DOE
ENERGY

190
5-22-81
(88)

(1)

MASTER

LD. 2663

DOE/ET/12063-28
Distribution Category UC-92a

R-4535

ELECTRODRIL SYSTEM FIELD TEST PROGRAM
PHASE II: TASK C-1—DEEP DRILLING SYSTEM DEMONSTRATION

Final Report for Phase II: Task C-1

Work Performed for the Department of Energy
Under Contract DE-AC02-76ET12063
(Formerly EY-76-C-02-4033)

Date Published—April 1981

General Electric Company
Space Division
Houston, Texas

U. S. DEPARTMENT OF ENERGY

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

DISCLAIMER

"This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

Available from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161.

NTIS price codes

Paper copy:	\$7.00
Microfiche copy:	\$3.50

**ELECTRODRIL SYSTEM FIELD TEST PROGRAM
PHASE II: TASK C-1—DEEP DRILLING SYSTEM DEMONSTRATION**

Final Report for Phase II: Task C-1

B. V. Traynor, Jr., *Contract Manager*
Peter D. Taylor, *Principal Investigator*
General Electric Company
Space Division
P.O. Box 58408
Houston, Texas 77058
(713)332-4511

C. Ray Williams, *Technical Project Officer*
Bartlesville Energy Technology Center
P.O. Box 1398
Bartlesville, Oklahoma 74003
(918)336-2400

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared for the Department of Energy
Under Contract DE-AC02-76ET12063
(Formerly EY-76-C-02-4033)

Date Submitted—November 1980
Date Published—April 1981

U.S. DEPARTMENT OF ENERGY

FOREWORD

This report covers the work performed during Phase II, Task C-1 of the Electrodrill System Field Test Program. This work was to improve the downhole connectors and verify performance with extensive testing. After a static inverter is fabricated, the system is ready to be field tested.

The Electrodrill System Field Test Program is a cooperative, cost-sharing venture between the U.S. Department of Energy (DOE), General Electric Company and the petroleum industry with the prime contractor being General Electric Company (GE). The work was performed under DOE Contract Number EY-76-C-02-4033. Other industry participants are as follows:

- AMOCO Production Company
- Brown Oil Tools Company
- Chevron Oilfield Company
- Dresser Industries
- Gulf Oil Exploration and Development Company
- Mobil Research and Development Company
- Union Oil Company of California

The Electrodrill concept is to provide a method to drill with a downhole electric motor that uses a retrievable power cable and employs a telemetry system which makes downhole measurements of various drilling and safety parameters and transmits them to the surface. If successful development of Electrodrill can be achieved, it should provide a significant addition to drilling technology.

All technical work for this project has been monitored by the Bartlesville Energy Technology Center.

C. Ray Williams
Project Manager
Drilling, Offshore & Arctic Technology
Bartlesville Energy Technology Center

TABLE OF CONTENTS

	<u>Page Number</u>
1.0 SUMMARY	1
2.0 INTRODUCTION	2
3.0 OBJECTIVES	2
4.0 TECHNICAL APPROACH	3
5.0 TEST DATA ACQUISITION	11
6.0 TEST RESULTS	16
7.0 CONCLUSIONS	21
8.0 PRODUCT IMPROVEMENT CONSIDERATIONS	22
 APPENDIX A DETAILED TEST PROCEDURE	 23
APPENDIX B TEST CONFIGURATION DETAILS	30

ILLUSTRATIONS

Table 1	19
 Figure 1	 4
Figure 2	5
Figure 3	6
Figure 4	6
Figure 5	7
Figure 6	7
Figure 7	9
Figure 8	10
Figure 9	12
Figure 10	13
Figure 11	14
Figure 12	20
Figure 13	20

ABSTRACT

The Electrodril Deep Drilling System field test demonstrations were aborted in July 1979, due to connector problems. Subsequent post test analyses concluded that the field replaceable connectors were the probable cause of the problems encountered.

The designs for both the male and female connectors, together with their manufacturing processes, were subsequently modified, as was the acceptance test procedures. A total of nine male and nine female connectors were manufactured and delivered during the 2nd Quarter 1980. Exhaustive testing was then conducted on each connector as a precursor to formal qualification testing conducted during the month of October 1980, at the Brown Oil Tool test facility located in Houston, Texas.

With this report, requirements under Phase II, Task C-1 are satisfied. The report documents the results of the connector qualification test program which was successfully completed October 28, 1980. In general, it was concluded that connector qualification had been achieved and plans are now in progress to resume the field test demonstration program so that Electrodril System performance predictions and economic viability can be evaluated.

1.0 SUMMARY

In July of 1979, the Electrodril Deep Drilling System Field Test Demonstrations were aborted due to connector problems. Subsequent post test analyses concluded that the field replaceable connectors were the probable cause for the problems encountered.

Since that time both the male and female connector designs have been modified and their manufacturing and quality control processes have been tightened.

Nine male and nine female connectors were subsequently produced to these new design and manufacturing requirements and were delivered during the 2nd Quarter 1980. These connectors were then exhaustively tested in preparation for a series of tests conducted in a simulated well environment intended to requalify the connector design.

