a suitable test fixture and their normal mounting means. A minimum of 8" of wire was unsupported on both ends of the connectors. The connectors were subjected to one shock pulse in each direction of each of the three mutually perpendicular axes. Each pulse was approximately half-sine waveform, 50g peak and 11 milliseconds in duration. The series wired contacts were monitored for discontinuities at 100 ma. There were no discontinuities in excess of one microsecond. Results are recorded on Data Sheet 23.

Contact Resistance, Par 6.16

The resistance of 25 contact sets of each mated connector was measured. The four wire method of MIL-C-23216C was used. The voltage drop across a 6" length (mated contacts approximately in the middle) was measured at a test current of 7-1/2 amperes dc.

Due to the minimum amount of electrical engagement of the main joint contacts, erratic and intermittent readings occurred. Some circuits in connector #7 exceeded the 60 millivolt specification limits. An investigation disclosed the problem to be in the main joint area and not in the terminating area.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

This was confirmed by taking a single pin and socket contact soldered to a three foot length of 20 AWG wire and measuring the failing circuits of the unmated connector halves. All circuits passed the 60 millivolt specification limit. The maximum was 47 millivolts.

A spot check of several circuits that previously had passed were measured for comparison purposes. The data obtained on these circuits was comparable to the results of the failing circuits. Therefore, it is the opinion of this laboratory that the problem is in the main joint area and not in the terminating area. Refer to Par 6.9 (this report) where electrical engagement problems were encountered. Recorded data of all potential drop readings can be obtained from Data Sheets 24, 25.

Operating Torques, Par 6.3

Each plug was coupled to its counterpart receptacle and uncoupled at a slow, uniform rate. The peak torques were measured and recorded. These forces exceeded the specification limit due to the use of the double waved washers. Refer to Data Sheet 26.

Fluid Immersion, Lube Oil MIL-L-23699, Par 6.20.2

The unmated connectors were immersed in the lubricating oil at room temperature for 20 hours. The parts were then allowed to drain for one hour at room temperature. A visual examination disclosed no swelling of the components in the connectors. The connectors were then subjected to the subsequent tests.

Operating Torques, Par 6.3

The operating torques were again measured as previously described and the peak coupling and uncoupling forces were recorded. Again the forces exceeded the specification limits due to the double waved washer. Refer to Data Sheet 27.

Group II Tests, Samples #9, #10

Temperature Cycle, Par 6.8

The unmated connectors were subjected to five continuous cycles of temperature shock. Each cycle consisted of one-half hour at -65°C. (-85°F.) followed by one-half hour at +175°C. (+347°F.). The elapsed time between temperature extremes was less than two minutes.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

At the conclusion of the test, visual examination disclosed no detrimental effects to any of the connectors as a result of the temperature cycle test. Due to the problem previously mentioned in Group I, pertaining to the minimum amount of electrical engagement of the main joint contacts, the second waved washer was added to the Group II test samples at this time. Operating torques were measured after temperature cycling. Results are included on Data Sheet 20.

Insulation Resistance @ Elevated Temperature, Par 6.13

The insulation resistance of the mated connectors was measured between each of 12 contacts and all other contacts and shell tied electrically in common. Six of the contacts were adjacent to the shell. These measurements were recorded after the connectors were subjected to a temperature of +175°C. (+347°F.) for 30 minutes. The measurements were made at a test potential of 500 volts dc and the electrification time did not exceed two minutes per circuit. All circuits had an insulation resistance greater than 5000 megohms. Insulation resistance was measured with a General Radio megohm bridge, F-1514, calibrated 8/29/72. Results are on Data Sheets 28, 29.

Air Leakage, Par 6.14

Each wired, unmated plug and receptacle were mounted on a test fixture suitable for application of a pressure of 30 psig to the mating face. The connectors and wires were immersed in Neosol so that any leakage was visually observed as bubbles. The assembly was soaked at a temperature of -65°C. (-85°F.) and then pressurized to 30 psig. Leakage, if any, was measured by collecting the bubbles in an inverted Neosol-filled, graduated cylinder.

Receptacle #9 had a leakage rate of 182 cubic inches per hour. The leakage appeared to be between the insert and the shell. Later investigation disclosed two voids between the filler and the shell where the leakage occurred. There was no visible leakage on any of the other connectors. Refer to Data Sheet 30.

Contact Resistance, Par 6.16

The resistance of 25 contact sets of each mated connector was measured. The four wire method of MIL-C-23216C was used. The voltage drop across a 6" length (mated contacts approximately in the middle) was measured at a test current of 7-1/2 amperes dc.

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V. DETAILED REPORT (Continued)

Due to the minimum amount of electrical engagement of the main joint contacts, as described in the Group I tests, erratic and intermittent readings occurred. Six circuits in connector #9 and one circuit in connector #10 exceeded the 60 millivolt limit. Results of all potential drop readings can be obtained from Data Sheets 31, 32.

Operating Torques, Par 6.3

Each plug was coupled to its counterpart receptacle and uncoupled at a slow, uniform rate. The peak torques were measured and recorded. The torques again exceeded the specification limit due to the double waved washer. Recorded data is included on Data Sheet 26.

Contact Retention, Par 6.6

Removable Contacts, Par 6.6.1

Fifteen contacts were removed and replaced with a specially made test contact for contact retention. This special contact incorporated its own retention member release sleeve and had a body long enough to allow the load to be applied. A load (tensile) of 15 pounds was applied at a rate of approximately one pound per second and monitored for a time period of 5-10 seconds. Each retention mechanism tested held the special contact. The maximum displacement was .0085". Refer to Data Sheets 33, 34.

Fixed Contacts, Par 6.6.2

Fifteen fixed contacts, same contact numbers used above in each connector half, had a load of 15 pounds applied to their mating ends at a rate of approximately one pound per second and monitored for a period of 5-10 seconds. The maximum displacement was .005". Load data and displacement can be obtained from Data Sheets 35, 36.

Fluid Immersion, Hydraulic Oil, MIL-H-5606, Par 6.20.1

The unmated connectors were immersed in the hydraulic oil at room temperature for 20 hours. The parts were allowed to drain for one hour at room temperature. Visual examination disclosed no swelling of the components in the connectors. The connectors were then subjected to the subsequent tests.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

Operating Torques, Par 6.3

The operating torques were again measured as previously described and the peak coupling and uncoupling forces were recorded. Forces were again above the specification limit due to the double waved washer. Refer to Data Sheet 27.

Group III Tests, Samples #11 and #12

Durability, Par 6.18

The mated connectors were subjected to 200 cycles of mating and unmating at a maximum rate of 200 cycles per hour. The coupling mechanism was operated in a manner to simulate actual service operation with the receptacle securely mounted.

Visual examination after the 200 cycles of mating and unmating showed very little wear on the pin contact mating ends. This is believed due to the minimum amount of electrical engagement caused by the improper positioning of the Stub E inserts in the MIL-C-26482 type connector shells. The coupling mechanism in both connectors disclosed a small amount of wear, mainly in the coupling ramps. This wear is not abnormal for the number of cycles the connectors were subjected to. The connectors showed no mechanical or electrical defects detrimental to the operation of the connectors.

At this time the second waved washer was introduced to the Group III test samples. The operating torques were measured before and after the addition of the second waved washer. The recorded forces are included on Data Sheet 37.

Temperature Life, Par 6.19

The unmated connectors were subjected to a temperature of +175°C. (347°F.) for a period of 1000 hours. At the end of the 1000-hour test and while at 175°C., the insulation resistance was measured between each of 12 contacts and all other contacts and shell tied electrically in common. Six of the contacts were adjacent to the shell. The measurements were made at a test potential of 500 volts dc and electrification time was less than two minutes per circuit. All circuits had an insulation resistance greater than 170,000 megohms. Insulation resistance was measured with a General Radio megohm bridge, F-0555, calibrated 6/6/72.

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V. DETAILED REPORT (Continued)

Visual examination after temperature life disclosed the hard dielectric inserts had discolored. This is not abnormal and is to be expected after a 1000-hour heat aging test. All lubrication in the coupling mechanism had dried and flaked off. The plating on both the plug shells and coupling nuts had discolored during the temperature life test. The plating on the receptacle shells showed less discoloration than the plug shells. The discoloration of plating on the receptacle shells appeared to be normal for this type of plating after being subjected to 1000 hours heat age at 347°F. Refer to Data Sheets 38, 39.

Operating Torques, Par 6.3

Each plug was coupled and uncoupled with its counterpart receptacle. The initial force required to couple and uncouple the mating connectors was measured. The operating forces were greatly increased over the forces recorded after the addition of the second waved washer. This is attributed to the absence of lubrication due to the Temperature Life test. A 40 to 60 inch pound increase was recorded. Complete results are on Data Sheet 40.

Dielectric Withstanding Voltage, Par 6.5

The mated connectors had a potential of 1500 volts ac rms, 60 Hz, applied between each contact and all other contacts and shell connected electrically in common. Electrification time was two seconds per circuit. Any leakage current in excess of one milliamperere was considered a failure. There were no electrical flashovers or breakdowns noted. This test was conducted on the automatic connector tester, F-1680, calibrated 12/6/72.

Contact Retention, Par 6.6

Removable Contacts, Par 6.6.1

Fifteen contacts randomly selected were removed and replaced with a specially made test contact. This special contact incorporated its own retention member release sleeve and had a body long enough to allow the load to be applied. A load (tensile) of 15 pounds was applied at a rate of approximately one pound per second and monitored for a time period of 5-10 seconds. In all cases the retention mechanism retained the special contact. The maximum displacement was .007". Data and displacement can be obtained from Data Sheets 41, 42.

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V. DETAILED REPORT (Continued)

Fixed Contacts, Par 6.6.2

Fifteen fixed contacts, the same contact numbers used for the removable contact retention test, had a load of 15 pounds applied to their mating end at a rate of approximately one pound per second and monitored for a period of 5-10 seconds. The maximum displacement was .0045". For complete results see Data Sheets 43, 44.

Insulation Resistance, Par 6.4

The insulation resistance of the mated connectors was measured between each contact and all other contacts and shell tied electrically in common. The measurements were made at a test potential of 500 volts dc and the electrification time did not exceed two minutes per circuit. All values were greater than 5000 megohms. This test was conducted on the automatic connector tester, F-1680, calibrated 12/6/72.

Contact Resistance, Par 6.16

The resistance of 25 contact sets of each mated connector was measured. The four wire method of MIL-C-23216C was used. The voltage drop across a 6" length (mated connectors approximately in the middle) was measured at a test current of 7-1/2 amperes dc. The maximum allowable potential drop is 70 millivolts after the temperature life conditioning. All circuits in connector #12 were within the 70 mv limit. Connector #11 had three circuits exceed the specified limit. This is attributed to the minimal electrical engagement.

Circuit #1 was an intermittent circuit. An investigation into this problem disclosed this contact was incorrectly positioned in the insert. Therefore, only the socket hood completed the electrical circuit. Data on all potential drop readings can be obtained from Data Sheets 45, 46.

Final Examination of Product, Par 6.22

At the completion of all testing, the connectors were visually examined for general conditions and any damage which would be considered abnormal for the tests to which the connectors were exposed.

The identification markings on all connector shells and the screen printing on all insert faces was clear and legible.

ENGINEERING LABORATORY REPORT 12-5194

V. DETAILED REPORT (Continued)

The hard dielectric inserts of the Group III samples had discolored after the 1000-hour heat aging. The plating on both plug shells of this group had discolored. All lubrication had baked off during the Temperature Life test.

The mechanical and electrical capabilities of all connectors was satisfactory at the completion of all tests.

Due to the high operating forces and the absence of lubrication after the Temperature Life test, plug #12 was lubricated with Uni-Temp 9-3502. The operating forces were then measured and were considerably lower than the forces recorded after Temperature Life. This then proves the lack of lubricant on the coupling mechanism after temperature life contributed to the extremely high forces.

