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CF-105 A/C 1, 2 & 3

PROPOSED FLIGHT TEST PROGRAM

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DEC. 1955.

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CF-105

PROPOSED FLIGHT TEST PROGRAM

(A/C 1, 2 and 3)

Classification cancelled/changed to ....
by authority of .... (date) ....
Signature .... Rank ....

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Avro Aircraft Ltd.,
Malton, Ontario.

December 1955.

FLIGHT TEST PROGRAM AND INSTRUMENTATION FOR THE FIRST THREE PROTOTYPES

INTRODUCTION

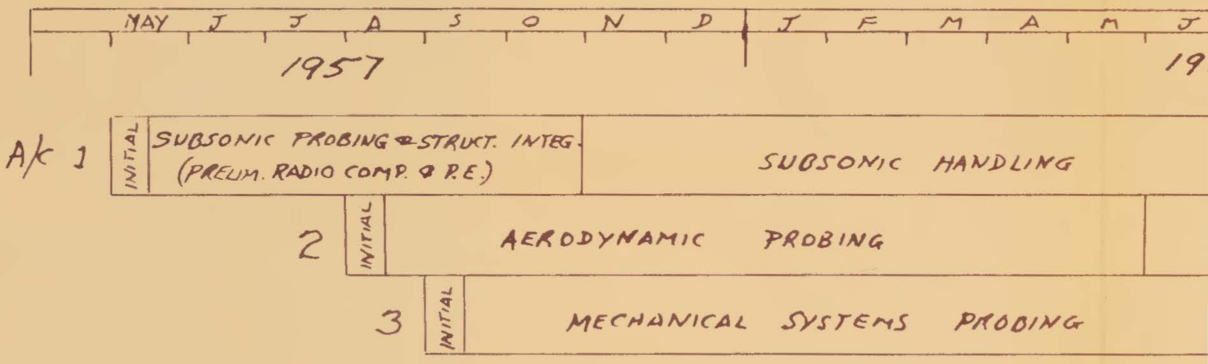
The primary role of the first two airplanes will be to check out the stability and control, however, during the early flights of the first airplane, it will be necessary to check quickly that the various mechanical and electrical systems are operating in a satisfactory manner. At this stage we would not attempt to develop the systems to meet the full requirements of AIR 7-4 or associated specs. but merely satisfy ourselves that they are safe to continue flying. The development to AIR 7-4 standards will be carried out on the third airplane.

It can be assumed, broadly speaking, that when the third airplane gets through its initial shakedown tests that it will do all mechanical and electrical systems testing and airplanes one and two will concentrate in aerodynamic testing. All three airplanes will have the instrumentation listed in the Appendix so that any one of them could become an aerodynamic or mechanical development test vehicle as emergency dictates.

The flight test program for these airplanes is shown in Fig. I and pages 2 to 6, and instrumentation is listed in the Appendix. The instrumentation list on 'Structural Integrity' only covers preliminary testing, the list for final structural integrity is not included as the method by which this shall be done and the airplane which will be allocated for these tests has not been definitely decided.

CF 105 FLIGHT TEST

(A/C 1, 2 & 3)



...HT TEST PROGRAM
..., 2 & 3)

A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
1958									1959					

...DLING	SUPERSONIC HANDLING	PERFORMANCE
	SUPERSONIC HANDLING	PERFORMANCE
...ODING	STRUCTURAL INTEGRITY, THERMODYNAMICS AND MECHANICAL DEVELOPMENT	

DEC. 1955

FIG. 1

A/C NO. 1 - AERODYNAMIC TESTS

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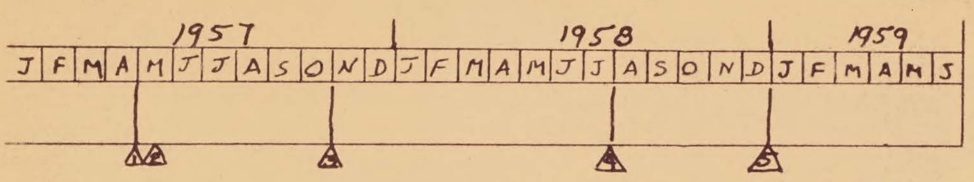

