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TRACKING AND COMMUNICATIONS DEVELOPMENT DIVISION

INTERNAL NOTE

TASK 520

POGO SUMMARY REPORT

MAIN PROPULSION TEST

STATIC FIRINGS 1-7

FOR

SHUTTLE DEVELOPMENT FLIGHT INSTRUMENTATION

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SHUTTLE

JSC 11613

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SHUTTLE DEVELOPMENT FLIGHT INSTRUMENTATION

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For

Tracking and Communications Development Division

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

JUNE 1980

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1. INTRODUCTION

Shuttle main engine tests on the Shuttle Main Propulsion Test Article (MPTA) have been performed at the National Space Technology Laboratories (NSTL) since April, 1978. Tests objectives include that of determining the pogo characteristics of the Shuttle Main Propulsion System (MPS). Parameters selected for this determination include those corresponding to the pogo measurements to be made on the first Shuttle orbiter vehicle, OV-102, as well as those incorporated especially for the Main Propulsion Tests (MPT).

The Tracking and Communication Development Division has performed a number of data system analyses to ascertain the degree of accuracy that can be expected for these parameters. These various tasks are outlined in a task plan, reference 1. In addition to these analyses, consultation has been provided with pogo analysts, NSTL personnel and RISD-Downey personnel concerning the solutions to instrumentation problems which have been experienced during the course of the MPT Static Firings (SF). Oscillograph records have been made for data obtained during each of the tests. These records have been reviewed to estimate data validity and to determine possible causes of any invalid data.

This report summarizes the performance of the MPT pogo instrumentation experienced during SF-1 through SF-7-02. This report also describes the instrumentation problems which have occurred and the actions which have been taken to correct these problems.

2. SUMMARY

A total of 106 pogo and pogo-related measurements have been evaluated after each MPT static firing test. A significant number of defective and questionable measurements have been noted as data from each test were reviewed. The quantities versus test number are as follows:

	DEFECTIVE	QUESTIONABLE
SF 4*	19	11
SF 5	5	19
SF 6-04	29	25
SF 7-02	15	30

* Representative of results obtained, SF 1 through 4.

The above numbers show a significant increase in measurement problems experienced on SF 6-04 as compared with the earlier static firings. This test was the first full duration test. The increased number of discrepancies is apparently due to the longer periods of high level engine power experienced during the full duration tests. Over the course of the MPT static firings, investigations have been performed in an attempt to determine the causes of the relatively large number of data discrepancies which have been experienced. The results of these investigations indicate that a large number of the discrepancies have been caused by intermittent failures of the miniature coaxial cables and connectors which are used to connect the transducers to signal conditioners. The integrity of these cables is difficult to determine under static conditions. The problems may only become apparent as the equipment is exposed to the severe environmental condition which occurs during the engine tests. Cable assembly, installation, handling, and check-out techniques have been developed which should minimize the associated data problems. A summary of recommended techniques are given in appendix A of this report.

In addition to the above cable and connector considerations, the following efforts have been made to correct data discrepancies and to verify data validity.

2.1 TRANSDUCER RESONANCE

During the first four static firings, the engine high pressure fuel and oxygen turbopump vibration measurements saturated to the extent that no data was obtained. It was determined that the wideband signal conditioners (WBSC) were saturating and that the saturation was caused by excitation of the transducer resonance at approximately 27 KHz. This problem was solved by installing in-line low pass filters between the accelerometers and the WBSC's. Filters were provided for all engine measurements which could be subjected to vibration at frequencies sufficiently high to excite transducer resonance. Technical data concurring this problem and filter use are given in references 2 and 3.

2.2 PRESSURE TRANSDUCER ACCURACY

Piezoelectric pressure transducers are used for acquiring the dynamic pogo pressure measurements. The engine low pressure oxidizer turbopump inlet pressure measurements are used as red-lines for engine cut-off so the integrity of these measurements is important. There is presently no National Bureau of

Standards (NBS) recognized method which can be used for calibrating these transducers so there is some uncertainty of the accuracy of the calibrations performed by the transducer manufacturer. The results of transducer calibrations performed on several transducers by the manufacturer and by the NBS were evaluated to determine if the engine red-line limits should be changed to allow for transducer errors. This evaluation indicated that a change was not justified. The results of the evaluation are reported in reference 4.