The qualification test series was conducted at the Brown Oil Tools test facility in Houston, Texas, during the period October 13 through 28, 1980. During this test program, a total of 181 test matings were successfully made and evaluated in a simulated well environment. During this thirteen day test period the new connector pairs were subjected to a wide range of services similar to that typically encountered during the 1979 field test demonstrations. There was no incidence of water intrusion during this test period. It was this problem that had caused the termination of the McCook tests, and the problem to which all corrective actions have been directed.

This report documents the results of the Brown Oil Tool connector qualification test program and concludes in general, that such a qualification has been achieved. Plans are now in progress to resume the field test demonstration program so that Electrodril System performance predictions and economic viability can be evaluated.

2.0 INTRODUCTION

This report documents the results of a test program conducted on modified Electrodril male and female connectors. The test program was conducted at the Brown Oil Tools test well during the period October 13 through October 28, 1980.

This test program was necessitated by connector problems which occurred during the Electrodril Deep Drilling System Field Test Demonstration in June/July 1979. The details of this demonstration are reported in the Phase II, Task C Final Report dated October 1979. In this report the field replaceable connectors were identified as the focal point for the problems encountered during the system demonstration and the need to modify and requalify the connectors prior to any future system demonstrations was established. These connector modifications relate more to the manufacturer's assembly and quality control processes and acceptance test procedures than to specific design changes.

The connector manufacturer was instructed to provide nine sets of field replaceable connectors conforming to modified and much more stringent manufacturing and quality control criteria. These nine sets of connectors were the focal point of the test program detailed in this report.

3.0 OBJECTIVE

The objective of the test program was to requalify the Electrodril field replaceable male and female connectors preparatory to resumption of Electrodril System field test demonstrations.

The specific objectives of the test program were:

1. To test nine sets of modified field replaceable connectors and establish that the connectors were capable of withstanding water intrusion in the mated and unmated configuration.
2. To test nine sets of modified field replaceable connectors in an electrical environment and establish that the connectors were capable of maintaining electrical continuity at the power levels required in Electrodril System operation.
3. To determine the susceptibility of the field replaceable connectors to surface oxidation and to quantify this oxidation susceptibility in terms of changes in electrical resistance of mated connectors.
4. To evaluate the utility of a supplemental device attached to the box end of a prewired Electrodril drill pipe in the mousehole makeup of electrical connectors to preclude chances for mechanical damage.

4.0 TECHNICAL APPROACH

One conclusion of the 1979 Electrodril field demonstration post test analysis was that the cables and downhole assemblies did not exhibit electrical leakage and/or discontinuities. This conclusion was reached after an extensive evaluation of each cable and downhole device that was deployed during the field test demonstration. This is a key technical point which had much significance in establishing the technical approach to be taken to satisfy the test objectives. It followed, therefore, that there was no need to include the cables in the test configuration. While the pragmatics of implementing the test configuration could require cables, their use should be minimized to limit the effects of cables in the connector test results.

An idealized test configuration would be one which has a load cell simulating the bottom hole assembly, a power source and a pressure chamber with a means for readily introducing different connectors for testing. Schematically this idealized test configuration is shown in Figure 1. This test configuration need not, of course, be associated with a drill rig.

The practical considerations of relating the test results to drill rig deployment readiness and the constraints of the Electrodril System by virtue of the characteristics of its elemental parts dictated that the idealized test configuration be modified.

The test configuration finally selected is shown in Figure 2. This configuration utilizes a maximum of conventional rig equipment and maintains the Electrodril electrical configuration. The plugged downhole motor assembly was run in the test well (Figure 3) on approximately 120-ft. of drill pipe. This depth permitted the use of one 90-ft. length of Electrodril cable and a 30-ft. sinker bar. The downhole cable assembly was suspended on a standard Electrodril hanger sub while the drill pipe was supported in the rig slips. This assembly constituted the test chamber.

The electrified kelly with slip ring assembly was used to deliver electrical power to the test connectors. Electrical power was provided by a motor generator set (Figure 4) through a step up transformer to the slip ring assembly. The Electrodril power skid is shown in Figure 5.

The test connectors were installed into the existing Electrodril 30-ft. pre-wired drill pipes. These test assemblies were introduced into the test drill string as single, double and triple joints. By varying the test connector locations in these assemblies and by appropriate sequencing, many combinations of the female and male connectors were evaluated.

After each test assembly was introduced to the test drill string, the kelly was made up and basic electrical checks made. The pressure was increased to 3000 psig, electrical checks reverified and the motor started. Figure 6 shows the data recorder with channels dedicated to motor voltage, current, temperature and test pressure.

FIGURE 1
IDEALIZED TEST
SCHEMATIC

FIGURE 2
CONNECTOR TEST
PIPE CONFIGURATION

FIGURE 3
MOTOR BEING RUN INTO WELL

FIGURE 4
MOTOR GENERATOR SET

FIGURE 5

ELECTRODRIL POWER SKID

FIGURE 6

DATA RECORDER

The motor was run at 60 Hz (i.e., 200 rpm). The motor rpm was considered on the high side of actual conventional drilling speeds and thus a good test representation. This motor operating regime requires 1160 VAC with a current demand of 300 amps inrush and 30 amps steady state.

It should be noted that in the baseline test configuration depicted schematically in Figure 7, the connectors on the motor and sinker bar (F8 & M8) are a permanent part of the test set up. The remaining inventory of connectors was used to vary male/female test combinations. Because the motor and sinker bar connector remained mated for the test duration (nominally 13 days), valuable performance data relating to long term downhole immersion was developed.

