

Change  
2.6 Hubbell 5266 to Hubbell 3331G

NEMA inside racks

Add  
✓ 2.6.1 A 3-phase, 208 volt, four wire outlet will supply power for the ramlock solenoid valves. This will be a four wire system capable of supplying 100 amps of 120 VAC power when connected between a line and neutral.

Change  
✓ 2.7 Maintenance Philosophy  
System level maintenance on the 747 Fatigue Test Instrumentation system will be performed by the system operators. System level maintenance is defined as that maintenance performed on site with the equipment in its operating location. In general it will include making level adjustments, isolation of malfunctioning parts by substitution, test point monitoring etc., and diagnostic programs.

Other maintenance, component level and periodic, will be handled by the Maintenance Lab, Org. 6-8220 In some instances component level may be interpreted as the card level. In general periodic maintenance will be scheduled between runs or during inspection periods.

Change  
✓ 2.7.1 Repeat 2.7 from Rev. B

Change  
✓ 3.0 See Figure 3.0.1 for a conceptual view of the Instrumentation System equipment layout.

Add  
✓ 3.2.3 A control and monitor panel for the Body Air System will be located at the Test Directors Station. This Panel will be 3.50 nominal height by standard 19 inch width. ~~Instrumentation Projects (6-8224)~~ will provide the panel and all components.

✓ 3.3.1 Airplane Moment Display  
Revise -- It is required that the airplane roll moment be displayed at the Test Director's Console.

✓ 3.3.3 Vertical Reaction Recorders  
Add -- These recorders shall be located at the Test Director's Console.

✓ 3.3.4.1 Test Spectrum Number  
Revise -- A spectrum counter is required to tally the total number of spectra completed. The counter shall count only if the ram locks are open. The count shall be displayed at the Test Director's Station.

✓ 3.3.4.2 Program Condition Number:

Revise -- A condition number counter is required to determine progress within the spectrum. The counter will tally the total number of condition points completed within the active spectrum. The count will be displayed at the Test Director's Station.

3.3.5 Reaction, Programmed and Applied Load Monitors;

Ten recorder channels are required at the Test Director's Console for Reaction, Programmed and applied load monitoring. It shall be possible to switch reaction, test and/or programmed loads into these recorders. Use output connector J-2 from the Boeing Std. Controller for the test load input. It shall be possible to record each load on two separate recorders (not simultaneously). It shall be possible to switch in one additional variable into each recorder and thereby, with switches properly set, compare programmed and actual loads from each channel. Each recorder shall have an event marker to indicate the beginning of a new spectrum. The response time of the recorders shall be  $\frac{1}{2}$  second full scale or better. The readout accuracy shall be  $\pm 1.0\%$  or better. Each recorder channel shall have at least 10 inches F.S. travel. All recorders will be operated with pen zero at center scale to facilitate switching in positive and negative (or both) loads at random. This requirement plus that of paragraph 3.3.3 will constitute a total of 16 recorder channels or 8 dual channel recorders.

*Buffered Feedback*

3.3.6 Unless specifically stated to the contrary, the Body Air System will hold the programmed pressure level when lockup of the Hydraulic System occurs. When the Programmer Override Switch on the M.C.C. is switched to the "Override" position the Body Air System will Dump.

*Require to run Body Air System independent of loads.*

✓ 3.3.6.4 Body Air System will ~~Dump~~ <sup>only if Body air controller fails.</sup> **ADDED**

✓ 3.3.6.6 Body Air System will ~~Dump~~ <sup>Hold</sup> **ADDED**

✓ 3.3.6.7 Revise -- Excess roll moment shall be displayed by a red light on the System Operator's Console, rack no. 4, and be displayed by a malfunction print out on the teletype. Excess roll moment shall cause a system lock-up.

✓ 3.3.6.8 Revise -- First line should read "...Normally Closed switches...."

*add to*  
3.3.6.9 ~~Revise~~ -- Excess reaction load<sup>and excess roll moment</sup> shall be sensed on the same bridge that is being recorded on the strip chart recorders. Each reaction load shall have two limit ranges; each range shall be adjustable. The high range shall be used to reset the system; it shall be activated by means of a ~~momentary~~ switch located on the ~~Test Operator's Panel.~~  
*System*

3.3.6.15 ~~Revise~~ -- First line should read "Data Acquisition *bridge power*  
= ~~sub-system...~~" and line 4 "~~...sub-system failure...~~".