2.3 LOW PRESSURE FUEL TURBINE PUMP PRESSURE

The pressure ports originally provided for these measurements were required for pressure measurements associated with engine control. Instead of the $\pm$ 20 psi dynamic pressure measurements, 0 to 200 psi static measurements were provided. An analysis was performed along with equipment evaluation to determine the feasibility of increasing the resolution which could be obtained from the static pressure measurements. It was determined that some improvement could be realized by using an a-c coupled strain gage signal conditioner. The improvement was not considered to be significant or necessary so this modification was not made. The results of the analysis and equipment tests are reported in references 5 and 6.

2.4 DATA PROCESSING

Data from engine pogo pressure measurements were 180^{0} out of phase with the orbiter Main Propulsion System (MPS) pogo pressure measurements. This difference was not expected, but was a result of negative polarity provided by the engine pressure transducers. These transducers were intended to be identical with the orbiter transducers but, due to procurement difficulties, substitute transducers had to be used. This problem should not affect data accuracy since the phase reversal can be corrected during data processing and analysis.

It has also been noted that some data processing facilities are using the FDM 50Hz calibration signal for setting measurement sensitivity. The FDM 50Hz signal was intended for phase shift calibration only. The amplitude accuracy is not sufficient to allow its use as an amplitude calibration signal. This was pointed out to the data users and a method was suggested to allow use of this signal for calibration. This method requires a comparison of the 50Hz signal with the accurately controlled FDM dc calibration levels to determine necessary correction factors.

3. DISCUSSION

3.1 DATA EVALUATION

The MPT pogo and pogo-related measurements are multiplexed by orbiter-type frequency division multiplexers and the multiplexed signals are recorded by an instrumentation magnetic tape recorder during the engine tests. The tapes are received by the JSC Tracking and Communications Development Division (TCDD), Development Flight Instrumentation (DFI) Laboratory. The recorded signals are reproduced and demodulated. The demodulated data signals are recorded on oscillograph paper so that the data characteristics can be observed for determining its validity. The evaluation for each of the applicable measurements are listed in Table I for the results obtained for the SF 4 (typical, SF 1-3), SF 5, SF 6-04, and SF 7-02. Note that several measurements per test are marked as questionable. Most of these measurements are probably valid, but some care must be exercised in using the data since, generally, there will be short periods during which the data will not be valid.

3.2 INSTRUMENTATION PROBLEMS

In addition to estimating data validity, the evaluation of the MPT data has been useful in determining the corrections to problems which might have been experienced with the Shuttle orbital flight test pogo instrumentation. These problems are discussed as follows:

3.2.1 CABLE/CONNECTORS

The pogo instrumentation system uses piezoelectric transducers to convert the dynamic acceleration and pressure to electrical charge. The charge signals are coupled from the transducers to the WBSC's by miniature coaxial cable. The WBSC's convert the charge to a voltage signal and provide the necessary amplification filtering and bias. The charge signal can suffer severe degradation due to movement of a loose/defective coaxial connector or by movement of a defective coaxial cable. The coaxial cables used are necessarily small and are somewhat delicate. It is very important that proper procedures be used in handling and installing these cables. The cables must be properly constructed and must be adequately tied down to prevent movement which could cause damage during test vibration. Various vibration instrumentation users and manufacturers were consulted to determine effective procedures which can be used for insuring cable/connector integrity. The information obtained is summarized in Appendix A of this report. It is expected that the use of this information could significantly increase the reliability of the Shuttle OV-102 pogo instrumentation system.

3.2.2 WBSC SATURATION

The pogo vibration data frequency range of interest is 1.5 to 50Hz. The signal produced by the accelerometer will contain data within this frequency range as well as signals at higher frequencies. The WBSC provides low pass filtering such that the signals at frequencies above 50Hz are effectively eliminated from the WBSC output. However, the first stage (charge converter) of the WBSC is not filtered, so there is a possibility of overloading the WBSC at this point.