		FLIGHTS	AIRCRAFT MONTHS
1.	Initial flights for airframe and engine acceptance	4	0.5
2.	Subsonic probing and structural integrity		
	A/C stability and control	7	
	Adjust and assess automatic stabilization	21	
	Preliminary structural integrity	7	
	Preliminary position error	1	
	Preliminary radio compass & Navigation Aids	3	
		39	5.5
3.	Subsonic handling tests		
	Dynamic stability	18	
	Static longitudinal stability	8	
	Elevator power and control	6	
	Effect of air brakes	3	
	Lateral control, rates of roll	5	
	Stalls, $C_{L\ max.}$, buffet boundary	10	
	Asymmetric power	4	
	Diving tests	6	
	External tank	3	
		63	9.0
4.	Supersonic handling tests (with A/C No. 2)		
	Dynamic stability	32	
	Static longitudinal stability	8	
	Elevator power and control	9	
	Lateral control, rates of roll	6	
	Stalls, $C_{L max.}$, buffet boundary	14	
	Asymmetric power	4	
	Diving tests	12	
	Total for A/C No. 1 and No. 2	85	13.0

(5 months available on A/C No. 1)

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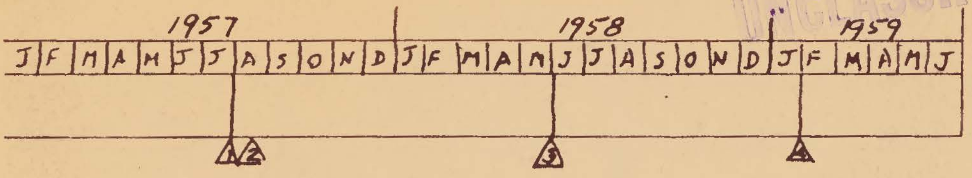
	FLIGHTS	AIRCRAFT MONTHS
5. Performance tests (with A/C No. 2)		
Calibration of pitot, static, temperature, sideslip and angle of attack probes	8	
Level speed and fuel consumption		
A/C clean	16	
External tank fitted	8	
Single engine operation	7	
Combat and ferry missions	10	
Climb, descent, ceiling	6	
Take-off and landing (normal cases)	0	
Take-off - engine failure	4	
Acceleration and deceleration	10	
Minimum turning radius at altitude	8	
Total for A/C No. 1 and No. 2	77	11
(6 months available on A/C No. 1)		
Total, Aircraft No. 1	265	27.0

A/C NO. 2 - AERODYNAMIC TESTS



		FLIGHT	AIRCRAFT MONTHS
1.	Initial flights for airframe and engine acceptance	4	0.5
2.	Aerodynamic Probing and structural integrity		
	Adjust & assess automatic stabilization	62	
	Preliminary structural integrity	4	
		66	9.5
3.	Supersonic handling (with A/C No. 1)	(91)	(13.0)
	(8 months available on A/C No. 2)		
4.	Performance tests (with A/C No. 1	(70)	(10.0)
	(5 months available on A/C No. 2)		
	Total, Aircraft No. 2	70	23.0

AIRCRAFT NO. 3 - MECHANICAL TESTS

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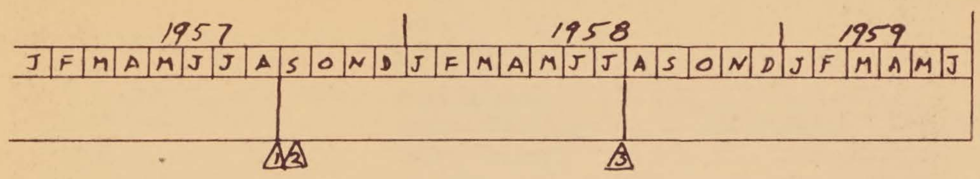

			FLIGHTS	AIRCRAFT MONTHS
1.	Initial flights - Airframe and engine acceptance		4	1/2
2.	Mechanical probing and testing			
	(A) FUEL SYSTEM	Transfer Press. ∲ Level regulation Temperatures Auxiliary Fuel Tank Baffling Unusual Attitudes etc.	20 flights	
	(B) ENGINE	Cooling Afterburner Operation Throttle handling ∲ response Lubrication Auxiliary Drives etc.	20 flights	
	(C) HYDRAULIC - Utility -	operating times Peak Pressures Temperatures Emergency system functioning etc.	7 flights	
	(D) L.P. PNEUMATIC	Air conditioning Cockpit Pressurization Canopy Seal Anti g suits (Fuel Transfer)	20 flights	
	(D) ELECTRICS	Loads Regulation Temperatures	6 flights	
	TOTAL FLIGHTS		73	10 1/2 Months

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3. Mechanical Development, Structural Integrity and Thermodynamics

	FLIGHTS	AIRCRAFT MONTHS
Structural integrity and thermodynamics Structure Fuel System Engine Cooling Inter Coolers etc.	60 flights	8 1/2 months
Mechanical development time (available)	17	2 1/2 months
TOTAL	155	22

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APPENDIX

INSTRUMENTATION TO BE INSTALLED IN A/C 1, 2 and 3

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D.R. Pattie
October /55.