VI. REFERENCES

Bendix Test Procedure L-15081-98, April 1972
MIL-C-23216C
ECL-0507, 92-102; ECL-0507B
ECL-0545, 4-9; ECL-0545A
CLT 3219, Job 05950-03, Q74535

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APPENDIX A

DATA SHEETS

LABORATORY DATA SHEET

TEST OPERATING FORCES				DATE OF TESTS 10-23-72		REPORT NUMBER 12-5194	
TEST SPECIMEN (S) L-27758-80 PLUGS mated WITH				TEMP. 74°F	R.H. 34%	ECL 05070-93	
L-27758-81 RECEPTACLES				LT. 3719	SPEC. L-15081-98	PARA. 6.3	
TEST EQUIPMENT STURTEVANT TORQUE FIXTURE		CAL. DATE N/A	DUE DATE 1-16-73	SPEC. LIMITS MAX. ENG. & DIS- ENGAGE - 2.5 IN. LB.			
PG-1178		10-16-72		TEST CONDITIONS Room Ambient			
STURTEVANT TORQUE WRANCH		1-16-73		INITIAL			
L-27758-80 #7 mated WITH L-27758-81 #7							
MATING FORCE				UNMATING FORCE			
8 lbs.-IN				17 lbs.-IN			
L-27758-80 #8 mated WITH L-27758-81 #8							
MATING FORCE				UNMATING FORCE			
7 1/2 lbs.-IN				15 lbs.-IN			
L-27758-80 #9 mated WITH L-27758-81 #9							
MATING FORCE				UNMATING FORCE			
6 lbs.-IN				12 lbs.-IN			
L-27758-80 #10 mated WITH L-27758-81 #10							
MATING FORCE				UNMATING FORCE			
7 lbs.-IN				17 lbs.-IN			
L-27758-80 #11 mated WITH L-27758-81 #11							
MATING FORCE				UNMATING FORCE			
7 1/2 lbs.-IN				16 3/4 lbs.-IN			
L-27758-80 #12 mated WITH L-27758-81 #12							
MATING FORCE				UNMATING FORCE			
8 lbs.-IN				18 1/2 lbs.-IN			
REF. SINGLE WAVE WASHER				Electrical Components Division		TESTED BY T.A. NABOLITAND	
						APPROVED BY [Signature]	
						WITNESSED BY	

Sidney, New York 13838

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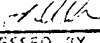
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LABORATORY DATA SHEET

TEST OPERATING FORCES		DATE OF TESTS 11-2-72		REPORT NUMBER 12-5174	
TEST SPECIMEN (S) L-27758-80 PLUGS MATED WITH		TEMP 74°		R.H. 34%	
L-27758-81 RECEPTACLE		LT. 32.19		SPEC. L-15081-9P	
TEST EQUIPMENT STURTEVANT TORQUE FIXTURE		CAL. DATE N/A		SPEC. LIMITS MAX ENG & DIS. ENGAGE .25 IN lbs.	
PG-1179		DUE DATE 1-16-73		TEST CONDITIONS Room AMBIENT	
STURTEVANT TORQUE WRENCH				THERMAL SHOCK	
AFTER THERMAL SHOCK L-27758-80 #7 mated with L-27758-81 #7 MATING UNMATING 9 IN lbs 10 IN lbs SINGLE WAVE WASHER * 29 IN lbs 43 IN lbs DOUBLE WAVE WASHER L-27758-80 #8 mated with L-27758-81 #8 MATING UNMATING 9 IN lbs 12 IN lbs SINGLE WAVE WASHER * 30 IN lbs 45 IN lbs DOUBLE WAVE WASHER L-27758-80 #9 mated with L-27758-81 #9 MATING UNMATING 7 IN lbs 12 IN lbs SINGLE WAVE WASHER * 17 IN lbs 37 IN lbs DOUBLE WAVE WASHER L-27758-80 #10 mated with L-27758-81 #10 MATING UNMATING 7 IN lbs 8 IN lbs SINGLE WAVE WASHER * 25 IN lbs 40 IN lbs DOUBLE WAVE WASHER					
REF. * SECOND WAVE WASHER WAS ADDED		 Bendix Electrical Components Division Sidney, New York 13838		TESTED BY J. R. NAPOLITANO APPROVED BY  WITNESSED BY	

VIBRATION LOG

Test Spec. used: **STUB-ELARGABR Tye, 1WTS CONNECTOR - TWO HATED PAIRS**
 Test Equipment: **MB - CRO**
 Vibration Exciter: **MB - CRO**
 Measuring System: **AGGREGATE IN 4099 @ AMPLIFIER F-H44; DISCONTINUITY MONITOR**
 F-0527; Report F-1311
 Requested by: **TRUDY NADUMMO**
 Tested by: **JFE KRISKO**
 Para: **6.9**
 Report No.:
 Approved: **JFE**

Date	Time	Clock Reading	Total Hours	Vibr. Axis	Velocity In./Sec.	Displ. In./D.A.	Acc. g	Frequency Hz	Cycle Period Minutes	Sweep Rate Degrees/Min.	Temperature of Ambient	Part	Note
11-08-72	9:05 AM	0170.9	-	Y	-	.060	20	10-2000-10	20	16	-85°F	-	1,3,6
11-08-72	10:06 AM	0171.9	1.0	Y	-	.060	20	10-2000-10	20	16	-85°F	-	4,5
11-08-72	10:57 AM	0172.7	1.0	Y	-	.060	20	10-2000-10	20	16	78°F	-	1,3,6
11-08-72	1:00 PM	0174.7	3.0	Y	-	.060	20	10-2000-10	20	16	78°F	-	4,5
11/8/72	2:00 PM	0175.9	3.0	Y	-	.060	20	10-2000-10	20	16	347	-	1,3,6
11-08-72	3:00 PM	0176.8	4.0	Y	-	.060	20	10-2000-10	20	16	346°F	-	4,5
VIBRATION COMPLETED IN THIS AXIS.													
11-09-72	9:03 AM	0179.3	-	X	-	.060	20	10-2000-10	20	16	-85°F	-	1,3,6
11-09-72	10:03 AM	0180.3	1.0	X	-	.060	20	10-2000-10	20	16	-85°F	-	4,5
11-09-72	11:15 AM	0181.5	1.0	X	-	.060	20	10-2000-10	20	16	347°F	-	1,3,6
11-09-72	12:15 PM	0182.5	2.0	X	-	.060	20	10-2000-10	20	16	347°F	-	4,5
11-09-72	1:15 PM	0183.5	2.0	X	-	.060	20	10-2000-10	20	16	78°F	-	1,3,6

Notes: ① Parts soaked at temperature for 24 1/2 hour prior to start of vibration. ② Vibration started ③ All contacts connected in series & no. 11 used for discontinuities of 1/2 sec or greater. ④ Vibration stopped. ⑤ No discontinuities noted. ⑥ Vibration resumed.

Test Set Up Illustration

Vibration Axis

Part Orientation

Electrical Components Division
 S. P. 11118

12-5194
 ECL-05078-123

ETL 0421A-186

21

12-5194
ECL-0507B-124

VIBRATION LOG

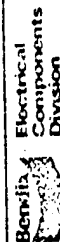
Test Specimen		Specification		Para.		Vibration Log No.	
STUB F/2648R TIE, LWT'S CONNECTOR		L-15041-98		6.9			
Test Equipment		Reported by		Report No.		Approved	
MB-C20		JTE KRISKO		419			
Measuring System		Frequency		Sweep Rate		Temperature of	
HENDON F-0527; PROTEST F-1311		10-2000-10		16		Ambient	
Date	Time	Clock Reading	Total Hours	Vibr. Axis	Velocity In./Sec.	Displ. In. D.A.	Acc. G's
11-09-72	3:15 PM	0185.5	4.0	X	-	0.060	2.0
VIBRATION COMPLETED IN THIS AXIS.							
11-09-72	4:29 PM	0186.8	-	Z	-	0.060	2.0
11-09-72	5:28 PM	0187.8	1.0	Z	-	0.060	2.0
VIBRATION COMPLETED IN THIS AXIS.							
11-09-72	6:42 PM	0189.0	1.0	Z	-	0.060	2.0
11-09-72	7:43 PM	0190.0	2.0	Z	-	0.060	2.0
VIBRATION COMPLETED IN THIS AXIS.							
11-09-72	8:27 PM	0192.7	2.0	Z	-	0.060	2.0
11/9/72	10:33 PM	0192.8	4.1	Z	-	0.060	2.0
VIBRATION COMPLETED IN THIS AXIS.							
SEE SHEET 1							

Test Set Up Illustration

NOTE: ① PARTS SCANNED AT TEMPERATURE FOR 12 1/2 HOUR PRIOR TO START OF VIBRATION. ② VIBRATION STARTED. ③ ALL CONTACTS CONNECTED IN SERIES & MONITORED FOR DISCONTINUITIES OF 1.0 MSec OR GREATER. ④ VIBRATION STOPPED. ⑤ NO DISCONTINUITIES NOTED. ⑥ VIBRATION RESUMED

Part Orientation

Vibration Axis



Bend Sin Electrical Components Division

SUN, N.Y. 10938

1-555

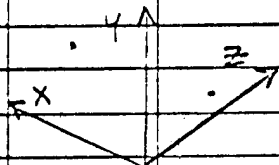
ETL 0421A-187

22

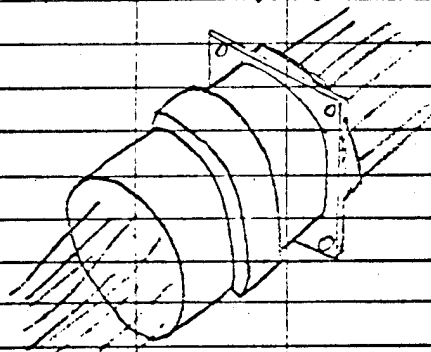
Test	MECHANICAL SHOCK - 50G, 11 MILLISECOND, HALF-SINE	Ref.
Test Specimen	STUB - E/26482 TYPE, INTS CONNECTOR	Date 11-13-72
	TWO MATED PAIRS @ ALL CONTACTS WIRED IN SERIES	Spec.
Test Instrument(s)	HYGE SHOCK MACHINE - MODEL 3401 ACCELERATION MEASURING SYSTEM IC-578 DISCONTINUITY MONITOR F-0527	Para.
		Tested By J.E. KRISKO
		Approved EJD

Test Conditions APPLY ONE 50G SHOCK IN EACH DIRECTION OF EACH OF THREE MUTUALLY PERPENDICULAR AXES. MONITOR FOR DISCONTINUITIES OF 1/2 SEC OR GREATER.

AXES OF SHOCKS



PART ORIENTATION



DATE	AXIS	APPLIED SHOCKS ①	RESULTS
11-13-72	Z	✓	No DISCONTINUITIES NOTED; NO MECHANICAL DEGRADATION NOTED
11-13-72	Z'	✓	No DISCONTINUITIES OR MECHANICAL DEGRADATION NOTED
11-13-72	Y	✓	No DISCONTINUITIES OR MECHANICAL DEGRADATION NOTED
11-13-72	Y'	✓	" " " " " "
11-13-72	X	✓	" " " " " "
11-13-72	X'	✓	" " " " " "

① A (✓) INDICATES AN APPLIED SHOCK OF 50G, 11 MILLISECONDS DURATION, HALF-SINE WAVEFORM.

LABORATORY DATA SHEET

ETL 0421A-188

72-354-1

Electrical
Components
Division

Sidney, N. Y. 13838

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LABORATORY DATA SHEET						DATE OF TESTS		REPORT NUMBER																																																																															
TEST CONTACT RESISTANCE						11-15-72		12-5194																																																																															
TEST SPECIMEN(S) L-27758-P0 PLUG #7 MATED						TEAR 141		R.H. 672																																																																															
						ECL 705070-119																																																																																	
WITH L-27758-P1 RECEPTACLE #7						LT. 3219		SPEC. L-15087-98																																																																															
						CAL. DATE 7-5-73		DUE DATE 7-2-73																																																																															
TEST EQUIPMENT KEPKO POWER SUPPLY F-1375						SPEC. LIMITS 100 MILLIVOLTS MAX.																																																																																	
WESTON D.C. AMMETER F-0089						INITIAL L																																																																																	
HEWLETT-PACKARD DVM F-1XZZ						VIBRATION SHOCK																																																																																	
HEWLETT-PACKARD DIGITAL RECORDER						N/A		7.5 Amps																																																																															
<table border="1"> <thead> <tr> <th>POTENTIAL DROP</th> <th>AFTER SEVERAL MATINGS</th> <th>* UNMATINGS</th> </tr> </thead> <tbody> <tr><td>38</td><td>54.8</td><td></td></tr> <tr><td>39</td><td>53.3</td><td></td></tr> <tr><td>* 40</td><td>66.8</td><td>52.2</td></tr> <tr><td>* 55</td><td>64.8</td><td>56.1</td></tr> <tr><td>37</td><td>48.8</td><td></td></tr> <tr><td>* 20</td><td>61.2</td><td>59.9</td></tr> <tr><td>21</td><td>50.5</td><td></td></tr> <tr><td>22</td><td>50.3</td><td></td></tr> <tr><td>41</td><td>49.5</td><td></td></tr> <tr><td>54</td><td>50.1</td><td></td></tr> <tr><td>* 36</td><td>60.5</td><td>67 STILL FAILING</td></tr> <tr><td>19</td><td>50.8</td><td></td></tr> <tr><td>8</td><td>50.2</td><td></td></tr> <tr><td>9</td><td>50.0</td><td></td></tr> <tr><td>23</td><td>51.5</td><td></td></tr> <tr><td>42</td><td>49.0</td><td></td></tr> <tr><td>53</td><td>56.2</td><td></td></tr> <tr><td>35</td><td>50.1</td><td></td></tr> <tr><td>18</td><td>50.3</td><td></td></tr> <tr><td>7</td><td>59.8</td><td></td></tr> <tr><td>* 2</td><td>62.2</td><td>58.5</td></tr> <tr><td>10</td><td>59.0</td><td></td></tr> <tr><td>24</td><td>50.3</td><td></td></tr> <tr><td>43</td><td>48.2</td><td></td></tr> <tr><td>* 1</td><td>60.6</td><td>56.0</td></tr> </tbody> </table>										POTENTIAL DROP	AFTER SEVERAL MATINGS	* UNMATINGS	38	54.8		39	53.3		* 40	66.8	52.2	* 55	64.8	56.1	37	48.8		* 20	61.2	59.9	21	50.5		22	50.3		41	49.5		54	50.1		* 36	60.5	67 STILL FAILING	19	50.8		8	50.2		9	50.0		23	51.5		42	49.0		53	56.2		35	50.1		18	50.3		7	59.8		* 2	62.2	58.5	10	59.0		24	50.3		43	48.2		* 1	60.6	56.0
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GROUP I						Saratov, New York 13838		APPROVED BY [Signature]																																																																															
								WITNESSED BY																																																																															