This possibility was considered during WBSC evaluation tests. These tests, as well as current analysis, showed that the expected vibration levels would cause no problem. During the first four MPT static firings, the WBSC's used with the high pressure fuel and oxidizer vibration measurements were saturated to the extent that no data were obtained. Further WBSC evaluation tests were performed to attempt to duplicate the saturation which occurred during the MPT tests. The saturation could only be duplicated by applying signals which are equivalent to 550 to 600 g pk-pk at frequencies between 24 and 30 KHz. These signals cause the WBSC to saturate and lock up at negative limiting. It was noted that the transducer resonant frequency is approximately 27 KHz with a gain at resonance of 40 to 50. It was theorized that the MPT test problems were caused by excitation of transducer resonance. The undesirable high frequency signals can be eliminated by connecting a filter between the transducer and the WBSC. Such a filter was purchased and tested with the WBSC. The test results, reported in Reference 2, showed that the filter performance was satisfactory. Additional tests were performed at the NSTL shuttle single engine test stand. These tests verified that the engine vibration excited transducer resonance and that the resulting high frequency signal could be eliminated by using a filter at the WBSC input.

As a result of the above test and analysis, filters were provided for use with 25 of the MPT pogo measurements prior to SF 5. The measurements filtered versus filter cut-off frequency are listed in Table II. This information was obtained from Reference 7.

3.3 DATA PROCESSING

The MPT and orbital flight test pogo data will be used in determining vehicle stability margins. The use of measured WBSC phase response data is required to achieve a maximum phase error between measurements of five degrees. The estimated maximum error, given in Reference 8, is 4.6 degrees. This error was calculated before it was determined that additional filtering would be required. As shown in Table II, 1 KHz filters are used with some of the measurements while 200 Hz filters are used with other measurements. The phase shift of the filters must be taken into account when filtered measurements are compared with unfiltered measurements and when measurements filtered at 1000 Hz are compared with measurements filtered at 200 Hz. The estimated filter phase shift and tolerance, vs. frequency, is given in Table III. The cut-off frequency of the low pass filter varies with the value of the associated source capacitance. The source capacitance consists of the parallel combination of the transducer capacitance and the capacitance of the cable which connects the transducer to the filter. The tolerances listed in Table III are based on a ± 1000 pfd variation in the value of the source capacitance. The data in Table III shows that the phase shift variation versus frequency is essentially linear or that a constant time delay could be used to compensate for the filter phase shift.

The estimated total maximum phase error between channels at 50 Hz is 5.3 degrees (200 Hz filter) and 4.6 degrees (1000 Hz filter). This is based on the assumption that the filter delay is taken into account when filtered measurements are compared with unfiltered measurements or when measurements filtered at 200 Hz are compared with measurements filtered at 1000 Hz.

4. CONCLUSION

The investigations and analyses to date appear to be providing solutions to correct the majority of discrepant/questionable measurements. Corrective action in the handling of cables and connectors should have a large impact, especially for the longer firing periods. Most of the questionable measurements exhibit short intermittent dropouts where most of the data is valid. Others exhibit a level shift prior to or after the test firing.

It is anticipated that with the current fixes installed and proper cable/connector interfaces the pogo measurement quality will continue to increase. Probable causes have been suggested except for two discrepant conditions: unacceptable levels of very low frequency noise and data level shifts. These two problems may be related to the test stand grounding configuration, but further investigation is required.

5. REFERENCES

1. Task Plan, Amplitude, and Phase Response Accuracy Analysis for Pogo and Other Wideband Measurements, LEC-8306, April 1976.