CF-105 INSTRUMENTATION - ISSUE 5.

STABILITY AND CONTROL

In the following list, the instrumentation has been grouped under four headings:-

1. Ambient Conditions.
2. Motion of Aircraft.
3. Control Surface Motion.
4. Control Mechanism.

Three sketches are provided to show the location of instrumentation, or to define quantities to be measured.

Items marked * - Phase shift at 15 cps must not exceed 3°.

Items marked X - Required on continuous trace as well as at specified sampling frequency. Provision to be made to telemeter each of these items on continuous trace, but no more than eight of these items will be telemetered at any one time. Required accuracy in continuous trace recording and in telemetry is ± 3%.

Changes from issue 4, Ref. 3533/22/J are underlined.

1. AMBIENT CONDITIONS (see Fig. 1)

ITEM	RANGE	ACCURACY	ACCURACY % of full range	SAMPLING FREQUENCY
Ambient Conditions				
1) Aircraft Static Pressure	150-2160 lb/ft²	±10 lb/ft²	± 0.5%	1/2 sec X
Limited Range	150-750 lb/ft²	± 4 lb/ft²	± 0.5%	1/2 sec
2) Differential Pressure (Total Head-Aircraft Static)	0-3000 lb/ft²	± (4 + 0.002P) lb/ft²		1/2 sec X
3) Free Air Total Temperature	-65 +350°F	± 2°F	± 0.5%	1/2 sec

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2. MOTION OF AIRCRAFT (see Fig. 2)

ITEM	Range	Accuracy	Accuracy % of full range	Sampling Frequency
4) Angle of Pitch θ *	-60 +60°	± 0.5°	± 0.5%	10/sec
Limited Range *	-10 +10°	± 0.1°	± 0.5%	10/sec
5) $\dot{\theta}$	-30 +30°/sec	± 0.3°/sec	± 0.5%	10/sec X
6) Azimuth Angle ψ*	0-360°	± 0.5°	± .0.1%	10/sec
Limited range *	-10 +10°	± 0.1°	± 0.5%	10/sec
7) $\dot{\psi}$	-30 +30°/sec	± 0.3°/sec	± 0.5%	10/sec X
8) $\ddot{\psi}$	-50 +50°/sec^2	± 0.5°/sec^2	± 0.5%	10/sec X
9) Angle of Bank ϕ *	-85 +85°	± 0.5°	± 0.5%	10/sec X
" Limited range *	-25 +25°	± 0.25°	± 0.5%	10/sec
10) $\dot{\phi}$	-300 +300°/sec	± 2°/sec	± 0.5%	10/sec X
11) Angle of Attack α	-10 +40°	± 0.1°	±0.2%	10/sec X
12) Angle of Sideslip β	-15 +15°	± 0.1°	±0.5%	10/sec X
13) Longitudinal Acceleration $\ddot{X}$	-32 +32 ft/sec^2	± 0.3 ft/sec^2	±0.5%	5/sec
14) Lateral Acceleration $\ddot{Y}$	-16 +16 ft/sec^2	± 0.15 ft/sec^2	±0.5%	10/sec X
15) Normal Acceleration $\ddot{Z}$	-100 +300ft/sec^2 (-3 +8g)	± 2 ft/sec^2	±0.5%	10/sec X

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3. CONTROL SURFACE MOTION (see Fig. 1)