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-128-

LABORATORY DATA SHEET

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LABORATORY SHEET				DATE OF TESTS		REPORT NUMBER																																																																																																									
TEST OPERATING FORCES				11-16-72		12-5194																																																																																																									
TEST SPECIMEN(S) L-27758-80 PLUGS MATED				TEMP. 74° R.H. 34%		ECL2843A-1 11-04-72-103																																																																																																									
WITH L-27758-81 RECEPTACLES				LT. 3219		SPEC. 1-15081-78 6.3																																																																																																									
TEST EQUIPMENT		CAL. DATE		DUE DATE		SPEC. LIMITS																																																																																																									
STURTEVANT TORQUE FIXTURE		N/A				2.5 IN. MAX																																																																																																									
STURTEVANT TORQUE WRENCH		10-16-72		1-16-73		TEST CONDITIONS																																																																																																									
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Geo. T. & P.				Sydney, New York 13838		WITNESSED BY																																																																																																									

LABORATORY DATA SHEET

TEST OPERATING FORCES		DATE OF TESTS 11-21-72		REPORT NUMBER 12-5194	
TEST SPECIMEN(S) L-27758-80 PLUG MATED WITH		TEMP. 142		R.H. 34%	
L-27758-81 RECEPTACLE		LT. 32.19		SPEC. L-15591-9F	
TEST EQUIPMENT STRUCTURE TAPING FIXTURE		CAL. DATE N/A		SPEC. LIMITS MAX. ENG P DIS. EN 8000 - 25 in lbs.	
STRUCTURE TAPING WRENCH		DUE DATE 10-16-73		TEST CONDITIONS FLUID IMMERSION	
				MEASUREMENTS IN INCH POUNDS	
LUBE OIL - MIL-L-232 79					
L-27758-80 Pins #7 mated with L-27758-81 #7					
MATING		UNMATING			
31 in lbs		39 in lbs			
L-27758-80 #8 mated with L-27758-81 #8					
MATING		UNMATING			
31 in lbs		36 in lbs			
HYDRAULIC OIL - MIL-H-5606					
L-27758-80 #9 mated with L-27758-81 #9					
MATING		UNMATING			
19 in lbs		22 in lbs			
L-27758-80 #10 mated with L-27758-81 #10					
MATING		UNMATING			
27 in lbs		33 in lbs			
REF. 2 WAVE WASHERS					
Q.P. I & II				Electrical Components Division	
		Sunny, New York 10008		TESTED BY T. D. McCallum	
				APPROVED BY all	
				WITNESSED BY	

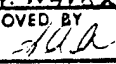
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72-354-2

LABORATORY DATA SHEET

TEST CONTACT RESISTANCE		DATE OF TESTS 11-15-72		REPORT NUMBER 12-5194																																																																														
TEST SPECIMEN (S) L-27758-R0 PLUG #9 MATED		TEMP. 111°F	R.H. 64%	ECL SPEC PARA. 05075-121																																																																														
WITH L-27758-R1 RECEPTACLE #9		LT. 3219	SPEC. L-15081-98																																																																															
TEST EQUIPMENT POWER SUPPLY		CAL. DATE 7-5-72	DUE DATE 7-2-73	SPEC. LIMITS 10.0 MILLIVOLTS MAX																																																																														
KEPCO D.C. AMMETER F-132		TEST CONDITIONS INITIAL																																																																																
WESTON D.C. AMMETER F0028		AIR LEAKAGE																																																																																
HEWLETT-PACKARD DVM F1822		7.5 AMPS.																																																																																
E-467X																																																																																		
HEWLETT-PACKARD DIGITAL RECORDER		11A																																																																																
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REF. MEASUREMENTS IN MILLIVOLTS		 Electrical Components Division Sirany, New York 13838		TESTED BY Z. R. NAGALATANG APPROVED BY  WITNESSED BY																																																																														
GROUP II																																																																																		

LABORATORY DATA SHEET

TEST CONTACT RESISTANCE		DATE OF TESTS 11-15-72		REPORT NUMBER 12-5194																																																																																																																																																													
TEST SPECIMEN(S) L-27752-80 PLUG #10 MATED		TEMP. 74°F	R.H. 34%	ECL EPL 00070-102																																																																																																																																																													
WITH L-27752-81 RECEPTACLE #10		LT. R219	SPEC. 1-15081-98		PARA. 6.16																																																																																																																																																												
TEST EQUIPMENT KEPCO POWER SUPPLY E-1375		CAL. DATE 7-5-72	DUE DATE 7-2-73	SPEC. LIMITS 6.0 MILLIVOLTS MAX																																																																																																																																																													
WESTON DC AMMETER E-0039		6-19-72	12-27-72	TEST CONDITIONS INITIAL																																																																																																																																																													
HEWLETT-PACKARD DVM E-1822		10-9-72	4-2-75	AIR LEAKAGE																																																																																																																																																													
HEWLETT-PACKARD DIGITAL RECORDER E-4622		N/A		7.5 AMPS																																																																																																																																																													
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LABORATORY DATA SHEET

TEST		DATE OF TESTS		REPORT NUMBER																																																	
OPERATING FORCES		11-3-72		12-5194																																																	
TEST SPECIMEN(S)		TEMP. R.H.		ECL																																																	
L-27758-80 PLUG #11 #12 mated		14°F 34%		05070-117																																																	
WITH RECEPTACLE - L-27758-81 #11 #12		LT.		SPEC.																																																	
TEST EQUIPMENT		3219		L-15081-98																																																	
STURTEVANT TORQUE FIXTURE		CAL. DATE		DUE DATE																																																	
PG-1179		N/A		SPEC. LIMITS MAX ENG. & DISCHARGE																																																	
STURTEVANT TORQUE WRENCH		10-16-72		1-16-73																																																	
				TEST CONDITIONS Room Ambient																																																	
				DURABILITY																																																	
<table border="1"> <tr> <td>L-27758-80 #11 mated with L-27758-81 #11</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>MATING</td> <td></td> <td>UNMATING</td> <td></td> <td></td> <td></td> </tr> <tr> <td>5 in 16s</td> <td></td> <td>12 in 16s</td> <td></td> <td>SINGLE WAVE WASHER</td> <td></td> </tr> <tr> <td>* 26 in 16s</td> <td></td> <td>42 in 16s</td> <td></td> <td>DOUBLE WAVE WASHER</td> <td></td> </tr> <tr> <td>L-27758-80 #12 mated with L-27758-81 #12</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>MATING</td> <td></td> <td>UNMATING</td> <td></td> <td></td> <td></td> </tr> <tr> <td>6 in 16s</td> <td></td> <td>12 in 16s</td> <td></td> <td>SINGLE WAVE WASHER</td> <td></td> </tr> <tr> <td>* 29 in 16s</td> <td></td> <td>10 in 16s</td> <td></td> <td>DOUBLE WAVE WASHER</td> <td></td> </tr> </table>						L-27758-80 #11 mated with L-27758-81 #11						MATING		UNMATING				5 in 16s		12 in 16s		SINGLE WAVE WASHER		* 26 in 16s		42 in 16s		DOUBLE WAVE WASHER		L-27758-80 #12 mated with L-27758-81 #12						MATING		UNMATING				6 in 16s		12 in 16s		SINGLE WAVE WASHER		* 29 in 16s		10 in 16s		DOUBLE WAVE WASHER	
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* SECOND WAVE WASHER		Electrical Components Division		J. A. NAPOLITANO																																																	
ADDED		Sidney New York 13838		APPROVED BY																																																	
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LABORATORY DATA SHEET				DATE OF TESTS		REPORT NUMBER	
TEST CONTACT RESISTANCE				12-20-72		12-5194	
TEST SPECIMEN (S) L-27758-80 PLUG #11 MATCO				TEMP. 74°F R.H. 34%		ECL. 05850-16	
WITH L-27758-81 RECEPTACLE #11				LT. 3219		SPEC. L-15081-98	
TEST EQUIPMENT				CAL. DATE		DUE DATE	
KUPCO POWER SUPPLY (DC) F-1375				7-5-72		7-2-73	
WESTON DC AMMETER F-0028				12-20-72		6-13-73	
HEWLETT-PACKARD DIGITAL VOLTMEETER F-1822				10-9-72		4-2-73	
HEWLETT-PACKARD DIGITAL RESISTOR E-4622				N/A		7.5 AMPS	
TEST CONDITIONS				TEST SPEC. LIMITS			
AFTER TEMPERATURE LIFE				70 MILLIVOLTS MAX			
CONTACT				POTENTIAL DROP			
38				52.5			
39				49.9			
* 40				83.6 EXCEEDS SPEC LIMIT			
65				58.6			
37				50.3			
20				64.5			
21				51.7			
22				49.6			
41				66.8			
54				49.2			
36				53.4			
19				68.9			
8				52.2			
9				49.2			
23				48.6			
42				49.5			
53				49.9			
35				52.1			
18				52.8			
* 7				109.8 EXCEEDS SPEC LIMIT			
2				47.3			
10				66.3			
24				53.4			
43				52.2			
* 1				76.9 intermittent circuit			
REF. MEASUREMENTS IN MILLIVOLTS				TESTED BY			
ADDUP TIL				T. A. WAPOLITAWA			
Bendix Electrical Components Division				APPROVED BY			
Sydney New York 13838				WITNESSED BY			

LABORATORY DATA SHEET				DATE OF TESTS		REPORT NUMBER	
TEST CONTACT RESISTANCE				12-20-72		12-5194	
TEST SPECIMEN(S) L-27758-80 PLUG #12 MATED				TEMP. 74°F		R.H. 34%	
L-27758-81 RECEPTACLE #12				LT. 3019		ECL 05298-17	
TEST EQUIPMENT KEPCO D.C. Power Supply F-1375				CAL. DATE 7-5-72		DUE DATE 7-2-73	
WESTON D.C. Ammeter F-0028				12-20-72		6-13-73	
HEWLETT-PACKARD DVM F-1822				10-9-72		4-2-73	
HEWLETT-PACKARD Digital Recorder				M/P		7.5 Amps.	
TEST CONDITIONS AFTER TEMPERATURE LIFE				SPEC. LIMITS 70 MILLIVOLTS MAX			
CONTACT				POTENTIAL DROP			
38				54.6			
39				48.9			
40				63.1			
55				67.3			
37				51.9			
20				67.1			
21				58.2			
22				51.4			
41				50.2			
54				48.9			
36				57.6			
19				50.4			
8				50.4			
9				49.8			
23				50.9			
42				49.0			
53				60.0			
35				54.4			
18				50.3			
7				52.3			
2				48.4			
10				50.8			
24				50.6			
43				50.5			
1				67.2			
REF. MEASUREMENTS IN MILLIVOLTS				TESTED BY T. A. NABLIANO			
GALV. TIT				APPROVED BY [Signature]			
Sindix Electrical Components Division				WITNESSED BY			
Sindix New York 13838							

ENGINEERING LABORATORY REPORT 12-5194

APPENDIX B

BENDIX TEST PROCEDURE

L-15081-98

L-15081-98

PRE-PRODUCTION TESTING OF
INTEGRATED WIRE TERMINATION
SYSTEM ELECTRICAL CONNECTORS.
FOR USAECOM

THE BENDIX CORPORATION
ELECTRICAL COMPONENTS DIVISION
SIDNEY, NEW YORK

1.0 Scope

The purpose of this test procedure is to establish the samples and test methods to be used in pre-production testing of MIL-C-81511B and "Stub-E" (Ordinance Document 11176551) type electrical connectors which are modified for inclusion of the Integrated Wire Termination System.

The test methods and limits contained herein were chosen as being applicable for these connector designs. They are derived essentially from the two documents referenced above.

2.0 Test Agency

All tests herein described will be performed at and by the Engineering Laboratory, Electrical Components Division, The Bendix Corporation, Sidney, New York 13838.