2. MPTA/DFI Pogo Accelerometer Filter Characteristics, JSC-11610, August 1978.

3. Pogo WBSC Overload Tests, Sine Vibration 400-1800 Hz, LEC-13181, January 1979.

4. Low Pressure Oxygen Turbopump Accuracy Analysis (Pogo Pressure Transducers) JSC-14655, December 1978.

5. Low Pressure Fuel Turbopump Measurement Evaluation, JSC-11611, December 1978.

6. Test Report, AC Coupled Strain Gage Signal Conditioner Performance, LEC-13041, December 1978.

7. Rockwell International Space Division Internal Letter, Minutes - MPT Instrumentation Tiger Team Review Telecon Meeting, No. 392-210-78-110, November 1977.

8. MPTA DFI Pogo Pre-Firing Report, JSC-11607, November 1977.

TABLE 1. DATA EVALUATION SUMMARY

TRK-CH	MEASUREMENT #	MEASUREMENT TITLE	SF 4	SF 5	SF 6-04	SF 7-02
1-1	V41P9195H	E1 LPOTP IN PRESS	OK	Q	OK	OK
1-2	V41P9295H	E2 LPOTP IN PRESS	OK	BAD	OK	OK
1-3	V41P9395H	E3 LPOTP IN PRESS	OK	OK	Q	OK
1-4	F4SK9490H	PULSER SERVO CURRENT MONITOR	OK	OK	OK	OK
1-5	F48C9492H	MONITOR	OK	OK	OK	OK
1-6	F48H9491H	PULSER PISTON POSITION	OK	OK	OK	OK
1-7	V08D9451H	E1 GMBL X VIB	BAD	OK	OK	OK
1-8	E41D9193H	E1 HPOTP X VIB	BAD	Q	Q	OK
1-9	V08D9463H	E1 LPOTP IN X VIB	BAD	OK	Q	OK
1-10	V08D9460H	E1 LPOTP IN X VIB	OK	OK	Q	Q
1-11	V08D9454H	E2 GMBL X VIB	BAD	OK	OK	OK
1-12	E41D9293H	E2 HPOTP IN X VIB	BAD	OK	Q	Q
1-13	V08D9457H	E3 GMBL X VIB	OK	OK	OK	OK
1-14	V08D9466H	E3 LPOTP IN X VIB	OK	OK	Q	Q
1-15	E41D9391H	E3 LPOTP IN X VIB	BAD	Q	Q	OK

TABLE I. (CONT.)

	MEASUREMENT #	MEASUREMENT TITLE	SF4	SF5	SF6-04	SF7-02
2-2	A08D9195M	ORB-ET FWD. INT. Y-AXIS VIB	OK	OK	OK	OK
2-3	A08D9196M	ORB-ET FWD. INT. Z-AXIS VIB	OK	OK	OK	OK
2-4	A08D9197M	ORB-ET AFT INT. X-AXIS VIB	OK	OK	OK	OK
2-5	A08D9198M	ORB-ET AFT INT. Y-AXIS VIB	OK	OK	OK	OK
2-6	A08D9199M	ORB-ET AFT INT. Z-AXIS VIB	OK	OK	OK	OK
2-7	A08D9194M	ORB-ET FWD INT. X-AXIS VIB	OK	OK	BAD	Q
3-1	A41P9994M	LO2 AFT FEED MANIFOLD PRESSURE	OK	OK	OK	OK
3-2	A49D9878M	E1 HPFTP Y-AXIS VIB	BAD	Q	Q	Q
3-3	G08D9828M	TS/ET LINK FWD INT. X-AXIS VIB	OK	OK	OK	OK
3-4	G08D9829M	TS/ET LINK FWD INT. Y-AXIS VIB	OK	OK	OK	OK
3-5	G08D9830M	TS/ET LINK FWD INT. Z-AXIS VIB	Q	OK	BAD	Q
3-6	A49D9879M	E-1 HPFTP Z-AXIS VIB	BAD	OK	Q	Q
3-7	G08D9836M	TS/ET LINK AFT INT Y-AXIS VIB	OK	OK	BAD	OK
3-8	G08D9837M	TS/ET LINK AFT INT Z-AXIS VIB	OK	OK	BAD	OK
3-9	F4809835M	POGO PULSER CG Z-AXIS	NA	OK	NA	N.A.