The female connector on the kelly (F7) is permanently installed. This connector was exposed to repetitive matings with many male connectors and saw numerous pressure cycles and motor starts. Valuable connector life performance data were developed from this arrangement.

The detailed connector test procedure is presented in Appendix A. This procedure calls for 38 test configurations which yields 181 test combinations. Using a three hour per test baseline consisting of one hour to rig up, one hour to run and one hour to rig down and assuming a three configuration tests/day schedule, the 38 configurations were estimated to be completed in 13 days of rig time.

As a direct result of the mating difficulties experienced during the 1979 field test program, a drill pipe and connector makeup tool (Figure 8) was designed and fabricated to maintain the alignment of mating drill pipe (with connectors inside) as the makeup process is executed. This guide sub was used as each 30-ft. joint was added to the test string and during kelly make up and was evaluated under rig floor conditions during the test series.

Some concern was voiced during the November 1979 Technical Advisory Board Meeting about the long term susceptibility of the connector rings to corrosion during storage. As a result of this concern, the evaluation of connector susceptibility to oxidation during long term storage exposure both indoors and out was an additional test objective. During November 1979 four pairs of connectors were electrically tested to establish a performance baseline. Half of these connectors were stored outside, and the other half were stored inside, for one year. During the 1980 test series, data were obtained to compare with the 1979 performance baseline. The comparative data are included in this document.

FIGURE 7
BASELINE CONNECTOR CONFIGURATION
FOR TEST

FIGURE 8
GUIDE SUB

5.0 TEST DATA ACQUISITION

Pre Rig Up Test Data

All system elements required to support the test were mechanically and electrically prechecked. Each system element had a backup on site to assure that test continuity could be maintained. All electrical test data were recorded and formatted to optimize evaluation of connector performance.

The connector test articles were exhaustively tested at the manufacturers facility prior to acceptance. They were all individually subjected to low (atmosphere) and high (10000 psig) pressure water immersion and the gamut of before and after electrical testing to establish baseline performance integrity. The connectors were then subjected to the same series of tests while in the mated configuration. All test data from this factory acceptance test program have been recorded and are on file.

Post Rig Up Test Data

When Electrodrill cable and subsystem rig up was accomplished prior to the initiation of normal connector testing, each test string was checked at two stages. The downhole segment of the test string comprising the motor, a 30-ft. sinker bar and a 90-ft. cable was checked for electrical continuity and resistance to ground. This test was conducted on the rig floor and the data were recorded manually on test data sheet No. 1 shown in Figure 9. The surface segment of the test string comprising the electrified kelly, the slip ring assembly and the power to rig cable was also checked for electrical continuity and resistance to ground. Since each element in both test string segments had previously been tested, the nominal value of both segments was established prior to these checks.

Mated Electrical Test Data

With both test string segments installed in the rig and checked out, the first mated connector test was conducted on the female in the kelly mated to the male at the top of the 90-ft. cable. This mated connector pair together with the downhole and surface segments of the test string was checked at a connection strip on the output side of the power transformer. Test data taken during this check were recorded manually on data sheet No. 2 shown in Figure 10. With successful completion of the electrical check, the internal pressure was increased to 3000 psig and another electrical check was taken and recorded. The electrical check at this point would reveal water ingress into the test string should it occur. With a successful electrical check, the operational test cycle was begun. This "load" cycle consisted of five minutes of motor operations, followed by a soak repeated four times. During motor operation, the motor voltage, current and temperature together with test pressure were recorded on a strip chart. A typical recording is shown in Figure 11. With the basic test configuration successfully checked out, the test connectors were then ready for evaluation.

CONNECTOR TEST RIG FLOOR MEASUREMENTS

[illegible]

CONNECTOR TEST POWER SKID MEASUREMENTS

TEST CONFIGURATION

DATE _____

all measurements are in OHMS

[illegible]

Test Data Sheet No. 2

Figure 10

Typical Strip Chart Recording

Figure 11

The kelly was disconnected from the downhole segment of the test string and the first 30-ft. cable assembly was introduced. Electrical checks for both the surface and downhole segments of the test string were made as previously described and recorded. Upon successful completion of these electrical checks, the kelly was mated to the top of the first 30-ft. test assembly and the total string was again checked electrically at the power transformer. The test cadence from this point on was as described above: pressuring up - checking, starting the motor and recording data. In a similar manner, the various connector combinations delineated in the test procedure were tested until the test series was completed.

5.0 TEST RESULTS

Rigging-up of the Electrodrill equipment at the BOT facility began on October 13, 1980. The basic test configuration was deployed October 14 and connector tests were begun at that time. Tests ran for 13 days and were concluded October 28. Rig-down and equipment removal was completed October 28.

The test procedure used during the test series is presented in Appendix A of this document. The procedure used does not precisely match that cited in the October Task C-1 test plan, as some modifications became necessary due to rig operation constraints. The differences between the operations cited in the October test plan and those used during the BOT test are not of a nature to invalidate the test data.

A total of 38 test configurations were evaluated. The detail makeup of these configurations is presented in Appendix B. These configurations yielded test data on 181 specific male to female connector mate combinations.