3.0 Standard Test Conditions

Unless otherwise specified, tests and examinations specified by this procedure will be conducted under any combination within the ranges below:

Temperature	68°F to 95°F
Relative Humidity	10% to 80%
Barometric Pressure	24" to 31" Hg

4.0 Test Samples

A total of 12 mating connectors will be required for this test program. They are identified as follows:

<u>Test Sample No.</u>	<u>Type</u>	<u>Bendix Part No.</u>	<u>Shell Config.</u>	<u>Retention</u>
1,2,3,4,5,6	81511	L-27758-24	Plug	Metallic
"	"	L-27758-25	Receptacle	"
7,8,9,10,11,12	Stub"E"	L-27758-104	Plug	Dielectric
"	"	L-27758-105	Receptacle	"

The MIL-C-81511 connectors have 85 Size 22D contacts, (18-85 arrangement), and the Stub "E" connectors have 55 Size 20 contacts (22-55 arrangement).

5.0 Test Sequence

The connectors shall be subjected to the tests in the following sequence in the order listed:

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Electrical Components Division

L-15081-98
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Test	Para.	Test Samples		
		1,2,7,8	3,4,9,10	5,6,11,12
Examination of Product	6.1	X	X	X
Wire & Prepare	6.2	X	X	X
Operating Torques	6.3	X	X	X
Insulation Resistance	6.4	X	X	X
Dielectric Withstanding Voltage	6.5	X	X	X
Contact Retention (Remov. & Fixed)	6.6	X	X	X
Maintenance Age	6.7	X		
Contact Retention (Remov. Only)	6.6.1	X		
Thermal Shock	6.8	X	X	
Vibration	6.9	X		
Shock	6.10	X		
Moisture Resistance	6.11	X		
Dielectric Withstanding Voltage (Alt.)	6.12		X	
Insulation Resistance (Elev. Temp.)	6.13		X	
Air Leakage	6.14		X	
Water Immersion	6.15		X	
Contact Resistance	6.16	X	X	
Salt Spray	6.17		X	
Operating Torques	6.3	X	X	
Contact Resistance	6.16		X	
Contact Retention (Remov. & Fixed)	6.6		X	
Durability	6.18			X
Temperature Life	6.19			X
Fluid Immersion - Lube Oil	6.20.1	X		
Fluid Immersion - Hydr. Oil	6.20.2		X	
Operating Torques	6.3	X	X	X
Insert Retention	6.21	X		
Dielectric Withstanding Voltage	6.5			X
Contact Retention	6.6			X
Insulation Resistance	6.4			X
Dielectric Withstanding Voltage (Alt.)	6.12			X
Contact Resistance	6.16			X
Final Examination of Product	6.22	X	X	X

6.0 Test Descriptions

Following are the descriptions of how each individual test will be performed.

6.1 Examination of Product

The individual connectors will be inspected for conformance to the applicable Bendix assembly drawings and for general quality of workmanship.

6.2 Wire and Prepare

Each connector half shall be permanently marked (etched) with its own test number, (ref. Para. 4.0). Each removable socket termination shall be crimped to a three foot length of teflon insulated wire and installed into the insert cavities. The Stub "E" connectors shall all be wired with nominal diameter 20 gage wire. Samples 1, 3 & 5 (81511) shall be wired with minimum diameter wire while 2, 4 & 6 shall be wired with maximum diameter wire.

6.3 Operating Torques

Each plug shall be coupled to its counterpart receptacle and uncoupled at a slow uniform rate. The peak torques shall be measured using a torque wrench and appropriate fixturing. The torques shall be within the following limits:

Connector	Torque - Lb. In.	
	Max. Eng. & Disengaging	Minimum Disengaging
MIL-C-81511	28	4
Stub "E"	25	-

6.4 Insulation Resistance

The insulation resistance of the mated connectors shall be measured between each of 12 contacts and all other contacts and shell tied electrically in common. Six of the contacts shall be adjacent to the shell. The measurements shall be made at a test potential of 500 VDC $\pm$ 10% and electrification time shall not exceed 2 minutes. All values shall be greater than 5,000 megohms.

6.5 Dielectric Withstanding Voltage

The mated connectors shall have an AC potential applied between each contact and all other contacts and shell tied electrically in common for a period of 2 seconds per circuit. Leakage current shall not exceed 1 ma. The applied voltage shall be as follows:

<u>Connector</u>	<u>Potential-A.C. RMS</u>
81511	1300
Stub "E"	1500

6.6 Contact Retention

6.6.1 Removable Contacts

Fifteen contacts shall be removed and replaced with a specially made test contact for contact retention. This contact shall incorporate its own retention member release sleeve and have a "tail" long enough to allow a load to be applied. With this fixture in each contact cavity to be tested, a load will be applied at a rate of approximately 1 lb/sec. and monitored for a period of 5-10 seconds without being displaced by more than 0.012 in. while under load. The loads to be applied are:

<u>Connector</u>	<u>Load-Lbs.</u>
81511	10
Stub "E"	15

6.6.2 Fixed Contacts

Fifteen fixed contacts in each connector half shall have a load (see 6.6.1) applied to their mating ends at a rate of approximately 1 lb/sec. and monitored for a period of 5 to 10 seconds without being displaced by more than 0.012 in. while under load.

6.7 Maintenance Age

Each removable contact shall be removed from and reinserted into its individual insert cavity using appropriate insertion and removal tools. The fifteen contacts already subjected to contact retention shall be removed and reinserted an additional 9 times. The forces to insert and remove these contacts shall be measured on the 1st and 9th cycles.

6.8 Thermal Shock

The unmated connectors shall be subjected to 5 continuous cycles of temperature shock. Each cycle shall consist of 1/2 hour at -65 +0° C followed by 1/2 hour at +175 +3° C
-5° -0°

with no more than 5 minutes elapsing between temperature extremes. There shall be no damage detrimental to the operation of the connector after being subjected to this conditioning.

6.9 Vibration

The mated connectors shall be rigidly mounted on a vibration exciter using a suitable vibration test fixture and their normal mounting means. A minimum of 8 inches of wire shall be unsupported on both ends of the connector. The connector shall be subjected to a vibration level of either 0.06 inch d.a. or 20G peak, whichever is less. The vibration frequency shall be varied logarithmically between 10 and 2000 Hz and back to 10 Hz in a period of 20 minutes. The vibration sweep shall be applied 12 times (4 hours) in each of 3 mutually perpendicular axes. Each 4 hour period shall be conducted 1 hour at -65°C, 2 hours at room temperature and 1 hour at 175°C. During the vibration, the series wired contacts shall be monitored for discontinuities at a direct current of 100 ma. Discontinuities of 1 microsecond or greater will constitute a failure.

6.10 Shock

The mated connectors shall be rigidly mounted on a shock test machine using a suitable test fixture and their normal mounting means. A minimum of 8 inches of wire shall be unsupported on both ends of the connectors. The connectors shall be subjected to one shock pulse in each direction of each of the three mutually perpendicular axes. Each pulse shall be of approximately half-sine waveform, 50G peak and 11 milliseconds duration. The series wired contacts shall be monitored for discontinuities at a direct current of 100 ma. Discontinuities of 1 microsecond or greater shall constitute failure.

6.11 Moisture Resistance (81511 Only)

The mated 81511 type connectors shall be subjected to the moisture resistance test of MIL-STD-202, Method 106, with step 7b vibration excluded. After a minimum of 3 hours after completion of the final cycle, while the connectors are still subjected to high humidity, the insulation resistance shall be measured as specified in 6.4 except that it shall be 500 megohms or greater.

6.12 Dielectric Withstanding Voltage at Altitude (81511 only)

The mated 81511 type connectors shall be tested as specified in 6.5 except that they shall be placed in a vacuum chamber and evacuated to a simulated altitude of 110,000 feet for 1/2 hour and then subjected to a test potential of 1000V AC RMS.

6.13 Insulation Resistance at Elevated Temperature

The insulation resistance of the mated connectors shall be measured as in 6.4 except that they shall have been subjected to a temperature of 175°C for 30 minutes prior to making the measurements. All measurements shall be in excess of 200 megohms.

6.14 Air Leakage

The unmated plugs and receptacles shall be mounted on a test fixture suitable for application of a pressure of 30 psig to the mating face. The assembly shall be soaked at a temperature of -65°C and then pressurized to 30 psig. The leakage rate shall not be more than 1 in ³/hour.

6.15 Water Immersion (81511 only)

The mated 81511 type connectors shall be immersed in tap water to a depth of 6 ft. for a period of 48 hours. They shall then be removed from the water and insulation resistance will be measured as specified in 6.4 except that all measurements shall be in excess of 100 megohms.

6.16 Contact Resistance

The resistance of 25 contact sets of each mated connector shall be measured. The four wire method of MIL-C-23216C (Figure 4) shall be used. The voltage drop across a 6 in. length (contact set approximately in the middle) shall be measured at the following test currents:

Connector Type	Contact Size	Wire Size	Test Curr. Amps. DC	Maximum Potential Drop M.V.	
				Initial	After Temperature Life & Salt Spray
81511	22D	24	3	55	65
81511	22D	28	1 1/2	35	45
Stub"E"	20	20	7 1/2	60	70

6.17 Salt Spray (81511 only)

The unmated 81511 type connectors shall be subjected to the salt spray test as specified in MIL-STD-202, Method 101, Test Condition B. The salt concentration shall be 5%. Following the exposure the connectors shall be washed off with tap water and dried in a circulating air oven at a temperature of 38° ± 3°C for 12 hours maximum, after which they shall be removed and inspected. The connectors shall be mated and unmated one cycle to insure mateability and to remove free salt deposits.

6.18 Durability

The mating 81511 type connectors shall be subjected to 500 cycles of mating and unmating at a maximum rate of 300 cycles per hour. The Stub "E" connectors will be similarly subjected to 200 cycles. The coupling mechanism will be operated in a manner to simulate actual service operation. The connectors shall show no mechanical or electrical defects detrimental to the operation of the connector.

6.19 Temperature Life

The mated connectors shall be subjected to a temperature of 175°C for a period of 1000 hours. At the end of 1000 hours, while at 175°C, the insulation resistance shall be measured as specified in 6.4 except that all measurements shall be in excess of 200 megohms.

6.20 Fluid Immersion

6.20.1 Hydraulic Oil MIL-H-5606

The unmated connectors shall be immersed in the hydraulic oil at room temperature for 20 hours. The parts shall be allowed to drain for 1 hour at room temperature prior to being subjected to the subsequent tests.

6.20.2 Lubricating Oil MIL-L-23699

The unmated connectors shall be tested as in 6.20.1 except that MIL-L-23699 lube oil shall be used.

6.21 Insert Retention (81511 only)

The inserts in the 81511 type connector shells shall have axial loads applied to their mating faces at a rate of approximately 10 lb/sec until a load equivalent to 75 psig is reached. This load shall be retained for a period of 10 to 15 seconds without becoming dislodged.

6.22 Final Examination of Product

At the completion of testing, the connectors shall be examined for general condition and damage considered to be abnormal for the tests to which the connectors have been exposed.

7.0 Test Report

A test report shall be written at the completion of testing which is to include all pertinent test information, copies of original test data and conclusions. The report shall be written in standard Bendix/ECD Engineering Laboratory Report format. Three copies of this report will be supplied to USAECOM, Fort Monmouth, New Jersey.

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8.0 Equipment List

The following equipment or suitable equivalent will
be used in performing the foregoing tests:

Torque Fixture	Sturtevant	ICF-100-I
Torque Wrench	Sturtevant	M-5-1S
Torque Wrench	Sturtevant	M-25-1S
Torque Wrench	Sturtevant	M-50-1S
Megohm Bridge	General Radio	1644A
Automatic Connector	Bendix	F-1680
Tester		
High Voltage A.C.	Bendix	L-9947-25
Supply		
Universal Testing	Instron	TTC
Machine		
Thermal Shock Machine	Blue-M	WSP109C-3
Vibration Test System	M-B	C-20
Shock Test Machine	Consol. Vac.	3" Hyge
Humidity Chamber	Blue-M	FR-386
Circulating Air Oven	Blue-M	POM-206C
Cold Chamber	Murphy & Miller	LTF-4-120
Constant Current	Kepeco	KS-18-10M
Power Supply		
Digital Voltmeter	Hewlett Packard	3450A
Ammeter	Weston	931
Salt Spray Chamber	Ind. Filter &	411-1C
	Pump Co.	
Connector Durability	Bendix	44-76531
Machine		

Lewis A. Armitage
Engineering Laboratory

ds

Engineering Laboratory Report

12-5204

EVALUATION

BURNDY POSITIVE LOCKING

CONTACT INSERTION TOOLS

DATE OF TEST: 1.30.73 to 2.7.73

DATE OF REPORT: February 20, 1973

REPORTED BY: Robert H. Waghorn

APPROVED BY: Leonard A. Grant

APPROVED BY: DC Baker 2/19/73

NOTED BY: Gen. Swanson

WITNESSED BY: _____



**Electrical
Components
Division**

Sidney, N. Y. 13838

ENGINEERING LABORATORY REPORT 12-5204

I. PURPOSE

The purpose of this test is to evaluate a contact insertion tool that will indicate if the contact is locked into the retention mechanism of an electrical device and determine its suitability as a universal terminal insertion tool for applications such as the IWTS type connector.