TRK CH	MEASUREMENT #	MEASUREMENT TITLE	SF4	SF5	SF 6-04	SF 7-02
4-1	V41P1100M		NA	OK	BAD	BAD
4-3	E41P9197P	E1 HPOTP IN PRESS	BAD	OK	Q	BAD
4-4	E41P9397A	E3 HPOTP IN PRESS	OK	Q	OK	OK
4-5	E41P9199A	E1 MCC PRESS	OK	OK	OK	OK
4-6	E41P9399A	E3 MCC PRESS	OK	Q	OK	OK
4-7	V08D9461A	E1 LPOTP IN Y	BAD	OK	Q	OK
4-8	V08D9462A	E1 LPOTP IN Z	BAD	OK	BAD	OK
3-10	F48D9984M	POGO PULSER CG X-AXIS	NA	OK	BAD	OK
3-9	F48D9985M	POGO PULSER Y-AXIS	NA	NA	OK	Q
3-11	F48D9990M	POGO PULSER CG Y-AXIS	NA	OK	BAD	NA
3-11	F48D9986M	POGO PULSER Z-AXIS	NA	NA	NA	OK

TABLE I. (CONT.)

TRK-CH	MEASUREMENT #	MEASUREMENT TITLE	SF4	SF5	SF6-04	SF7-02
4-9	E41D9194A	E1 HPOTP Y	BAD	Q	Q	Q
4-10	E41D9195A	E1 HPOTP Z	BAD	Q	Q	Q
4-11	V08D9452A	E1 GIMBL PAD Y	OK	OK	OK	OK
4-12	V08D9453A	E1 GIMBL PAD Z	OK	OK	OK	OK
5-1	V41P1300M		NA	OK	OK	OK
5-2	V41P9400A	LOX FEED MAN. PRESS	OK	OK	OK	OK
5-3	E41P9298A	E2 HPFTP IN PRESS	OK	OK	OK	OK
5-4	E41P9198A	E1 HPFTP IN PRESS	OK	OK	OK	OK
5-5	E41P9398A	E3 HPFTP IN PRESS	OK	OK	OK	OK
5-6	A49D9877M	E1 HPFTP X	BAD	Q	Q	OK
5-7	V08D9467A	LOX MAN X	OK	OK	OK	OK
5-8	V08D9468A	LOX MAN Y	OK	OK	OK	OK
5-9	V08D9458A	E3 GIMBL Y	OK	OK	OK	OK
5-10	V08D9459A	E3 GIMBL Z	BAD	OK	OK	OK
6-2	A08D9874M	E1 LPFTP X	OK	Q	OK	OK

TABLE I. (CONT.)

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TABLE I. (CONT.)

TNK/CH	MEASUREMENT #	MEASUREMENT TITLE	SF 4	SF 5	SF6-[illegible]+	SF 7-0
6-3	A08D98[illegible]M	AFT COMP Z-AXIS VIB	OK	OK	Q	OK
6-4	A08D9897M	AFT COMP X-AXIS VIB	OK	BAD	OK	OK
6-5	A08D9[illegible]	AFT COMP Y-AXIS VIB	OK	Q	BAD	BAD
6-6	A08D99[illegible]	ORB AFT SECT Y-AXIS VIB	OK	OK	Q	OK
6-7	A08D9[illegible]M	ORB AFT SECT X-AXIS VIB	OK	OK	Q	BAD
7-8	V08D9464A	E2 LPOTP IN Y-AXIS	BAD	Q	BAD	BAD
7-9	V08D9465A	E2 LPOTP IN Z-AXIS	BAD	OK	BAD	BAD
7-1	V41P1200M		NA	OK	BAD	BAD
7-11	V08D9456A	E2 GMBL PAD Z-AXIS	OK	OK	OK	OK
7-3	E41P9297A	E2 HPOTP INLET PRESS		OK	OK	OK
7-10	V08D9455A	E2 GMBL PAD Y-AXIS	OK	OK	OK	OK
7-5	E41P9299A	E2 MCC PRESS	O[illegible]	OK	OK	OK
7-6	E41D9294A	E2 HPOTP Y	BAD	Q	BAD	BAD
7-7	E41D9295A	E2 HPOTP Z	BA[illegible]	Q	BAD	BA[illegible]