The most salient result of these tests is that over the 13 day test period, connector pairs were subjected to a range of services in a simulated operational environment. There was no instance of the water intrusion problem which had caused the termination of the Field Test Demonstration at McCook, Texas in 1979. The correction of this water intrusion problem had been the major focal point of our corrective actions. Moreover, there were no connector continuity problems which could not be corrected in situ by using a 500 volt meg-ohm meter to verify conductor continuity. Except for two instances of human error, which caused excessive leakage due to incorrect dielectric greasing of the female connector, drilling demonstrations could have proceeded after each of the 181 connector matings. Significant additional accomplishments resulted from the connector test series. For example:

1. The baseline configuration (Figure 7) was deployed downhole in fluid for a total of 336 consecutive hours without electrical degradation or failure. While downhole, this configuration was subjected to 37 pressure cycles to 3000 psig and was exposed to 3000 psig in excess of 132 hours.
2. The motor, while downhole for 14 days, was started 151 times and accrued a total running time of 13 hours. Post test inspection of the motor oil reservoir showed no anomalies and oil leakage across the lower seal to be within the design goal of 6cc/running hour.
3. The 90-ft. cable assembly, kelly cable assembly and sinker bar were downhole for 14 days and exposed, without degradation or failure, to 132 hours at 3000 psig while supporting 151 motor starts requiring 1150 VAC 60 Hz with a current demand of 300 amps inrush and 30 amps idle.
4. The 181 mated connector combinations all successfully withstood four test cycles each consisting of a 5-minute motor run. Each motor run was conducted at 3000 psig using a motor excitation of 1150 VAC 60 Hz, having a current demand of 300 amps inrush and 30 amps idle.

5. Significant effort was expended in the careful collection of test data before, during and after the test series. Analysis of these data verifies that no electrical degradation of the connectors or supporting Electrodril test equipment had taken place.

Test Anomalies

Of the 181 connector mate combinations tested, 37 anomalies were noted. Only two of these would have required correction or replacement during normal rig operations and could have been avoided, but for operator oversight.

Of the 37 anomalies identified, 19 related to malfunctions in test support equipment and 18 related to actual test activities. The 18 test related anomalies can be categorized as follows:

1. Open conductor or higher conductor resistance than expected. A total of 11 anomalies of this category were noted. See test configuration sheets 3, 6, 7, 8, 11, 14, 16, 21, 28, 29 and 30 for details. Items 11, 16, 21 and 28 relate to power conductors and the remaining seven items relate to the signal conductor.
2. Lower conductor resistance than expected. A total of three anomalies in this category were noted, two of which relate to downhole situations (test configurations 2 & 14) and one (4) related to surface equipment.
3. Erratic data recordings. A total of four of this type of anomaly were noted as shown in test configurations 14, 29, 30 and 35. Of these anomalies, three (14, 29 & 30) were noted on the instrument trace of the strip chart recorder, and one (35) was a current trace on the same chart recorder.

Connector Surface Oxidation Evaluation

To determine the susceptibility of connectors to surface oxidation during various storage conditions and to quantify this susceptibility in terms of electrical resistance, four male and four female connectors were cleaned and their contacts polished. These connectors were then randomly mated (using DC-3 grease as a lubricant) and the total resistance (in milliohms) of each mated conductor was established by measuring the voltage drop across the connector conductor while it was passing a constant 40 amps of current.

This baseline evaluation was completed in late October 1979 after which two of the mated pairs were demated and degreased while the other two pair were just demated. A degreased and greased pair of connectors were then stored, both indoors and outdoors, for one year. At the end of this storage period (i.e., after the BOT connector tests), the eight connectors were visually examined. All connector contacts exhibited surface discoloration attributed to oxidation. Those ungreased ones stored outdoors appeared more severe with some indication of verdigris. Grease seemed to retard but not eliminate oxide formation.

After rinsing all connectors in water, they were again mated with the same pairing as before and resistance again determined. Table I presents the initial and final resistance and the resistance change attributable to oxidation. The average increase in resistance attributable to surface oxidation was 0.12 milliohms. It should be pointed out that the resistance value determined is the sum of the contact resistance at each end of the mated pair, the contact resistance of the mated male/female interface and the resistance of the copper and Ampcoloy material used.

Guide Sub Evaluation

As a result of some difficulties encountered during the 1979 Field Test Demonstrations, a "Guide Sub" was designed and manufactured during early 1980 for evaluation during the connector tests at BOT. The sub is intended to act as a retainer and funnel as kelly to drillpipe joints are made in the mousehole and as drillpipe joints are made up in the slips. This guide sub was used successfully each time the kelly was made up. No male connector sustained damage which required change out. In one instance connector M9 had its ground tip slightly flattened (Figure 12) during make-up of the kelly in test configuration #27, but the damage was cosmetic and not functional. M9 was subsequently used in Test Configurations 28, 29, 30, 31, 32 and 33 with no problems.

As a result of the mishap during the make-up of test configuration #27, the guide sub will be modified to provide better connector protection. The position of the sub's lifting handles will also be changed so that the rig crews can more easily control the sub while lifting it on and off the drill string. The technical approach for the guide sub appears valid and experience with it during the BOT test program was encouraging.