II. CONCLUSIONS

- A. The tool satisfactorily performs the retention test on the wired contact when it is withdrawn from the connector after contact insertion.
- B. The tool release force was not significantly affected by changes in the wire type, insulation finish and the finished OD of the wire. The 28 AWG wire MS22759/11 did lower the tool release force to a point where the tool did not properly release the wire or recycle.
- C. The tools were easy to operate and are comfortable for the average size hand.
- D. Working volume available behind a mounted electrical device for circuit modification or repair has to be equivalent to a cylinder six inches in diameter and ten inches long. Access to this working area is another consideration.

III. RECOMMENDATIONS

- A. It is recommended that this type of insertion tool be utilized in electrical devices having "blind" insertions such as in the IWTS type connector.
- B. It is also recommended that individual tools be gauged and set to accommodate specific OD ranges, as in the case of the 28 AWG wire.

IV. ACTION TAKEN

None.

ENGINEERING LABORATORY REPORT 12-5204

V. DETAILED REPORT

Tools Submitted

One Burndy tool P/N RTM20D24 with tool release force set at 4.0 pounds, one Burndy tool P/N RTM20D24 modified with tool release force set for 1.8 to 2.3 pounds. The RTM20D24 tool was used with wire/contact combinations with Size 20 contacts. The modified tool was used with wire/contact combinations utilizing 22D contacts.

Sample Preparation

Fifteen pieces of each wire listed below and their corresponding pin and socket contacts were prepared and crimped using standard MS crimp tools. A pin and socket contact was put on opposite ends of each twelve inch length of MIL-W wire.

This list defines the size contact that shall be used in conjunction with each wire:

Table I

<u>Contact</u>	<u>Wire</u>	<u>Finished OD</u>	<u>Actual OD</u>
22D	M22759/11-28	.031-.035	.0335-.0345
	M16878/4-26	.035-.043	.0375-.038
	M81381/1-26	.034-.040	.0345-.0355
	M22759/9-26	.046-.050	.0465-.0485
	M81044/4-24	.038-.042	.040-.041
	M16878/4-24	.040-.048	.044-.045
	M16878/4-22	.046-.054	.049-.050
	M81381/1-22	.043-.050	.045-.047
20	M22759/7-24	.060-.064	.062-.066
	M16878/4-24	.040-.048	.044-.045
	MIL-W-5086A-22	.064-.072	.068-.070
	M22759/7-22	.071-.075	.0725-.074
	M81381/1-22	.043-.050	.045-.047
	MIL-W-5086A-20	.074-.082	.075-.0765
	MIL-W-22759		
	MS18104-20	.056-.060	.0585-.0595
	M22759/7-20	.080-.084	.0815-.0835
	M22759/11-20	.056-.060	.0585-.0595
	M81044/12-20	.053-.057	.053-.054

ENGINEERING LABORATORY REPORT 12-5204

V. DETAILED REPORT (Continued)

Test Procedures and Results

Tests were performed following the outline of L-15081-92, Rev A, as modified by Burndy's letter dated 11/24/72.

A. Tool Release Force

Measurement of tool release force per wire type was measured using the Chatillon Automatic Force Measuring Device. An axial force was applied to the insertion tool to simulate a rate normally used when removing an insertion tool after inserting a contact into a connector. Every attempt was made to insure that the pull was axial and not off center. A different wire/contact combination was used for each measurement. The pin and socket of each wire was checked and a total of ten release forces were measured and recorded on Data Sheets 1, 2 and 3 of Appendix A.

The tool instruction sheets list 4.0 pounds as the release force for the unmodified tool and a range of 1.8 to 2.3 pounds for the modified tool. In general, the unmodified tool exhibited forces less than the 4.0 pounds indicated. The modified tool fared better with the range provided, but still had release forces of less than 1.8 pounds.

The modified tool did not complete its operational cycle (reset) on the first five wire/contact (28 AWG) combinations. The grip jaw area was blown off with approximately 90 psig of filtered air to clean the grips and possibly dislodge any foreign matter causing the malfunction. The tool seemed to perform satisfactorily throughout this phase of testing. The release and reset functioned as designed.

B. Tool Damage

The wire/contact samples used in the Tool Release Force test were inspected using a 12 power microscope. Examination for tool damage was of the area where the grip jaws secured the OD of the insulation. The general area was 2 to 2-1/4 inches and 3 to 3-1/4 inches back on the wire with respect to the crimp shoulder of the Size 20 and 22D contacts respectively. Only the slightest irregularity of the insulation OD was visible at 12 power and there was no apparent damage. This irregularity is more easily detected by moving a fingernail over the area in question.

ENGINEERING LABORATORY REPORT 12-5204

V. DETAILED REPORT (Continued)

Attention was also paid to the magnitude of creepage of the insulation away from the contact crimp well. There was no evidence of insulation creepage.

C. Crimp Tensile

Five each of the listed wire/contact combinations were tested for crimp joint strength. The contacts at both ends of the wire were tested separately at a pull rate of one inch/minute. The five wire/contact combinations of the Tool Release Force test were also tested in a like manner. Comparison of the data from the two samplings does not indicate a significant difference in crimp joint tensile strengths. See Appendix A, Data Sheets 4 through 8.

D. Tool Use

The last five of each wire/contact combination were used to subjectively evaluate tool feel and ease of handling when inserting contacts into connectors. This was done in conjunction with the operator's past experience with other types of insertion and removal tools and mainly the MS27509 plastic tools used on the Bendix JT-R (MIL-C-38999) connector and the MS3447 insert-extract plastic tool used with the Bendix PT-DRE (MIL-C-0026482F) connector.

Both Burndy tools were easy to handle. The operation to check positive locking of the contact seemed to be consistent and the mechanics smooth. The modified tool used on 22D contacts with the smaller finished OD wires did not function well until used on the wires with .040" or more. The tool has to perform two steps to ready the tool for a subsequent contact insertion. 1) It must perform the retention test to assure the contact is secured by the retention mechanism. 2) Simultaneously with the tool release, the grip jaws should snap open. The second function did not consistently occur when the tool was used with the wires having a finished OD of less than .040". Thus, the "no-cycle" button has to be employed before the insertion of another wired contact can be made.

Also, the minimum working volume required behind an electrical device in order to easily operate this type of tool, insert a contact and withdraw the tool conveniently, was determined in the following manner.

ENGINEERING LABORATORY REPORT 12-5204

V. DETAILED REPORT (Continued)

This is also dependent on the accessibility of the item to be modified or repaired. The diameter of the working area for one's hand on the tool and the ability to place the hand in a position to place the wired termination into the tool is approximately six inches. The tool with a wired termination is approximately ten inches in length. Hence, this working volume needs to be the shape of a cylinder ten inches long and six inches in diameter.

VI. REFERENCES

CLT 3282, ECL-0538-92 to -95, ECL-0538B-25 to -32
L-15081-92, Rev A (Bendix Procedure)
Letter dated 11/14/72, J.D. Anderson to D.H. Gould (Burndy to Bendix)

ENGINEERING LABORATORY REPORT 12-5204

APPENDIX A
DATA SHEETS

LABORATORY DATA SHEET

TEST TOOL RELEASE FORCE				DATE OF TESTS 1.29 & 30.73		REPORT NUMBER 12-5201	
TEST SPECIMEN (S) BURNDY TOOL P/N RTM20D24 W/ WIRE				TEMP 74°F	R.H. 34%	ECL05388-25	
CONTACTS AS LISTED				LT. 3282	SPEC.	PARA.	
TEST EQUIPMENT CHATILLON AUTOMATIC FORCE MEASURING DEVICE E-4511		CAL. DATE PRIOR TO USE		DUE DATE		SPEC. LIMITS	
DAYTRONIC MODEL 300D T.A.I		10.31.72		3.25.73		TEST CONDITIONS ROOM AMBIENT. TOOL RELEASE SET @ 4 LBS.	
TRANSDUCER AMPLIFIER INDICATOR F-1536		12.7.72		3.6.73			
HONEYWELL ELECTRONIC A RECORDER F-1366		1.18.73		2.8.73			
OHAUS STD-A-WEIGH SET PG 1008							

M22759/1-24		M16878/1-24		MIL-W-5086 I-22		M22759/7-22	
TOOL RELEASE FORCE IN POUNDS		TOOL RELEASE FORCE IN POUNDS		TOOL RELEASE FORCE IN POUNDS		TOOL RELEASE FORCE IN POUNDS	
SIZE 20 PINS 1	3.85	SIZE 20 PINS 1	3.65	SIZE 20 PINS 1	4.1	SIZE 20 PINS 1	3.7
2	3.65	2	3.55	2	4.05	2	3.65
3	3.65	3	3.6	3	4.0	3	3.6
4	3.7	4	3.55	4	4.1	4	3.95
5	3.85	5	3.6	5	4.1	5	3.7
SIZE 20 SOCKETS 1	3.75	SIZE 20 SOCKETS 1	3.45	SIZE 20 SOCKETS 1	4.0	SIZE 20 SOCKETS 1	3.65
2	3.85	2	3.55	2	4.15	2	3.7
3	3.75	3	3.45	3	4.3	3	3.85
4	3.7	4	3.6	4	4.0	4	3.7
5	3.6	5	3.8	5	4.05	5	3.65
$\bar{X}$	3.74	$\bar{X}$	3.58	$\bar{X}$	4.09	$\bar{X}$	3.67
$\bar{X} + 3\sigma$	4.0	$\bar{X} + 3\sigma$	3.87	$\bar{X} + 3\sigma$	4.35	$\bar{X} + 3\sigma$	3.95
$\bar{X} - 3\sigma$	3.47	$\bar{X} - 3\sigma$	3.29	$\bar{X} - 3\sigma$	3.82	$\bar{X} - 3\sigma$	3.38

M1381/1-22		MIL-W-5086 I-22		MIL-W-22754 MS18104-20		M22759/7-20	
T.R.F. IN POUNDS		T.R.F. IN POUNDS		T.R.F. IN POUNDS		T.R.F. IN POUNDS	
SIZE 20 PINS 1	3.2	SIZE 20 PINS 1	4.45	SIZE 20 PINS 1	3.25	SIZE 20 PINS 1	4.25
2	3.25	2	4.25	2	4.05	2	3.85
3	3.25	3	4.15	3	3.85	3	3.9
4	3.5	4	4.2	4	3.8	4	3.8
5	3.4	5	4.05	5	3.8	5	3.95
SIZE 20 SOCKETS 1	3.3	SIZE 20 SOCKETS 1	4.05	SIZE 20 SOCKETS 1	3.8	SIZE 20 SOCKETS 1	4.1
2	3.25	2	4.05	2	4.0	2	3.9
3	3.3	3	4.15	3	3.95	3	4.1
4	3.95	4	4.2	4	4.05	4	4.05
5	3.5	5	4.1	5	3.95	5	4.15
$\bar{X}$	3.34	$\bar{X}$	4.17	$\bar{X}$	3.85	$\bar{X}$	4.01
$\bar{X} + 3\sigma$	3.66	$\bar{X} + 3\sigma$	4.51	$\bar{X} + 3\sigma$	4.51	$\bar{X} + 3\sigma$	4.42
$\bar{X} - 3\sigma$	3.02	$\bar{X} - 3\sigma$	3.82	$\bar{X} - 3\sigma$	3.19	$\bar{X} - 3\sigma$	3.59

REF. ECL0538-93 & 94.	 Electrical Components Division Sidney, New York 13838	TESTED BY R.D. WAGHORN
		APPROVED BY 
		WITNESSED BY

[illegible]

LABORATORY DATA SHEET

TEST TOOL RELEASE FORCE				DATE OF TESTS 1. 29 30.73		REPORT NUMBER 12-52.09	
TEST SPECIMEN (S) BURNBY TOOL P/N RTN20D24 MODIFIED, W/				TEMP. 74°F. R.H. 34%		ECL05388-27	
WIRED CONTACTS AS LISTED				LT. 3282		SPEC. _____ PARA. _____	
TEST EQUIPMENT CHATILLON AUTOMATIC		CAL DATE		DUE DATE		SPEC. LIMITS	
FORCE MEASURING DEVICE E-4511		PRIOR TO USE					
DAYTRONIC MODEL 300D T.A. I		10.31.72		4.25.73		TEST CONDITIONS	
TRANSDUCER AMPLIFIER INDICATOR F-1536		12.7.72		3.6.73		ROOM AMBIENT.	
HONEYWELL ELECTRONIC 19 RECORDER F-1366		1.18.73		2.8.73		TOOL RELEASE SET @ 2 LBS.	
OHAUS STD-A-WEIGH SET PG 1008						1.8 TO 2.3 LBS.	