TRK-CH	MEASUREMENT #	MEASUREMENT TITLE	SF 4	SF 5	[illegible]	SF 7[illegible]
8-1	A08D9875M	E1 LPFTP Y-AXIS VIB	OK	OK	OK	OK
8-2	A08D9876M	E1 LPFTP Z-AXIS VIB	OK	OK	OK	OK
8-3	A08D9857M	ORB MID SECT Z-AXIS VIB	OK	OK	Q	Q
8-4	A08D9858M	ORB AFT SECT X-AXIS VIB	OK	Q	BAD	BAD
8-5	A08D9996M	LH2 MANIFOLD X-AXIS VIB	OK	BAD	OK	OK
8-6	A08D9997M	LH2 MANIFOLD Y-AXIS VIB	OK	OK	OK	OK
8-7	A08D9998M	LH2 MANIFOLD Z-AXIS VIB	OK	OK	OK	OK
8-8	A08D9831M	E1 LO2 LN BEND X-AXIS VIB	OK	BAD	BAD	BAD
8-9	A08D9832M	E1 LO2 LN BEND Y-AXIS VIB	BAD	OK	OK	Q
8-10	A08D9833M	E1 LO2 LN BEND Z-AXIS VIB	OK	OK	BAD	BAD
8-11	A08D9834M	E2 LO2 LN BEND X-AXIS VIB	OK	OK	BAD	BAD
8-12	A08D9885M	E2 LO2 LN BEND Y-AXIS VIB	OK	Q	BAD	BAD
8-13	A08D9886M	E2 LO2 LN BEND Z-AXIS VIB	OK	Q	BAD	BAD

TABLE I. (CONT.)

TABLE I. (CONT.)

TRK-CH	MEASUREMENT #	MEASUREMENT TITLE	SF 4	SF5	SF 6-04	SF 7-02
9-1	T08D9946A	LH2 TANK BOTTOM X	OK	OK	BAD	OK
9-2	T08D9947A	LH2 TANK BOTTOM Y	OK	OK	BAD	OK
9-3	T08D9948A	LH2 TANK BOTTOM Z	OK	OK	BAD	OK.
9-4	T41P9093A	LH2 TANK BOTTOM PRESS	Q	Q	Q	OK
9-5	T08D9973A	MID LH2 TANK LONG	OK	OK	BAD	OK
10-1	T08D9979A	LO2 FEEDLINE AFT HARDPOINT X	OK	BAD	OK	OK
10-2	T08D9980A	LO2 " " " Y	Q	OK	OK	OK
10-3	T08D9981A	LO2 " " " Z	Q	Q	OK	OK
10-4	T41P9991A	LOX FWD FEEDLINE PRESS	OK	OK	OK	OK
10-5	T41P9992A	LOX MID FEEDLINE PRESS	OK	OK	OK	OK
11-1	T08D9970A	LO2 FEEDLINE LONG	Q	OK	OK	Q
11-2	T08D9971A	LO2 FEEDLINE TAN	Q	OK	Q	Q
11-3	T08D9972A	LO2 FEEDLINE NORM	Q	OK	OK	Q
11-4	T41P9993A	LOX LOWER FEEDLINE PRESS	OK	OK	OK	OK

TABLE I. (CONT.)