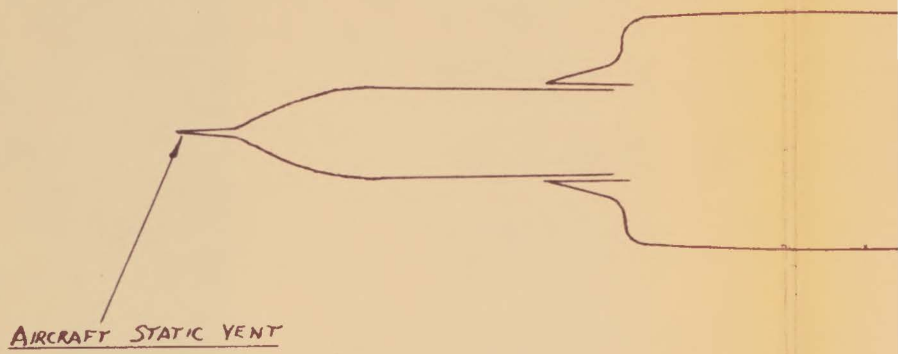
Item	Range	Accuracy	Accuracy % of Full Range	Sampling Frequency
16) Port Elevator Angle δ_e *	-30 +20°	± 0.3°	± 0.5%	20/sec X
Limited Range*	-10 +10°	± 0.1°	± 0.5%	20/sec
17) Port Elevator Angular Acceleration * $\ddot{\delta}_e$	-200 +200°/sec²	± 2°/sec²	± 0.5%	20/sec X
18) Stbd Elevator Angle δ_e *	-30 +20°	± 0.3°	± 0.5%	20/sec X
Limited Range *	-10 +10°	± 0.1°	±0.5%	20/sec
19) Port Aileron Angle δ_a *	-19 +19°	± 0.2°	± 0.5%	20/sec X
Limited Range *	-10 +10°	± 0.1°	± 0.5%	20/sec
20) Port Aileron Angular Acceleration * $\ddot{\delta}_a$	-200 +200°/sec²	±2°/sec²	± 0.5%	20/sec X
21) Stbd Aileron Angle δ_a *	-19 +19°	± 0.2°	± 0.5%	20/sec X
Limited Range *	-10 +10°	± 0.1°	± 0.5%	20/sec
22) Angle of Rudder δ_r *	-30 +30°	± 0.3°	± 0.5%	20/sec X
Limited Range *	-10 +10°	± 0.1°	± 0.5%	20/sec
23) Angular Acceleration of Rudder* $\ddot{\delta}_r$	-200 +200°/sec²	± 2°/sec²	± 0.5%	20/sec X
24) Port Airbrake Angle	0-60°	± 2°	± 3%	5/sec
25) Stbd Airbrake Angle	0-60°	± 2°	± 3%	5/sec