MS22759/11-23 TOOL RELEASE FORCE IN POUNDS		M16878/4-26 T.R.F. IN POUNDS		M81381/1-26 T.R.F. IN POUNDS		M22759/4-26 T.R.F. IN POUNDS	
SIZE 22D PINS 1	1.65	SIZE 22D PINS 1	2.15	SIZE 22D PINS 1	1.7	SIZE 22D PINS 1	2.0
2	1.7	2	2.0	2	1.7	2	1.95
3	1.5	3	2.05	3	1.75	3	2.15
4	1.35	4	1.95	4	1.75	4	2.0
5	1.95	5	2.0	5	1.75	5	1.95
SIZE 22D SOCKETS 1	1.65	SIZE 22D SOCKETS 1	2.0	SIZE 22D SOCKETS 1	1.75	SIZE 22D SOCKETS 1	1.9
2	1.55	2	1.85	2	1.75	2	2.0
3	1.55	3	2.0	3	1.75	3	2.05
4	1.5	4	2.0	4	1.75	4	2.0
5	1.7	5	1.9	5	1.75	5	1.9
$\bar{X}$	1.56		1.99		1.74		1.99
$\bar{X} + 3\sigma$	1.89		2.22		1.80		2.20
$\bar{X} - 3\sigma$	1.23		1.76		1.68		1.78

M81044/4-24 T.R.F. IN POUNDS		M16878/4-24 T.R.F. IN POUNDS		MIL-W-16874 4-22 T.R.F. IN POUNDS		M81381/1-22 T.R.F. IN POUNDS	
SIZE 22D PINS 1	1.8	SIZE 22D PIN 1	2.0	SIZE 22D PINS 1	2.1	SIZE 22D PINS 1	1.6
2	1.8	2	1.85	2	1.9	2	1.6
3	1.8	3	1.9	3	1.9	3	1.9
4	1.9	4	1.9	4	1.85	4	1.6
5	1.9	5	1.85	5	1.8	5	2.15
SIZE 22D SOCKETS 1	1.85	SIZE 22D SOCKETS 1	1.9	SIZE 22D SOCKETS 1	2.0	SIZE 22D SOCKETS 1	1.6
2	1.9	2	1.9	2	1.95	2	1.55
3	1.95	3	1.85	3	1.95	3	1.65
4	1.8	4	1.9	4	1.9	4	1.95
5	1.85	5	1.95	5	1.9	5	1.75
$\bar{X}$	1.86		1.90		1.93		1.74
$\bar{X} + 3\sigma$	2.01		2.03		2.16		2.30
$\bar{X} - 3\sigma$	1.70		1.77		1.69		1.166

REF. ECL0538-93E-99.	 Bendix Electrical Components Division Sidney, New York 13838	TESTED BY R.D. WASHORN
		APPROVED BY <i>Jalk</i>
		WITNESSED BY

LABORATORY DATA SHEET

TEST CRIMP TENSILE		DATE OF TESTS 2.1 to 2.5.73		REPORT NUMBER 12-5204
TEST SPECIMEN (S) WIRE/CONTACT COMBINATIONS AS LISTED.		TEMP 74°F.	R.H. 34%	ECL05388-28
		LT. 3282	SPEC.	PARA.
TEST EQUIPMENT INSTRON	PG1050	CAL. DATE 8.25.72	DUE DATE 2.25.73	SPEC. LIMITS
INSTRON	PG1077	10.17.72	4.17.73	TEST CONDITIONS ROOM AMBIENT. CRIMP TENSILE FORCES IN LBS. RATE OF 1in/MIN.

MIL-W-22759/7-29	T.R.F. SAMPLES CRIMP TENSILE IN POUNDS	CRIMP TENSILE SAMPLES IN POUNDS		MIL-W-22759/4-29	T.R.F. SAMPLES CRIMP TENSILE IN POUNDS	CRIMP TENSILE SAMPLES IN POUNDS	
SIZE 20 PINS				SIZE 20 PINS			
1	10.4 WBC	12.9 WB		1	11.2 WBC	11.3 WBC	
2	11.2 WBC	9.5 WBC		2	11.0 "	11. "	
3	9.0 WBC	11.3 "		3	10.7 "	11.3 "	
4	10.6 WBC	10.8 "		4	10.9 "	10.5 "	
5	10.0 "	12.9 WB		5	10.5 "	11.3 "	
SIZE 20 SOCKETS				SIZE 20 SOCKETS			
1	12.2 "	10.8 WBC		1	11.2 "	11.5 "	
2	12.4 "	12.8 WB		2	10.8 "	12.0 "	
3	11.2 "	11.0 WBC		3	12.0 "	11.6 "	
4	11.2 "	11.8 "		4	11.6 "	12.0 "	
5	12.7 "	11.1 "		5	10.8 "	11.0 "	
X	11.09	11.49		X	11.07	11.35	
X+3σ	14.36	14.66		X+3σ	12.35	12.66	
X-3σ	7.82	8.33		X-3σ	9.79	10.04	
MIL-W-20861-22	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES		MIL-W-22759/7-22	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES	
SIZE 20 PINS				SIZE 20 PINS			
1	21.5 WBC	21.0 WBC		1	20.0 WBC	20.0 WB	
2	21.5 "	21.0 "		2	20.5 "	20.0 "	
3	21.5 "	21.5 "		3	20.5 WB	20.0 "	
4	22.0 "	21.5 "		4	20.0 WBC	20.5 "	
5	19.5 "	21.0 "		5	20.0 WBC	20.0 WBC	
SIZE 20 SOCKETS				SIZE 20 SOCKETS			
1	22.0 "	21.0 "		1	20.0 WB	20.0 WB	
2	21.0 "	21.5 "		2	20.5 "	20.5 "	
3	18.0 "	21.0 "		3	20.0 "	20.5 "	
4	20.5 "	21.0 "		4	20.5 "	20.5 "	
5	21.5 "	22.0 "		5	20.0 "	20.0 "	
X	20.90	21.25		X	20.2	20.2	
X+3σ	24.50	22.26		X+3σ	20.94	20.94	
X-3σ	17.30	20.24		X-3σ	19.47	19.47	

REF.
ECL0538-93 & -94.
WB - WIRE BROKE.
WBC - " " AT CRIMP.
WPO - " PULLED OUT.



Electrical
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Sidney, New York 13838

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LABORATORY DATA SHEET

TEST CRIMP TENSILE				DATE OF TESTS 2.17 to 2.5.73		REPORT NUMBER 12-5201	
TEST SPECIMEN (S) WIRE/CONTACT COMBINATIONS AS LISTED.				TEMP 74°F	R.H. 34%	ECL 0538B-29	
				SPEC.	PARA.		
				LT. 3282			
TEST EQUIPMENT		CAL. DATE	DUE DATE	SPEC. LIMITS			
INSTRON PG 1050		8.25.72	2.25.73				
INSTRON PG 1077		10.17.72	4.17.73	TEST CONDITIONS ROOM AMBIENT. CRIMP TENSILE FORCES IN LBS. PULL RATE 1 IN./MIN.			

MIL-W-22754/1-22	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES		MIL-W-22754 TYPE I-20	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES	
SIZE 20 PINS				SIZE 20 PINS			
1	19.0 WBC	19.5 WBC		1	34.5 WBC	35.5 WBC	
2	18.5 "	19.0 "		2	35.5 "	36.5 "	
3	19.0 "	17.5 "		3	32.5 "	36.0 "	
4	18.5 "	19.0 "		4	34.5 "	36.5 "	
5	19.0 "	18.0 "		5	36.5 "	36.0 "	
SIZE 20 SOCKETS				SIZE 20 SOCKETS			
1	18.0 "	18.0 "		1	36.0 "	36.0 "	
2	19.0 "	18.5 "		2	35.5 "	36.5 "	
3	17.5 "	19.5 "		3	35.5 "	37.0 "	
4	17.0 "	17.5 "		4	34.5 "	36.5 "	
5	17.0 "	18.5 "		5	35.5 "	37.5 "	
$\bar{X}$	18.25	18.50		$\bar{X}$	35.05	36.40	
$\bar{X} + 3\sigma$	20.60	20.62		$\bar{X} + 3\sigma$	38.23	38.02	
$\bar{X} - 3\sigma$	15.90	16.38		$\bar{X} - 3\sigma$	31.87	34.78	
MIL-W-22754/1-22	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES		MIL-W-22754/1-22	T.R.F. SAMPLES CRIMP TENSILE	CRIMP TENSILE SAMPLES	
SIZE 20 PINS				SIZE 20 PINS			
1	33.5 WBC	31.5 WBC		1	30.5 WBC	31.0 WBC	
2	31.0 "	32.5 "		2	28.5 "	30.5 "	
3	31.0 "	32.5 "		3	30.5 "	30.5 "	
4	30.5 "	31.5 "		4	30.5 "	31.5 "	
5	30.5 "	31.5 "		5	31.5 "	32.0 "	
SIZE 20 SOCKETS				SIZE 20 SOCKETS			
1	32.5 "	33.0 "		1	31.0 "	31.0 "	
2	32.5 "	33.5 "		2	31.5 "	31.5 "	
3	33.0 "	33.0 "		3	32.0 "	32.0 "	
4	32.5 "	33.5 "		4	31.5 "	31.0 "	
5	32.5 "	32.5 "		5	32.0 "	32.5 "	
$\bar{X}$	31.95	32.50		$\bar{X}$	30.95	31.15	
$\bar{X} + 3\sigma$	35.06	34.73		$\bar{X} + 3\sigma$	33.91	33.23	
$\bar{X} - 3\sigma$	28.84	30.28		$\bar{X} - 3\sigma$	27.99	29.02	

REF.
ECL0538-934-94
WB-WIRE BROKE
WBC- " " AT CRIMP
WPO- " PULLED OUT.



Electrical
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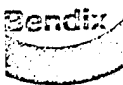
Sidney, New York 13838

TESTED BY R. D. WAGHORN

APPROVED BY
WITNESSED BY

[illegible]

LABORATORY DATA SHEET

TEST CRIMP TENSILE				DATE OF TESTS 2.17.2.5.73		REPORT NUMBER 12-5201	
TEST SPECIMEN (S) WIRE/CONTACT COMBINATIONS AS LISTED				TEMP. 79°F		R.H. 34%	
				SPEC. 3282		ECL05385-31	
				LT. 3282		PARA.	
TEST EQUIPMENT INSTRON		CAL. DATE 8.25.72		DUE DATE 2.25.73		SPEC. LIMITS	
PG 1077		10.17.72		4.17.73		TEST CONDITIONS ROOM AMBIENT. CRIMP TENSILE FORCES IN LBS. PULL RATE 1 IN./MIN.	
4322159/11-28		T.R.F. SAMPLES CRIMP TENSILE		416818/4-26		T.R.F. SAMPLES CRIMP TENSILE	
SIZE 22D PINS		CRIMP TENSILE SAMPLES		SIZE 22D PINS		CRIMP TENSILE SAMPLES	
1		3.2 WBC		1		8.9 WBC	
2		4.0 "		2		8.5 "	
3		3.1 "		3		8.3 "	
4		4.3 "		4		8.1 "	
5		4.1 "		5		9.0 "	
SIZE 22D SOCKETS		CRIMP TENSILE		SIZE 22D SOCKETS		CRIMP TENSILE	
1		4.9 "		1		8.5 "	
2		3.2 "		2		8.8 "	
3		4.2 "		3		9.0 WBC	
4		3.2 "		4		8.7 WBC	
5		4.6 "		5		8.3 "	
$\bar{X}$		3.83		$\bar{X}$		8.71	
$\bar{X}+3\sigma$		5.50		$\bar{X}+3\sigma$		9.91	
$\bar{X}-3\sigma$		2.16		$\bar{X}-3\sigma$		7.51	
4322159/11-28		T.R.F. SAMPLES CRIMP TENSILE		422754/4-26		T.R.F. SAMPLES CRIMP TENSILE	
SIZE 22D PINS		CRIMP TENSILE		SIZE 22D PINS		CRIMP TENSILE	
1		6.8 WBC		1		6.5 WBC	
2		7.6 "		2		6.6 "	
3		7.1 "		3		7.0 "	
4		8.3 "		4		7.2 "	
5		7.6 "		5		7.3 "	
SIZE 22D SOCKETS		CRIMP TENSILE		SIZE 22D SOCKETS		CRIMP TENSILE	
1		8.0 "		1		7.7 "	
2		7.7 "		2		5.9 "	
3		6.1 "		3		6.9 "	
4		7.9 "		4		7.7 "	
5		6.4 "		5		6.3 "	
$\bar{X}$		7.35		$\bar{X}$		6.91	
$\bar{X}+3\sigma$		9.40		$\bar{X}+3\sigma$		8.59	
$\bar{X}-3\sigma$		5.29		$\bar{X}-3\sigma$		5.23	
REF.		ECL0538-934-94.		Bendix		Electrical Components Division	
WB - WIRE BROKE.		" AT CRIMP.				TESTED BY R.D. WAGHORN	
WBC - " " PULLED OUT.				Sidney, New York 13838		APPROVED BY	
						WITNESSED BY	