TRK-CH	MEASUREMENT #	MEASUREMENT TITLE	SF 4	SF 5	SF6-04	SF 7-02
12-1	T08D9943A	LO2 TANK BOTTOM X		OK	OK	Q
12-2	T08D9944A	LO2 TANK BOTTOM Y	Q	OK	Q	Q
12-3	T08D9945A	LO2 TANK BOTTOM Z	Q	OK	BAD	Q
12-4	T41P9095A	LOX TANK OUTLET PRESS	OK	OK	OK	Q
13-1	T08D9961A	NOSE X	Q	OK	Q	Q
13-2	T08D9962A	NOSE Y	Q	OK	Q	Q
13-3	T08D9963A	NOSE Z	OK	OK	Q	Q
13-4	T08D9974A	MID LH2 TANK TAN	Q	Q	BAD	OK
13-5	T08D9975A	MID LH2 TANK RAD	OK	OK	OK	OK

TABLE II. - FILTERS VS. MEASUREMENTS

MEAS. #		DESCRIPTION			FILTER CUT-OFF FREQ.
B41D	9193A	E-1	HPOTP	X AXIS	1 KHz
B41D	9194A	E-1	HPOTP	Y AXIS	"
B41D	9195A	E-1	HPOTP	Z AXIS	"
B41D	9293A	E-2	HPOTP	X AXIS	"
B41D	9294A	E-2	HPOTP	Y AXIS	"
B41D	9295A	E-2	HPOTP	Z AXIS	"
B41D	9393A	E-3	HPOTP	X AXIS	"
A49D	9877M	E-1	HPFTP	X AXIS	"
A49D	9878M	E-1	HPFTP	Y AXIS	200 Hz
A49D	9879M	E-1	HPFTP	Z AXIS	1 KHz
B41P	9197A	E-1	HPOTP	IN PRESS	"
B41P	9297A	E-2	HPOTP	IN PRESS	"
B41P	9397A	E-3	HPOTP	IN PRESS	"
B41P	9199A	E-1	MCC	PRESS	"
B41P	9299A	E-2	MCC	PRESS	"
B41P	9399A	E-3	MCC	PRESS	"
V08D	9451A	E-1	GMBL	PAD X AXIS	"
V08D	9454A	E-2	GMBL	PAD X AXIS	"
V08D	9457A	E-3	GMBL	PAD X AXIS	"
V08D	9460A	E-1	LPOTP	X AXIS	200 Hz
V08D	9463A	E-2	LPOTP	X AXIS	"
V08D	9466A	E-3	LPOTP	X AXIS	"
B41P	9196A	E-1	ACCUM	PRESS	"
B41P	9296A	E-2	ACCUM	PRESS	"
B41P	9396A	E-3	ACCUM	PRESS	"

TABLE III.- LOW PASS FILTER PHASE

VS. FREQUENCY & ESTIMATED TOLERANCE

FREQUENCY Hz	PHASE DEGREES ± TOLERANCE 200	1000 Hz
5	1.0± .1	.2 *
10	2.0±.2	.4
15	3.0±/35	.6
20	4.0±.45	.8
25	5.1±.57	1.0
30	6.1±.7	1.2
35	7.1±.8	1.4
40	8.1±.9	1.6
45	9.2±1.0	1.8
50	10.2±1.9	2.0

* Phase error is negligible

SURVEY OF DYNAMIC TEST FACILITIES EXPERIENCED IN INSTRUMENTATION USE OF MINIATURE COAX CABLING AND CONNECTORS

(JSC/R. Sinderson)

A. NSTL Single Engine Firing-Rocketdyne/NST'. (Jack Nail, 494-2296, Bill Talbert, 494-2103)

- Microdot Golden Crimp Connector (P/N 132-0113-0003) but with:
  - adhesive added to rear seal (moisture protection and strain relief) to keep in place.
  - shrink tubing added for improved strain relief.
- More Flexible Cable (3'-10') Used To Interface Sensor With Fixed Vehicle Harness. (Tensolite rather than Endevco).
- Only 1-3 Techs assemble connectors to cable at fieldsite (highly trained).
- Pre-installation cable assembly sensor testing--resis. check, capacitance bridge check, sensor tap test, cable wiggle test (special buzz box).
  - cables installed, if possible, after any area rework has been performed.
  - sensor tap test after installation.
- High Torque, 100 ±5 in.-oz., to secure connector nut.
- Epoxy safetying.
- Tight service loop at sensor--cable looped up and back down and secured to sensor by 1/2 in. wide fiberglass tape.
- Connector-Sensor Encasement (Waterproofing using Proseal 501 Mylar).
- Frequent cable tie-downs, e.g. every 10 in. (Don't tie too tight or Teflon will flow and short may occur.)