Other Test Anomalies

Two other test anomalies were recorded. One was the failure of the slipring to power skid cable and the other was the failure of the retention screws on the kelly connector sleeve. The power skid cable failed electrically at the slipring adapter due to mechanical failure of its constraints. The kelly connector sleeve failure was due to shearing of its retention screws in the connector body. The sleeve was reinstalled using heat treated screws and the test program was continued without further problems.

Post Test Anomaly

One post test anomaly was identified on the phase 1 contact ring of male connector M1 (Figure 13). A 0.1" x 0.05" depression, believed to be a burn spot, was found. No similar mark could be discovered in any of the five female connectors which were known to have mated with M1. It is hypothesized that the spot was caused by localized high current density during one of the motor start cycles. Such a hot spot could have been produced by the dielectric grease acting as an insulator over all the contact area except that of the spot.

Storage Condition	ø1			ø2			ø3		
	R1	R2	ΔR	R1	R2	ΔR	R1	R2	ΔR
Indoors with grease	1.09	1.37	+ .28	1.02	1.07	+ .05	1.09	1.11	+ .02
Outdoors with grease	1.17	1.30	+ .13	1.20	1.41	+ .21	1.10	1.20	+ .10
Indoors without grease	1.34	1.52	+ .18	1.70	1.33	- .37	1.53	1.85	+ .32
Outdoors without grease	1.14	1.27	+ .13	1.14	1.32	+ .18	1.09	1.28	+ .19

R1 Average = 1.22
 R2 Average = 1.34
 ΔR Average = 0.12

Note: All resistance values are in milliohms
 R1 = Initial Resistance 11/2/79
 R2 = Final Resistance 10/31/80
 ΔR = Change in Resistance

Mated Pair Resistance

TABLE 1

FIGURE 12
FLATTENED MALE CONNECTOR TIP

FIGURE 13
POST TEST ANOMALY

7.0 CONCLUSIONS

The primary objective of the test program conducted at the Brown Oil Tool facilities was to requalify the field replaceable male and female connectors preparatory to the resumption of field test demonstrations. It is concluded from the test data presented in this document, that this primary objective was fully met. Over the 13 day test period, the "new" connector pairs were subjected to a range of services in a simulated operational environment and there was no incidence of water intrusion. This was the problem that caused the termination of the field test demonstration at McCook, Texas and the problem to which all corrective actions have been directed. There were no connector mating problems which could not be corrected without removal of the test string. Except for two instances of operator oversight, which caused the connectors to be unsuccessfully mated, drilling operations could have proceeded after each of the 181 connector matings. It is further concluded that the field replaceable connector design has been qualified and is now ready for operational evaluation in wells to depths of 15000 feet.

It can further be concluded that since the sinker bars, kelly cable and 90-ft. cables did not exhibit functional failures or instances of water intrusion during the McCook or recent Brown Oil Tool tests, their respective designs remain qualified for operational deployment.

In considering the Electrodril System ramifications of the signal conductor anomalies, it is concluded that should similar instances of erratic continuity occur during an operational deployment of the Electrodril System, the consequences of these events would be minimal. The motor voltage control circuit is currently being redesigned to respond to surface rather than downhole measurements, and as such system vulnerability to erratic downhole data acquisition will be obviated. Furthermore, it is currently concluded that the erratic signal continuity noted during these tests was due to the low power levels (20 VDC, 4 ma.) used to excite the motor temperature transducer, and was not representative of the power levels currently being used (115 VAC, 1 a.) for the Electrodril Instrument Subsystem.

In summary, the connector design and supporting equipment have been requalified and steps should now be taken to again conduct field test demonstrations of the system so that performance predictions and economic viability can be evaluated.

It was concluded that long term storage of Electrodril connectors does not cause sufficient oxidation to appreciably affect system performance. With or without the surface oxidation, the resistance of a mated pair of connectors meets the design goal of adding no more resistance than an equivalent length of cable.

It was also concluded that the use of the guide sub during operational deployment of Electrodril would help to prevent mechanical damage of the male connectors.

8.0 PRODUCT IMPROVEMENT CONSIDERATIONS

As a result of the experience gained using the Electrodril connectors in the simulated well environment at Brown Oil Tools, there are a number of product improvement suggestions that should be considered before specific equipment designs are frozen.

Considering the vulnerability of both the male and female connectors to impact damage, consideration should be given to incorporating the means to exchange the "guts" of a damaged connector. Field refurbishment of the connectors would minimize the expense associated with spares provisioning.

The bronze connector nut, for example, cannot be made up without the use of a special wrench. This problem is exacerbated in the muddy environment of an operational well. Consideration should be given to incorporating a quick disconnect mechanization for attachment of the connectors to cables, etc. in lieu of the current threaded approach.

The current method of packing the female connector cavity with dielectric grease is extremely cumbersome. Some means of prepackaging the grease in metered sachets for direct insertion into the cavity should be considered.

Currently, the test methods for establishing electrical readiness of the Electrodril System are based on engineering requirements. These test methods should be incorporated into a test device that is safe and convenient to use in a rig environment.

None of these product improvement suggestions are of such a nature as to preclude the resumption of Electrodril field test demonstrations before their inclusion.