LABORATORY DATA SHEET

TEST CRIMP TENSILE				DATE OF TESTS 2/1 to 2.5.73		REPORT NUMBER 12-5204	
TEST SPECIMEN (S) WIRE/CONTACT COMBINATIONS AS LISTED				TEMP. 74°F.		R.H. 34%	
				LT. 3282		SPEC. PARA.	
TEST EQUIPMENT INSTRON		PG 1050		CAL. DATE 8.25.72		DUE DATE 2.25.73	
INSTRON		PG 1077		10.17.72		4.17.73	
				TEST CONDITIONS ROOM AMBIENT CRIMP TENSILE FORCES IN LBS. PULL RATE 1 IN./MIN.			
MB1044/4-24 T.R.F. SAMPLES CRIMP TENSILE				MB678/4-24 T.R.F. SAMPLES CRIMP TENSILE			
CRIMP TENSILE SAMPLES				CRIMP TENSILE SAMPLES			
SIZE 22D PINS				SIZE 22D PINS			
1 13.1 WBC 9.8 WBC				1 12.3 WBC 12.6 WBC			
2 12.0 " 13.0 "				2 11.0 " 12.9 "			
3 12.3 " 10.1 WPO				3 12.2 " 12.4 "			
4 10.2 " 13.7 WBC				4 12.3 " 11.8 "			
5 12.6 " 12.9 "				5 12.9 " 12.5 "			
SIZE 22D SOCKETS				SIZE 22D SOCKETS			
1 11.0 " 10.6 "				1 11.8 " 12.4 "			
2 11.9 " 11.6 "				2 12.6 WB 12.8 "			
3 12.9 " 12.0 "				3 12.3 WBC 12.8 "			
4 13.0 " 13.0 "				4 12.5 " 12.9 "			
5 11.3 " 11.8 "				5 11.6 " 12.7 "			
X 12.03 11.85				X 12.15 12.15			
X+30 14.75 15.66				X+30 13.71 13.43			
X-30 9.31 8.05				X-30 10.59 11.63			
MB678/4-22 T.R.F. SAMPLES CRIMP TENSILE				MB1381/1-22 T.R.F. SAMPLES CRIMP TENSILE			
CRIMP TENSILE SAMPLES				CRIMP TENSILE SAMPLES			
SIZE 22D PINS				SIZE 22D PINS			
1 19.5 WBC 20.0 WBC				1 18.0 WBC 16.0 WPO			
2 19.5 " 20.0 "				2 19.5 WB 19.5 WB			
3 20.5 " 19.5 "				3 19.0 WBC 20.0 "			
4 19.5 " 20.0 "				4 19.0 " 17.5 WBC			
5 20.5 WB 18.5 "				5 19.0 WB 19.0 WBC			
SIZE 22D SOCKETS				SIZE 22D SOCKETS			
1 19.5 WBC 19.5 "				1 19.5 WBC 19.5 "			
2 19.0 " 18.0 "				2 18.5 " 17.5 "			
3 18.5 " 18.5 "				3 17.0 " 16.5 "			
4 19.0 " 19.0 "				4 18.5 " 19.0 "			
5 17.5 " 18.5 "				5 19.0 " 18.5 "			
X 19.30 19.15				X 18.70 17.8			
X+30 21.83 21.28				X+30 20.84 22.74			
X-30 16.71 17.02				X-30 16.56 12.86			
REF. ECL0538-934-94. WB - WIRE BROKE. WBC - " " AT CRIMP. WPO - " PULLED OUT.				Bendix Electrical Components Division Sidney, New York 13838		TESTED BY R.D. WAGHORN APPROVED BY WITNESSED BY	

[illegible][illegible]

CONTACT INSERTION TOOLS

THE BENDIX CORPORATION
ELECTRICAL COMPONENTS DIVISION
SIDNEY, NEW YORK

1.0 Scope

The purpose of this procedure is to establish the Bendix/ECD Engineering Laboratory's evaluation methods and tests that will be used to determine the suitability of the Burndy positive locking contact insertion tools and to establish a common reference for all interested parties.

2.0 Test Agency

All tests described herein will be performed at and by the Engineering Laboratory, Electrical Components Division, The Bendix Corporation, Sidney, New York 13838.

3.0 Test Samples

3.1 Tools

Two typical tools, Burndy No. RTM20D24MOD and RTM20024, shall be submitted for test. These tools shall be used to evaluate the design of the subject tool and determine their suitability as a universal insertion tool for the IWTS connector.

3.2 Wire & Connectors

3.2.1 Connectors

Standard Bendix JT type connectors which are designed for the following size contacts shall be used:

22D
22
20

This is because the terminal and retention system used for the IWTS connector is that of the standard JT connector.

3.2.2 Wire

The following list of MIL-W wire shall be prepared in twelve (12) inch lengths. This list defines the size contact that shall be used in conjunction with each wire:

Table I

<u>Contact</u>	<u>Wire</u>	<u>Finished OD</u>
22D	M22759/11-28	.031-.035
	M16878/4-26	.035-.043
	M81381/1-26	.034-.040

<u>Contact</u>	<u>Wire</u>	<u>Finished OD</u>
22D	M22759/9-26	.046-.050
	M81044/4-24	.038-.042
	M16878/4-24	.040-.048
	M16878/4-22	.046-.054
	M81381/1-22	.043-.050
22	M22759/9-26	.046-.050
	M16878/4-26	.035-.043
	M81381/1-26	.034-.040
	M16878/4-24	.040-.048
	M81044/4-24	.038-.042
20	M16878/4-22	.046-.054
	M81381/1-22	.043-.050
	M22759/7-24	.060-.064
	M16878/4-24	.040-.048
	MIL-W-5086A-22	.064-.072
	M22759/7-22	.071-.075
	M81381/1-22	.043-.050
	MIL-W-5086A-20	.074-.082
	MIL-W-22759	
	MS18104-20	.056-.060
	M22759/7-20	.080-.084
	M22759/11-20	.056-.060
	M81044/4-20	.054-.062

At least 15 pieces of each wire shall be prepared. There will be a corresponding number of contacts.

3.2.3 Preparation

Each of the above wires and corresponding contacts, pins, will be prepared and crimped using standard MS tools. A contact will be put on each end of the above wires.

4.0 Testing

The tests shall consist of subjecting each contact/wire to the tests outlined in Table II. The tests shall be performed on each contact/wire sample in the sequence listed. Unless otherwise specified, all tests shall be performed under prevailing room ambient conditions which can fall anywhere within the following ranges:

Temperature 15° to 35°C (59° to 95°F)
Relative Humidity 30 to 90%
Barometric Pressure 650 to 800 Torr

Table II

	Examination of Product	5.1
I	Tool Release Force	5.2
II	Tool Damage	5.3
III	Crimp Tensile	5.4
IV	Tool Use	5.5
V	Contact Insertion Forces	5.6

5.0 Test Methods

Unless otherwise specified or directed, the tests of Table II shall be performed as described using the equipment listed herein or Engineering approved equivalent. All data/measurements shall be recorded on standard laboratory data sheets. In all cases, the instruction sheets for each tool shall be strictly followed.

5.1 Examination of Product

All wires shall be inspected for nicks resulting from stripping and any damage to the insulation that would compromise the operation of the tool or physical characteristics of the contact/wire crimp joint.

5.2 Tool Release Force

The release force of each tool shall be measured on the Instron at .1, 1, and 10 inch/minute. Steel wire, appropriately grit blasted, of 20, 18, 16, 14 and 12 gage shall be used. Each reading shall be repeated five (5) times and averaged. If the results from the steel wire prove to be unreliable or not repeatable, M16878/4 wire of 20 and 22 AWG in the -24 and -24 MOD tool shall be used. Each time the tool is used with the M16878/4 wire, a new section of the wire shall be placed under the gripper. Every attempt shall be made to see that the pull is axial and not off center.

5.3 Tool Damage

Five samples of the wire listed in Table I shall be subjected to the same tensile test as above. The RTM20D24 tool shall be used with the 20 gage wired contacts and the MOD tool shall be used with the size 22 and 22D contacts. The results obtained shall be statistically compared to the results from Para. 5.2 above. The wires shall also be inspected for tool damage to the wire and the location of the damage with respect to the crimp shoulder of the contact. Attention shall also be paid to the magnitude of insulation creepage away from contact crimp well. This shall be measured for later analysis.

5.4 Contact Tensile

Using the Instron at 1 inch/minute, the crimp tensile of five wires of each contact/wire combination in Table I shall be measured. Both contacts on each end of the wire shall be pulled. The five contact/wire combinations tested in Para. 5.3 shall also be tested. The results shall be statistically compared for significant differences.

5.5 Tool Use

Selecting 5 of each contact/wire combinations from Table I, a subjective evaluation of tool feel and ease of handling shall be made. This will be made in conjunction with the present standard JT-R plastic tools. A determination shall also be made of the minimum working volume required behind the connector in order to insert the contact and withdraw the tool.

5.6 Contact Insertion Force

In conjunction with the evaluation of Para. 5.5, the force necessary to install the tool and contact into the connectors shall be measured. The force necessary to remove the tool shall also be measured. A tensile/compression load cell and a strip chart recorder with the appropriate load cell amplifier shall be used. The force required to seat the contact-tool combination shall be measured first. As the tool is withdrawn, the force necessary to remove it will be recorded.

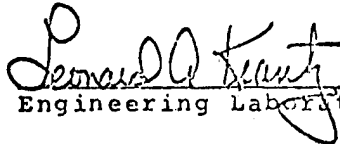
There will be several cavities with no or permanently damaged clips in the connectors so that the contact cannot be locked in place. The force necessary to remove the contact and tool shall be measured. Special attention shall be paid as to whether the grommet interference on the tool tip and contact is enough to pull the contact out of the tip by forcing the release mechanism to function. The force necessary to pull the tool tip and contact from the grommet shall be measured by removing the tool from the tip and pulling on the wire of the contact. A third force shall be measured, and that is the force necessary to remove the contact and an appropriate removal tool from the grommet. Install the removal tool, release the contact, and pull on the wire. All three forces shall be compared to determine if the release force on the tool is enough to determine if a contact is properly locked in place and if the contact is not locked, that the force is adequate to remove the unlocked contact and not leave it in the grommet. Also, a comparison shall be made as to the effect of wire insulation on the above.

5.7 Final Report

A final report shall be submitted; one good quality reproducible copy to Signal Corps for their approval. This report shall contain:

- 1) Title Page
- 2) Purpose
- 3) Conclusions
- 4) Recommendations
- 5) Action Taken
- 6) Details
- 7) References
- 8) Appendices W/All Data Sheets

This report shall be written in accordance with standard Bendix-ECD Engineering Laboratory procedures. Bendix/ECD judgements of the test results will appear in the Conclusions and Action Taken sections of the report which shall be subject to the acceptance and approval of the Signal Corps.


Engineering Laboratory



November 14, 1972

Bendix Corp.
Electrical Components Div.
Sidney, New York 13838

Attention: Mr. Donald H. Gould

Subject: Approval - Evaluation, Burndy Positive Locking Contact
Insertion Tools

Gentlemen:

We have reviewed document L-15081-92 Rev. A, Evaluation, Burndy Positive Locking Contact Insertion Tools and have the following comments:

5.2 Tool Release Force

"The release force of each tool shall be measured on the Instron at .1, 1, and 10 inch/minute. Steel wire, appropriately grit blasted, of 20, 18, 16, 14 and 12 gage shall be used. Each

Comment: We advised previously against the use of steel wire. Since that time we have experimented further with actuating the tool on bare steel wire and have determined beyond any doubt that the gripping jaws are damaged. The performance of the tool is rendered un-acceptable by use on steel wire. The gripping jaws, gripper slide angle, spring forces, etc., have been developed for proper performance on insulated electrical wire of the types specified for the contacts accommodated by the tools. For gripping on steel wire these components would have to be changed considerably, which would render them unfit for use on insulated electrical wire.

Please remove the use of steel wire in the tools and use actual insulated wire (such as the M16878/4 you have indicated).

5.6 Contact Insertion Force

3rd and 4th sentences, 2nd paragraph - "Special attention shall be paid as to whether the grommet interference on the tool tip and contact is enough to pull the contact out of the tip by forcing the release mechanism to function. The force necessary to pull the tool tip and contact from the grommet shall be measured by removing the tool from the tip and pulling on the wire of the contact."

Comment: The forces measured in sentence 4 above will have no relevance to the operation of the tool. As we reported in our March 8, 1972 reply - - "It is important to understand that any push or pull forces acting on the insertion tip of the tool

November 14, 1972

are not transmitted to the tool mechanisms which control tensile pull and release of the contact wire. The insertion tip is held by the tool body and forces on it are transmitted directly to the tool body. The only exception to this are the frictional drag forces between the insertion tip inside diameter, the contact, and the wire. Provided the wire diameter does not exceed the I.D. of the insertion tip, these friction forces are minimal and have been accounted for in the force setting adjustment of the tool."