RESULTS

Implementing the above methods has reduced the original major connector/cable problems to only very minor problems (the past 2 years they have had high success rate).

B. NSTL MPT Firings-NSTL/Rockwell (Charlie Knott, 494-3313).

- Microdot Golden Crimp Connector (P/N 132-0115-0002)* but with:
  - shrink tubing added for improved strain relief.
- Torque by hand, "by feel," using small pliers to secure connector nut.
- No safetying (no lockwire or epoxy).
- Tight service loop at sensor--see above.

* The 0115 connector is oversize for .090 dia. cable but their cable came in oversize.

RESULTS

Much improved recent results. Some connector damage from personnel traffic still occurring, but NSTL personnel think gross abuse of connector cannot be protected against. They are presently satisfied with their improved installation techniques. However, about 30 pogo and pogo related measurements still have questionable signal characteristics for reasons unknown according to JSC's evaluation.

C. Santa Suzanna Test Stand (Don Heim 984-8000/X5456, Rocketdyne).

- Endevco Std. 10-32 Plug (stainless steel, safety wire holes).
- Endevco Cable/Connector Std. Hi Environment Assembly, P/N 3090B.
- High torque 100-115 in.-oz. to secure connector nut.
- Teflon tape for moisture protection and connector safetying.

RESULTS

Satisfactory except for some handling damage.

D. Flight Orbiter Engines (Rudy Phillips, 984-3100, Rocketdyne)

- Endevco Std. 10-32 Plug (stainless steel, safety wire holes). (Replacement connector is Endevco EP159, Microdot Std. Connector 132-021-0001).
- Endevco Cable/Connector Std. Hi Environment Assembly, P/N 3090B.
- High torque, 100-115 in.-oz. to secure connector nut.
- RTV sensor connector encapsulation for moisture protection.

- FASCOS uses same connector/cable as for DFI (Endevco 3090B).

  RESULTS

  Must await FRF (should be similar to Santa Suzanna results given above.)

E. JSC Dynamics Test Lab (Bldg. 49, Bill Zuber, Stacy Huggins, X3483).

- Microdot Std. Connector, P/N 032-0021-0001.
- Long Microdot cables (orange, vinyl coated, flexible, low noise) to charge amplifiers.
- Fingertight connector torque.
- Close to sensor cable tiedown (2-3 in.) and frequent cable tiedowns thereafter.
- If signal noisy, then connector cleaned with freon or isopropyl alcohol.
- Capacitance check on Fluke Impedance Bridge (old style dynamic "eye" indicator) while connector-cable is wiggle tested.

  RESULTS

  Very satisfactory. Sometimes connector nut works loose, or pin/socket needs cleaning.

F. MSFC Dynamics Test Lab (Garland Johnston, 872-5971)

- Microdot Golden Crimp, P/N 132-112-0002.

G. Langley Dynamics Test Lab (Sy Ledbetter, 928-2446)

- Microdot Std. Connector, P/N 032-0021-0001.
- Short (2-20 ft.) Microdot cable interface with std. coax facility cabling.
- Fingertight connector torque.
- Frequent cable tiedowns (every 12 in. until off vibrating structure).
- No other special precautions.

RESULTS

No problems except for occasional contamination on center pin which can be cleaned with pencil eraser.

H. Dryden Aircraft Instrumentation (Cleo Maxwell, Arden Lawhead, 984-8611).

- Microdot Std. connector P/N 032-0021-0001.
- Fingertight connector torque.
- Locktite or strain-gage coating used to safety bond connector nut to sensor.
- Cable tied down close to sensor and frequently thereafter.
- Meggar check and AC signal simulator used after cable installation.

RESULTS

Very satisfactory except for occasional handling damage.