APPENDIX A

DETAILED TEST PROCEDURE

FOR
ELECTRODRIL

PHASE II TASK C-1
CONNECTOR TEST

November 1980

THERMAL SYSTEMS PROGRAMS

Houston, Texas

1.0 INTRODUCTION

Prior to initiation of any of the Test Steps detailed in this document, the baseline configuration depicted below will be deployed and checked at the rig floor. This baseline configuration is a permanent part of the test setup and will remain for the duration of the test in order to allow long term downhole performance data to be collected.

2.0 DETAILED PROCEDURE

STEP

MATING ACHIEVED MALE FEMALE

1. Kelly to top of baseline configuration
2. Pipe 1 with M1 and F1 to top of baseline configuration
3. Kelly to top of pipe 1
4. Set back pipe 1
5. Pipe 2 with M2 and F2 to top of baseline configuration
6. Kelly to top of pipe 2
7. Set back pipe 2
8. Pipe #3 with M3 and F3 to top of baseline configuration
9. Kelly to top of pipe 3
10. Pipe #1 with M1 and F1 to top of pipe 3
11. Kelly to top of pipe 1
12. Pipe 2 with M2 and F2 to top of pipe 1
13. Kelly to top of pipe 2
14. Pipe 2 with M2 and F4 to top of pipe 1
15. Kelly to top of pipe 2
16. Pipe 2 with M2 and F5 to top of pipe 1
17. Kelly to top of pipe 2
18. Pipe 2 with M2 and F6 to top of pipe 1

7	7
7	1
1	7
-	-
7	2
2	7
-	-
7	3
3	7
3	1
1	7
1	2
2	7
1	4
2	7
1	5
2	7
1	6

STEP

MATING ACHIEVED	
MALE	FEMALE

19.	Kelly to top of pipe 2	2	7
20.	Pipe 2 with M4 and F6 to top of pipe 1	1	6
21.	Kelly to top of pipe 2	4	7
22.	Pipe 2 with M4 and F5 to top of pipe 1	1	5
23.	Kelly to top of pipe 2	4	7
24.	Pipe 2 with M4 and F4 to top of pipe 1	1	4
25.	Kelly to top of pipe 2	4	7
26.	Pipe 2 with M4 and F2 to top of pipe 1	1	2
27.	Kelly to top of pipe 2	4	7
28.	Pipe 2 with M5 and F2 to top of pipe 1	1	2
29.	Kelly to top of pipe 2	5	7
30.	Pipe 2 with M5 and F4 to top of pipe 1	1	4
31.	Kelly to top of pipe 2	5	7
32.	Pipe 2 with M5 and F5 to top of pipe 1	1	5
33.	Kelly to top of pipe 2	5	7
34.	Pipe 2 with M5 and F6 to top of pipe 1	1	6
35.	Kelly to top of pipe 2	5	7
36.	Pipe 2 with M6 and F6 to top of pipe 1	1	6

STEPMATING ACHIEVED
MALE FEMALE

37. Kelly to top of pipe 2
38. Pipe 2 with M6 and F5 to top of pipe 1
39. Kelly to top of pipe 2
40. Pipe 2 with M6 and F4 to top of pipe 1
41. Kelly to top of pipe 2
42. Pipe 2 with M6 and F2 to top of pipe 1
43. Kelly to top of pipe 2
44. Set back pipe 2 with F2 and M6
45. Set back pipe 1 with F1 and M1
46. Pipe 2 with F2 and M6 to top of pipe 3
47. Pipe 1 with F1 and M1 to top of pipe 2
48. Kelly to top of pipe 1
49. Pipe 1 with F4 and M1 to top of pipe 2
50. Kelly to top of pipe 1
51. Pipe 1 with F5 and M1 to top of pipe 2
52. Kelly to top of pipe 1
53. Pipe 1 with F6 and M1 to top of pipe 2
54. Kelly to top of pipe 1
55. Pipe 1 with F9 and M1 to top of pipe 2

6	7
1	5
6	7
1	4
6	7
1	2
6	7
-	-
-	-
3	2
6	1
1	7
6	4
1	7
6	5
1	7
6	6
1	7
6	9

STEPMATING ACHIEVED
MALE FEMALE

56.	Kelly to top of pipe 1	1	7
57.	Pipe 1 with F9 and M9 to top of pipe 2	6	9
58.	Kelly to top of pipe 1	9	7
59.	Set back pipe 1	-	-
60.	Set back pipe 2	-	-
61.	Pipe 2 with F2 and M9 to top of pipe 3	3	2
62.	Pipe 1 with F9 and M6 to top of pipe 2	9	9
63.	Kelly to top of pipe 1	6	7
64.	Pipe 1 with F6 and M6 to top of pipe 2	9	6
65.	Kelly to top of pipe 1	6	7
66.	Pipe 1 with F5 and M6 to top of pipe 2	9	5
67.	Kelly to top of pipe 1	6	7
68.	Pipe 1 with F4 and M6 to top of pipe 2	9	4
69.	Kelly to top of pipe 1	6	7
70.	Pipe 1 with F1 and M6 to top of pipe 2	9	1
71.	Kelly to top of pipe 1	6	7
72.	Set back pipes 1, 2, and 3	-	-
73.	Pipe 1 with F1 and M6 to top of baseline configuration	7	1
74.	Pipe 3 with F3 and M3 to top of pipe 1	6	3