3.3.6.18 Change

High manifold air pressure, determined by a normally closed pressure switch shall be displayed by a yellow *blue* indicator light on the test director ~~rack #4, and~~ *station,* also by the malfunction printout of the teletype. ~~High manifold pressure shall stop programmer.~~

3.3.6.19 Change

Low receiver air pressure, determined by a normally open pressure switch, shall be displayed by a blue indicator light on the test director ~~rack #2.~~ *station,*

✓ 3.3.6.19.1 Excess body air pressure, determined by the control pressure transducer, shall be displayed by a red indicator light on the system operator *station* ~~rack #2.~~ and be displayed by the malfunction printout of the teletype. Excess pressure will cause hydraulic system lockup. Excess pressure will Dump body air.

3.3.6.20 Change

Low plant air, determined by a normally open pressure switch, shall be displayed by a red indicator light on test director ~~rack #2~~ *station* and be displayed by the malfunction printout of the teletype. Pressure failure shall cause system lockup. ~~Body air system will dump.~~

3.3.6.21 Revise -- Line 2 should read "...Rack #6."

3.3.6.22 Revise -- Line 2 should read "...Rack #6."

3.3.6.23 Revise -- Line 2 should read "...Rack #6."

3.3.6.24 Revise -- Line 2 should read "...Rack #6,..."

3.3.6.25 Whenever a "Dump" occurs in the hydraulic system it will affect both the Major and separate Stabilizer tests. A "dump" originating from the Major Test will be accompanied by an opening switch for use by the Stabilizer test. A "dump" originating from the Stabilizer Test will be accompanied by an opening switch for use by the Major Test.

✓ 4.2

#### Programmer

2nd Paragraph Revise -- The programmer will have the capability to automatically reset all channels to the point of lock-up or any selected program condition point. It shall also be possible to go from any condition point to any other selected condition point in a linear manner; all loads reaching the new condition point at the same time. It is required that a pre-determined number of ground air ground cycles be applied. It shall be possible to quickly and conveniently program these loads.

✓ 4.2.1

#### Independent Program Channels

Revise -- The programmer shall have rack space and be wired and equipped for a minimum of 55 independent program channels. Expansion capability should be considered in the design. ~~The actual requirements are for 48 independent program channels for load and pressure control, and 7 spares.~~

✓ 4.2.2

#### Isolated Outputs

Revise -- A minimum of <sup>90</sup>100 buffered programmer outputs are required. Expansion capability to ~~100~~ should be considered in design. Each output signal must be isolated from all other outputs by no less than 100 db at 60 Hz. The 55 independent programmer channels will be easily connected to the 100 buffered programmer channels in groups consisting of 1 to 8 outputs per programmer channel.

✓ 4.2.3

#### Test Spectrum (Change)

The total test spectrum shall contain a maximum of 600 load condition points and shall be similar to that shown in ST/T-32. The minimum load change between any consecutive load condition points will be 1%. The maximum load change between any consecutive load condition points will be 100%.

✓ 4.2.6

Delete the word "combined" from last sentence

4.2.7

#### Change

The Body Air System shall be treated in a similar manner to the hydraulic load channels. The feedback signal will be supplied by a bridge type pressure transducer. The servo controller output signal will be amplified to drive a series of Electro-pneumatic transducers which will in turn control the air system valves. }

✓ 4.3.1.1 Revise Table as follows:

Load Point	Load Range
36	5-20 K
42	30-50 K
54	70-100 K
8	150-250 K

This should follow 4.3.1

Tentative Values Est. 9-20-68  
Figure 4.3.1.1

✓ 4.3.3.1 Change

Dual range load cells shall be used to measure main landing gear reaction loads. Four independent outputs (2 each range) shall be provided for measure and control functions. Load cells will be provided by Instrumentation Projects.

✓ 4.3.6 Automatic Reset to Program

Revise -- An automatic reset system shall be provided which will bring the specimen from any spectrum condition point to any other condition point smoothly and without exceeding normal reaction or roll limits.

In case of lock-up, the system shall reset to the point of lock-up or any selected condition point.

✓ 4.4.2 Change

The body air system will use ten Electro-pneumatic transducers to control 10 inlet and 18 outlet valves. The output signal from the servo-controller will be amplified to provide sufficient current for the 10 transducers. Instrumentation Projects will provide the amplifier(s) and circuitry necessary to operate the transducers. The inlet valves will be fail-safe closed while the outlet valves will be fail-safe open.

another name? → exhaust  
?? { An ~~emergency dump~~ switch shall be provided for the body air system. This switch will close inlet and open outlet valves. Switch location will be on the test directors console.