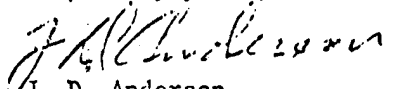
Put another way, the only means by which pulling forces can be transmitted from the insertion tip to the wire and contact, or vice-versa, is that small amount transmitted by the frictional resistance to the wire sliding inside the insertion tip. If you wish to determine the magnitude of this force it can be done in the following manner.

Solder, braze, or weld a small solid wire (or rod) to the nose of the contact. The wire or rod shall be small enough that it clears the retaining springs or grommets of the connector. A hole must be provided through the closed side in terminal block type connectors so that the wire or rod can feed straight through with no obstructions. Insert the contact into place into a cavity which has no clip (retention spring), leaving the insertion tip (removed from the tool) in its inserted position in the connector. Anchor the connector so that it does not move. Attach a force gage (A) to the solid wire or rod protruding from the nose of the contact. Pull with force gage (B) on the insertion tip so as to remove it from the connector cavity. Gage A will show the portion of the force B which is transmitted to the wire and contact due to friction.

Pulling the insertion tip out of the connector by pulling on the wire of the contact is a situation which cannot occur in the use of the Positive Locking Contact Insertion Tool. If this were done it could be expected that the thin front end of the insertion tip would be collapsed and spread by the contact shoulder, adding a great deal of resistance to removing the insertion tip from the cavity.

We have checked out the two tools and found them to be in good working order. They are being returned to your attention today.

Very truly yours,


J. D. Anderson
Engineering Manager
Installation Tool Products

cc: D. L. Pfendler, Bendix Corp.
H. Buttner
L. Tuck

Internal
Memorandum

Bondir Electrical
Components
Division

T73-35
Sidney, New York

Date January 26, 1973 Letter No.

To Messrs. D. Pfendler, D. Gould (2), A. Surdovel

From Mr. Walter E. Denny

Subject Dielectric Retention Mechanism on a Dummy Size 16 Contact

Ref: CLT3287, ECL0540 Pg. 97, ECL0540A-109-112

Purpose

To evaluate a dielectric retention clip that is an integral part of the contact.

Samples Submitted

9 Pcs. L-27758-108/109 Contact Clip Assembly (P-360 Material)
1 Pc. L-27758-125/127 Test Fixture

Conclusions

1. The data obtained on the limited amount of sampling and with the special test fixture, instead of a connector, showed that the dielectric retention system on a contact under these circumstances has a good potential.

Detailed Report

The forces required to insert the special dielectric retention size 16 dummy contact system in the test fixture was measured by use of the Instron. The force was applied at a steady rate of approximately 1 lb. per second until the system was completely seated in the test fixture. The peak force of inserting this contact was the force recorded on ECL0540A-109. Initial maximum forces measured on the nine submitted contacts was 8 1/4 lbs.

The force required to remove this dielectric contact system from the special fixture was also measured. The force required to insert the removal tool and release the contact was also measured by the use of the Instron and again the peak force was recorded. Maximum initial release force was 7 3/4 lbs. (ECL0540A-109).

The force, after the release of the retention system, to push the contact out of the special fixture was also measured using the same measuring system. The maximum initial pushout force was 4 3/4 lbs. All of the initial forces measured seemed to be reasonable and fairly consistent. See included Data Sheet ECL0540A-109 for individual forces.

The nine submitted dielectric retention contacts were subjected to 10 cycles of maintenance aging. The contact system was inserted in the test fixture, contacts were released from the fixture with the removal tool and the contacts were then removed from the fixture. The peak forces required to insert, release and remove the contact were measured on each cycle to note if the forces tended to increase or decrease. In most cases the force tended to decrease. In some

Internal
Memorandum

 **Electrical
Components
Division**
T73-35
Schenectady, New York

Date January 26, 1973 Letter No.

To Messrs. D. Pfendler, D. Gould(2), A. Surdovel

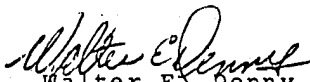
From Mr. Walter E. Denny

Subject Page 2

cases the outer shoulder of the contact dielectric retention system tended to shear and in other cases the shoulder rolled up. In the shear case the forces were lower but in the cases of the rolling effect, the forces increased or remained fairly high. Maximum insertion force in the 10th cycle was 8 1/2 lbs. The maximum removal force was 4 lbs. and the maximum contact pushout force was 3 lbs. All forces were 1 lb. or greater and all retention systems worked throughout the cycling.

Four contacts with the dielectric retention mechanisms were inserted into the special fixture. A load was applied to the contact until the retention system failed. In all cases, the outside shoulder of the retention system failed in the test fixture but the retention system still retained the contact. The loads ranged from 53 to 81 lbs.

Four contacts were subjected to a 30 lb. load and the displacement was measured while under the full load conditions. Maximum displacement was .007".


Walter E. Denny

ds

Attachments

[illegible]

TEST	MAINTENANCE AGE (Contact Insertion force)		DATE OF TESTS	1/3/73	TESTED BY	W.E. Denny	APPROVED BY	1/1/73	WITNESSED BY	REPORT NUMBER
TEST SPECIMEN(S)	1-27758-108/105 Contact/clip assembly		SPECIFICATION				PARA.		LT. NO.	TEMP & R.H.
TEST CONDITIONS	1-27758-108/105 Contact/clip assembly								3287	ECL 0576A-110
	TEST EQUIPMENT									EPL
	Instron									DATE DUE
	PG 105D									2/25/73
SPEC. LIMITS										
All forces in lbs										
CONTACT	2nd Insertion	3rd Insertion	4th Insertion	5th Insertion	6th Insertion	7th Insertion	8th Insertion	9th Insertion	10th Insertion	
1	10 lbs	7 lbs	4 1/2 lbs	4 1/2 lbs	5 1/2 lbs	6 1/2 lbs	6 1/2 lbs	6 1/2 lbs	6 1/2 lbs	2 3/4 lbs
2	6 3/4 lbs	6 lbs	5 1/4 lbs	6 3/4 lbs	7 lbs	6 1/2 lbs	4 3/4 lbs	4 1/4 lbs	3 lbs	3 lbs
3	6 1/2 lbs	5 1/2 lbs	3 lbs	4 1/4 lbs	2 3/4 lbs	4 3/4 lbs	4 lbs	2 3/4 lbs	2 3/4 lbs	2 3/4 lbs
4	6 3/4	5 1/4	6 3/4	6 3/4	6 1/2	5 1/2	3 3/4	3 3/4	3 3/4	3 3/4
5	4	4 1/4	5 1/2	4	8 1/2	7 1/2	7 1/2	7 1/4	4 3/4	4 3/4
6	8 1/4	3 1/2	6	3 1/2	6	8 1/4	6	7 3/4	5 3/4	5 3/4
7	5	3 3/4	8	3 3/4	6	4	3 1/4	6 1/2	3 1/2	3 1/2
8	9 1/4	8 1/4	7	5	9 3/4	7 1/2	6 1/4	8 1/2	8 1/2	8 1/2
9	6 1/4	3 1/4	5 1/4	4 1/4	7	5 1/2	3 1/4	3	3	3

LABORATORY DATA SHEET

Electrical Components Division

Sidney, New York 13838

72-355-1

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Battelle

Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201
Telephone (614) 299-1151
Telex 24-5454

March 17, 1972

Mr. A. J. Raffalovich
USAECON
Fort Monmouth, New Jersey 07703

Dear Mr. Raffalovich:

The following comments are offered in response to the "Engineering Accomplishment Report" dated January 10, 1972, on Contract Number DAAB07-71-C-0090, which listed nine conclusions that show disadvantages of the lusterless, conductive coating developed on Contract DAAB07-69-C-0360. As we discussed over the phone, we have had no contact with Bendix personnel and assume their knowledge of the process came from one or more of the Technical Reports. Comments from Bendix are intergrated with our response in the following list.

- (1) "The plating is adaptable only to flat surfaces."

During the program, shaped parts, including cable connectors, were successfully plated. No problems associated with shape occurred during the program.

- (2) "Barrel plating would not be possible."

Barrel plating was not investigated; therefore, it is not known if the process can be carried out by barrel plating. There is a reasonably good chance that a barrel-plating process could be devised. Based on our experience, both a lower current density and a higher pH might be needed for a barrel process.

- (3) "In order to plate round parts, the parts would have to be continually rotated in the plating bath."

Round parts about 1/4 and 1-1/2 inches were plated uniformly without rotation.

- (4) "The plating thickness used, 0.002 inch, is entirely too thick for connector applications. All threads would have to be heavily undercut."

The anodic pretreatment used to promote adhesion of nickel electroplates removed just enough metal so that threaded parts meshed after plating 0.002 inch of nickel. To provide good corrosion resistance and abrasion resistance, a substantial plate

March 17, 1972

thickness of about 0.002 inch is necessary. Good corrosion resistance was provided by the first 0.001 inch of plating, and good abrasion resistance was provided by the final 0.001 inch of the porous nickel.

- (5) "It would be doubtful that good adhesion, especially after thermal shock, would be obtained without having a zincate treatment prior to plating."

Good adhesion was obtained which resisted separation when the base metal was broken. Our experimental data show that the use of a zincate treatment sometimes gives good adhesion, but also promotes rapid lateral corrosion between the aluminum and the coating, leading to poor corrosion resistance.

- (6) "Its good abrasion and corrosion resistance is probably due to its heavy thickness."

The thickness of the first layer of dense nickel, about 0.001 inch, is not considered "heavy" for providing good corrosion resistance. ASTM-B-456-71 lists a nickel thickness of 0.001 to 0.0016 inch for protecting steel with nickel-chromium coatings. Thinner coatings do not provide good corrosion durability in corrosive environments.

- (7) "Its lubricity is probably a result of the inclusion of the carbon particles in the plating."

This conclusion may be valid. If so, the self-contained lubricant increases the resistance to abrasion of the lusterless, conductive coating.

- (8) "Problems would be encountered in plating blind holes, whether threaded or not."

Plating in blind holes is a recurring problem for any plating process. The new process developed on Contract DAAB07-69-C-0360 is similar to all prior-art nickel plating processes in this respect.

- (9) "In plating thickness common to connector parts (0.0002 inch), plated parts probably would not pass corrosion resistance tests."

This appears to be a valid statement. However, connectors plated with such a thin layer of nickel from any bath do not pass the combined requirements of low gloss, high conductivity, and good corrosion resistance. The new coating system was developed to meet all the requirements.

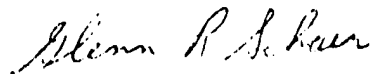
Mr. A. J. Raffalovich

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March 17, 1972

I hope these comments will supply you with the information you need. If not, please let us know and we will expand our discussion.

Sincerely,

A handwritten signature in cursive script, reading "Glenn R. Schaer".

Glenn R. Schaer
Project Leader
Electrochemical Engineering
Technology Division

GRS:nkd

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1. ORIGINATING ACTIVITY (Corporate author) The Bendix Corporation Electrical Components Division Sidney, New York 13838		2a. REPORT SECURITY CLASSIFICATION Unclassified	
		2b. GROUP	
3. REPORT TITLE Reliable Integrated Wire Termination Devices			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Technical Report - Final			
5. AUTHOR(S) (First name, middle initial, last name) Donald L. Pfendler Donald H. Gould			
6. REPORT DATE July 1973		7a. TOTAL NO. OF PAGES 202	7b. NO. OF REFS None
8a. CONTRACT OR GRANT NO. DAAB07-71-C-0090		9a. ORIGINATOR'S REPORT NUMBER(S)	
b. PROJECT NO. IF162203A119			
c. Task 35		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
d. Sub-Task 01		ECOM-0090-F	
10. DISTRIBUTION STATEMENT Approved for public release; distribution unlimited.			
11. SUPPLEMENTARY NOTES		12. SPONSORING MILITARY ACTIVITY U.S. Army Electronics Commnd. AMSEL-TL-ME Fort Monmouth, New Jersey	
13. ABSTRACT This final report covers an investigation into the design and evaluation of a single wire termination system capable of interconnection to various existing designs of multi-contact connectors. The devices utilizing this termination system were to be capable of assembly and maintenance with a common tool. In addition, the devices were to reliably withstand the environmental conditions encountered by ground and airborne Army equipment with emphasis on improvement for Army aircraft. The concept designed and evaluated makes waterproof connectors having crimp removable MS27491 series contacts practical to produce. However, to obtain sound insert moldings, minimum spacing between contact centerlines had to be established as follows:			
Terminal Size	22D	20	16
Minimum Space	.090 in. (tentative)	.130 in.	.190 in.
			.238 in.
It was found that the contact spacing of MIL-C-81511 connectors is inadequate for use with MS27491-22D contacts. Terminal insertion and removal tools were obtained, evaluated, and found useful. Terminal insertion and removal tips used for 22D contacts were mechanically weak. If the tip wall section must be increased, which is still to be determined, or if the dielectric wall thickness between contact cavities is inadequate for a reliable design, then the .090 in. spacing for this contact size may have to be increased.			

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Connectors Contacts Terminations Retentions						

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