STEP

MATING ACHIEVED
MALE FEMALE

75. Pipe 2 with F2 and M9 to top of pipe 3
76. Kelly to top of pipe 2
77. Pipe 2 with F2 and M5 to top of pipe 3
78. Kelly to top of pipe 2
79. Pipe 2 with F4 and M5 to top of pipe 3
80. Kelly to top of pipe 2
81. Pipe 2 with F5 and M5 to top of pipe 3
82. Kelly to top of pipe 2
83. Pipe 2 with F6 and M5 to top of pipe 3
84. Kelly to top of pipe 2
85. Pipe 2 with F9 and M5 to top of pipe 3
86. Kelly to top of pipe 2

3	2
9	7
3	2
5	7
3	4
5	7
3	5
5	7
3	6
5	7
3	9
5	7

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

SUMMARY

This document presents the details of the 38 test configurations evaluated during the Electrofil Connector Test Program at Brown Oil Tools during October 13-28, 1980.

In addition to a pictorial representation of each test configuration, measurements made at pressure just prior to the 1st motor turn-on are presented. Pertinent remarks documenting all anomalies are also included.

Actual data sheets and strip chart recordings are on file.

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 1

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
1.1	1.1	1.1	200 M	112
Remarks				
Fuses blew at start up. No problem				
detected. Fuses replaced and test				
begun. No strip chart data recorded				
for 1st four runs. A 5th run made to				
establish baseline recording for				
voltage, current and pressure. No				
strip chart recording of signal was				
made.				

DETAILED PROCEDURE STEP(S) 1

DATE 10/14/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 2

Measurements in OHMS				
1-2	1-3	2-3	Q-G	S-G
1.1	1.1	1.1	220K	
Remarks				
System not powered up because of				
leakage to ground. Demated! Pipe				
with M-1 and F-1 removed from string.				
No problem detected. Pipe, M-1 and				
F-1 subsequently used successfully.				

DETAILED PROCEDURE STEP(S) 2, 3

DATE 10/15/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 3

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.8	0.8	0.8	200 M	Open
Remarks				
No strip chart recordings of signal.				
Megger confirmed continuity. Signal				
open on all checks except run 2.				

DETAILED PROCEDURE STEP(S) 5, 6

DATE 10/15/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 4

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
1.1	1.1	1.1	70 M	120
Remarks				
After 3rd run config left overnite @				
pressure. Next morning Ø-gnd leakage				
traced to gnd pwr cable adapter.				
Adapter removed & test resumed. No				
signal trace recorded. Pressure not				
recorded because of wrong valve con-				
figuration at facility - test pressure				
was verified at rig floor.				

DETAILED PROCEDURE STEP(S) 8, 9

DATE 10/15/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 5

KELLY

FM #7
M #1

FM #1
M #3

FM #3
M #7

90' CABLE

SINKER BAR

FM #8
M #8

MOTOR

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	150 M	118
Remarks				
No signal strip chart recording.				

DETAILED PROCEDURE STEP(S) 10, 11

DATE 10/16/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 6

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
Signal increased to 122 ohms by 4th				
run. Left downhole overnight at				
pressure and made 5th run in the am.				
No strip chart recordings for signal.				
-				
-				

DETAILED PROCEDURE STEP(S) 12, 13

DATE 10/16/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 7

KELLY

FM #7
M #2

FM #4
M #1

FM #1
M #3

FM #3
M #7

90' CABLE

SINKER BAR

MOTOR.

FM #8
M #8

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
Blew fuses on 1st start. Replaced				
with higher rated ones. Signal				
resistance increased to 125 for 2nd,				
3rd and 4th runs. No signal strip				
chart recording.				

DETAILED PROCEDURE STEP(S) 14, 15

DATE 10/17/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 8

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				
Signal resistance increased to 132.				
No signal strip chart recordings.				

DETAILED PROCEDURE STEP(S) 16, 17
DATE 10/17/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 9

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
After 4 runs this configuration left				
downhole over weekend. Pressure bled				
down but was pumped back up prior to				
5th run made on Monday am. No signal				
strip chart recording for 1st four				
runs.				

DETAILED PROCEDURE STEP(S) 18, 19

DATE 10/17/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 10

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 20, 21

DATE 10/20/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 11

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	60	60	100 M	120
Remarks				
Motor started OK with 60 ohm con-				
tinuity. All subsequent readings				
were 0.9 ohms.				

DETAILED PROCEDURE STEP(S) 22, 23

DATE 10/20/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 12

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
<u>Remarks</u>				

DETAILED PROCEDURE STEP(S) 24, 25

DATE 10/20/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 13

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
<u>Remarks</u>				

DETAILED PROCEDURE STEP(S) 26, 27

DATE 10/20/80

ELECTRODRILL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 14

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	150
Remarks				
Signal increased to 200 ohms. Erratic				
signal on strip chart recordings. Ø-				
gnd degradation @ 2400 psig after ini-				
tial mating. Repeated after overnite				
soak. Females repacked with grease.				
No more problems.				

DETAILED PROCEDURE STEP(S) 28, 29
DATE 10/21/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 15

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	70 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 30, 31
DATE 10/21/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 16

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
200	200	0.9	80 M	120
Remarks				
Motor started OK. All subsequent				
continuity readings 0.9 ohms.				