✓4.5

### Roll Correction

Revise -- The system must be capable of correcting for excessive roll. Roll correction will be distributed in selective wing channels (4 RH, 4 LH). Roll will be sensed in the main landing gear reaction load cells. These load cells will have four bridges each; two for the 0 to \_\_\_\_\_ pound and two for the 0 to 25,000 pound ranges. One output of the low range shall be used for roll correction. The output of the low range shall be 2 mv/volt up to 25,000 pounds, and remain constant beyond 25,000 pounds. The second high range output shall be recorded on the Test Data System.

change all  
roll to  
roll moment

The airplane will be critical in roll during flight conditions. The MLG loads will be approximately 25,000 pounds during these conditions. Roll correction must be made in such a manner as not to exceed ~~the~~ tolerance limits ~~on~~ any loading channel. The feedback signal for roll correction will be the differential signal supplied from the summation of the low range of the MLG dual sensitivity load cells. It must be possible to scale these outputs ~~to match the roll characteristics of the airplane.~~ independently.

preset →

impossible!  
EOM

✓5.1

### System Lockup

When System Lockup occurs the Body Air will dump or hold depending on the cause of the lockup

✓5.1.1

The system will lock in place and Body Air will hold under the following conditions

- a. Excess load on ~~any~~ except Body Air System.
- b. Excess servo error on ~~any~~ except Body Air System.
- c. Excess travel of specimen or parts
- d. Recondor failure
- e. ~~Emergency~~ stop button pushed.
- f. Excess roll moment.
- g. Excess reaction loads.
- h. Hydraulic system malfunction (including dump)
- j. Low plant air pressure

✓5.1.2

The system will lock in place and Body Air will dump under the following conditions:

- a. Controller power failure
- b. Surveillance/Interrupt power failure
- c. ~~Low plant Air Pressure.~~
- d. Excess Body Air Pressure
- e. Main A. C. Power failure

✓5.2

Revise -- c. Excess servo error in Body Air channel ???  
~~Add -- d. Excess pressure in Body Air manifold.~~

✓5.3

~~Add -- f. Low Body Air receiver pressure.~~  
delete d.

✓6.1

Master Control Console Displays  
d. omit  
e. omit

- ✓ 6.2 Change -- 1000 to 600 (Condition points)
- ✓ 6.2.1 Change -- 1000 to 600 (Condition points) 2 places
- ✓ 6.3.1 Revise -- There shall be a graphic display of the test spectrum. It shall have indicator lights to identify the condition that is being run such as taxi, take-off, cruise, etc. Display will be provided by IPO
- ✓ 6.3.3 Revise -- There shall be a digital display showing the number of spectra completed.

✓ 7 Strain Gage Data Acquisition System

Strain Gage data from the specimen must be acquired and stored for processing at a later time. The 250 channel B and F recorder shall be used for this purpose. All 1040 Channel (600 Axial and 150 Rosettes) shall be recorded at one condition point of each spectrum five times each life (5000 spectrum). A patchboard will be used to switch selected channels to the recorder.

supplied by IPO

✓ 7.4 Dynamic Monitoring of Strain Gages

Revise -- In order to evaluate the magnitude of the effect on wing stress at speeds between 1/10 and 1/5 of the fundamental wing frequency, 10 axial strain gages will be monitored during cycling. This will require a dynamic recording of these 10 gages. The absolute recording accuracy will be the same as required on the strip charts, with a repeatability of  $\pm 1\%$ .

(IPO) IPO wires, IR&D provides recorders

The remaining 1040 channels of strain gages shall be recorded at each test condition two times each life. Approximately 100 strain gages will be recorded at each failsafe load condition 5 times each life.

4 - switch selectable chans

#### 4.6 Dual Actuator Body Load Systems

There will be a total of 5 body load systems that will require 2 hydraulic actuators per system. One servo controller and servo valve will supply both actuators. Two load cells, one used with each actuator, will provide 4 outputs which will be used as follows:

- Measure (A) - Data Acquisition
- Control (A)  $\frac{1}{2}$  Measure (B) - Summation to limit detector
- Control (B) - Servo Controller and Load Monitor (Strip Chart).

An excessive difference of bridge outputs Control A and Measure B will lock the hydraulic system in place. The body air system will hold. The difference detector

in outputs must be adjustable to detect a difference of 5% or 10% of full scale or greater.