DETAILED PROCEDURE STEP(S) 32, 33
DATE 10/21/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 17

KELLY

FM #7
M #5

FM #6
M #1

FM #1
M #3

FM #3
M #7

90' CABLE

SINKER BAR

MOTOR

FM #8
M #8

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 34, 35

DATE 10/21/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 18

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
Left in hole overnight at pressure on				
10/21. First run made 10/22.				

DETAILED PROCEDURE STEP(S) 36, 37
DATE 10/22/80

ELECTRODRILL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 19

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 38, 39
DATE 10/22/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 20

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				
Strip chart recording shows open				
signal part of Run 1. Due to broken				
wire at power skid. Shutdown and				
fixed broken wire going to the record-				
er--Resumed test without incident.				

DETAILED PROCEDURE STEP(S) 40, 41
DATE 10/22/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 21

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
200K	200K	0.9	80 M	120
Remarks:				
Motor started OK. All subsequent				
continuity readings 0.9 ohms				

DETAILED PROCEDURE STEP(S) 42, 43
DATE 10/22/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 22

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				
Left downhole overnight at pressure				
and 5th run made 10/23.				

DETAILED PROCEDURE STEP(S) 46, 47, 48

DATE 10/22/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 23

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 49, 50
DATE 10/23/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 24

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 51, 52
DATE 10/23/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 25

KELLY

FM #7
M #1

FM #6
M #6

FM #2
M #3

FM #3
M #7

90' CABLE

SINKER BAR

MOTOR

Measurements in OHMS @ 3000 psig.

1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M*	120

Remarks

*Not read until after 1st run.

DETAILED PROCEDURE STEP(S) 53, 54

DATE 10/23/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 26

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				

DETAILED PROCEDURE STEP(S) 55, 56
DATE 10/23/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 27

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
Let soak overnight at pressure on				
10/23. Power applied 10/24.				

DETAILED PROCEDURE STEP(S) 57, 58
DATE 10/24/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 28

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9-20M	0.9-20M	0.9	80 M	120
Remarks				
Readings on phases 1-2, 1-3 vary from				
0.9 ohms to 20 M. Motor started OK,				
all subsequent continuity readings				
0.9 ohms.				

DETAILED PROCEDURE STEP(S) 61, 62, 63

DATE 10/24/80

ELECTRODRILL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 29

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	70 M	120
<u>Remarks</u>				
Signal increased to 126 ohms.				
Signal erratic on strip chart record-				
ings runs 1, 2 and 3.				

DETAILED PROCEDURE STEP(S) 64, 65

DATE 10/24/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 30

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	80 M	120
Remarks				
Signal increased to 500 ohms. Signal				
erratic on strip chart recordings				
runs 1, 2, 3 and 4.				

DETAILED PROCEDURE STEP(S)

66, 67

DATE

10/24/80

ELECTRODRILL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 31

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Ø-G	S-G
0.9	0.9	0.9	70 M	120
Remarks				
Increased signal test current to				
.004 amps to try and correct erratic				
measurements.				

DETAILED PROCEDURE STEP(S) 68, 69
DATE 10/24/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 32

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	150 M	114
Remarks				
Left over weekend under pressure.				
Power applied 10/27.				

DETAILED PROCEDURE STEP(S) 70,71

DATE 10/27/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 33

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	60 M	120
Remarks				
Ø - and read 30M initially. When				
test terminal at power skid was				
dried, the resistance increased to				
60M & test was resumed.				

DETAILED PROCEDURE STEP(S) 73, 74, 75, 76
DATE 10/27/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 34

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	70 M	120
<u>Remarks</u>				
Pressure transducer P.S. left off during Strip chart recording run 1.				
Pressure verified at rig @ 3000 psig.				
Test resumed.				

DETAILED PROCEDURE STEP(S) 77, 78
DATE 10/27/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 35

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	60 M	120
Remarks				
Strip chart recording run 1, erratic				
current trace at start of power.				

DETAILED PROCEDURE STEP(S) 79, 80
DATE 10/27/80

ELECTRODRIL

CONNECTOR TEST PROGRAM

TEST CONFIGURATION 36

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	200 M	120
Remarks				
Strip chart recording run 2 shows				
pressure increase when rig valve				
was put in wrong position.				

DETAILED PROCEDURE STEP(S) 81, 82

DATE 10/28/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 37

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
End of run 2 strip chart recording				
destroyed when paper jammed!				

DETAILED PROCEDURE STEP(S) 83, 84

DATE 10/28/80

ELECTRODRIL
CONNECTOR TEST PROGRAM
TEST CONFIGURATION 38

Measurements in OHMS @ 3000 psig.				
1-2	1-3	2-3	Q-G	S-G
0.9	0.9	0.9	100 M	120
Remarks				
Strip chart recording run 4 voltage				
spikes due to loose wire on terminal				
board.				

DETAILED PROCEDURE STEP(S) 85, 86
DATE 10/28/80

UNITED STATES DEPARTMENT OF ENERGY
BARTLESVILLE ENERGY TECHNOLOGY CENTER
P.O. BOX 1398
BARTLESVILLE, OKLAHOMA 74003

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300

POSTAGE AND FEES PAID

UNITED STATES
DEPARTMENT OF ENERGY

Return this sheet to above address, if you
do NOT wish to receive this material ☐
or if change of address is needed ☐ (indi-
cate change, including ZIP code).