4. CONTROL MECHANISM (see Fig. 3)

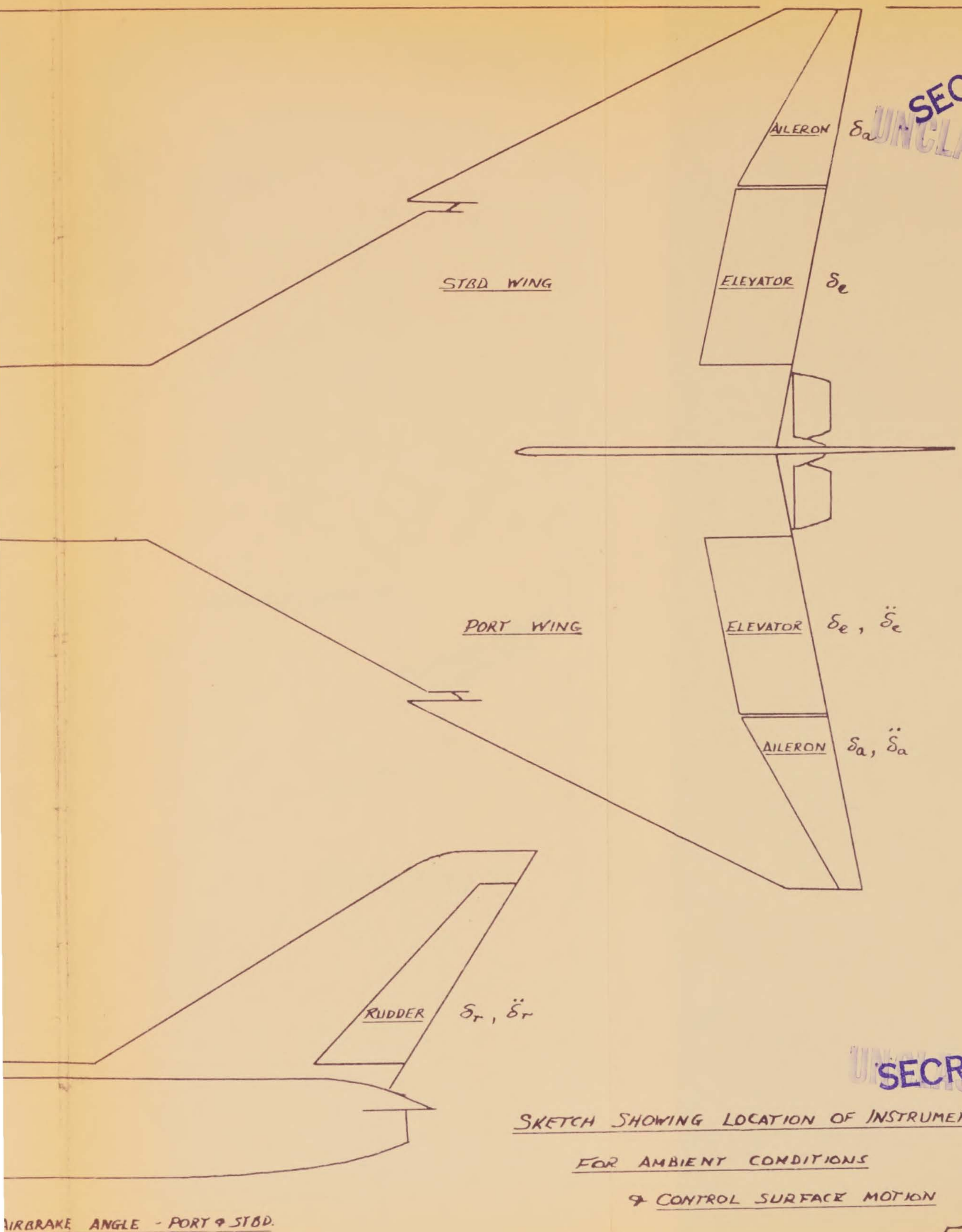
Item	Range	Accuracy	Accuracy % of Full Range	Sampling Frequency
Location (1), Fig 3				
26) Elevator Stick Force	-80 +120 lb	± 2 lb	± 1%	10/sec X
27) Aileron Stick Force	-30 +30 lb	± 1 lb	± 1%	10/sec X
28) Rudder Pedal Force	-150 +150 lb	± 3 lb	± 1%	10/sec
29) Stick position Elevator	0 - 11"	± 0.2"	± 2%	10/sec
30) Stick Position Aileron	0 - 10"	± 0.2"	± 2%	10/sec
31) Rudder Pedal Position	0 - 6.65"	± 0.15"	± 2%	10/sec
Location (2), Fig. 3				
32) Elevator Parallel Servo Position	0 - 3"	± 0.06"	± 2%	10/sec
33) Aileron Parallel Servo Position	0 - 3"	± 0.06"	± 2%	10/sec
Location (3), Fig. 3				
34) Elevator Damper Signal			± 2%	20/sec X
35) Aileron Damper Signal			± 2%	20/sec X
36) Rudder Damper Signal			± 2%	20/sec X
37) Emergency Rudder Damper Signal			± 2%	20/sec X
38) Port Elevator Damper Servo Position *	-0.6 +0.6"	± 0.01"	± 1%	20/sec X
39) Stbd Elevator Damper Servo Position *	-0.6 +0.6"	± 0.01"	± 1%	20/sec X
40) Port Aileron Damper Servo Position *	-0.6 +0.6"	± 0.01"	± 1%	20/sec X
41) Stbd Aileron Damper Servo Position *	-0.6 + 0.6"	± 0.01"	± 1%	20/ sec X
42) Rudder Damper Servo*	-0.5 + 0.5"	± 0.01"	± 1%	20/sec X

(Continued/...

Location (4), Fig. 3	Range	Accuracy	Accuracy % of full range	Sampling Frequency
43) Elevator Trimmer Position	0 - 59°	± 0.5°	± 1%	5/sec
44) Aileron Trimmer Position	0 - 47.1°	± 0.5°	± 1%	5/sec
45) Rudder Trimmer Position	0 - 39°	± 0.4°	± 1%	5/sec



(LOCATION OF TOTAL HEAD AND TOTAL TEMPERATURE PROBES NOT YET DECIDED)



SKETCH SHOWING LOCATION OF INSTRUMENTATION
FOR AMBIENT CONDITIONS
& CONTROL SURFACE MOTION

FIG. 1

DESCRIPTION OF SKETCH

Let OX, OY and OZ be three mutually perpendicular axis with origin O, such that:-

OX is parallel to the longitudinal datum of the aircraft,
OY is parallel to the lateral or spanwise datum,
and OZ is perpendicular to the plane XOY.

Let O be projected into a horizontal plane in O', also project OX into O' X', OY into O'Y', and let O'C be a reference direction in the horizontal plane.

Let the horizontal plane through O intersect XX' in X", and YY' in Y", then,

ANGLE OF PITCH θ = $\angle$XOX", the angle between the longitudinal datum of the aircraft and the horizontal plane.

ANGLE OF BANK ϕ = $\angle$YOY", the angle between the lateral datum of the aircraft and the horizontal plane.

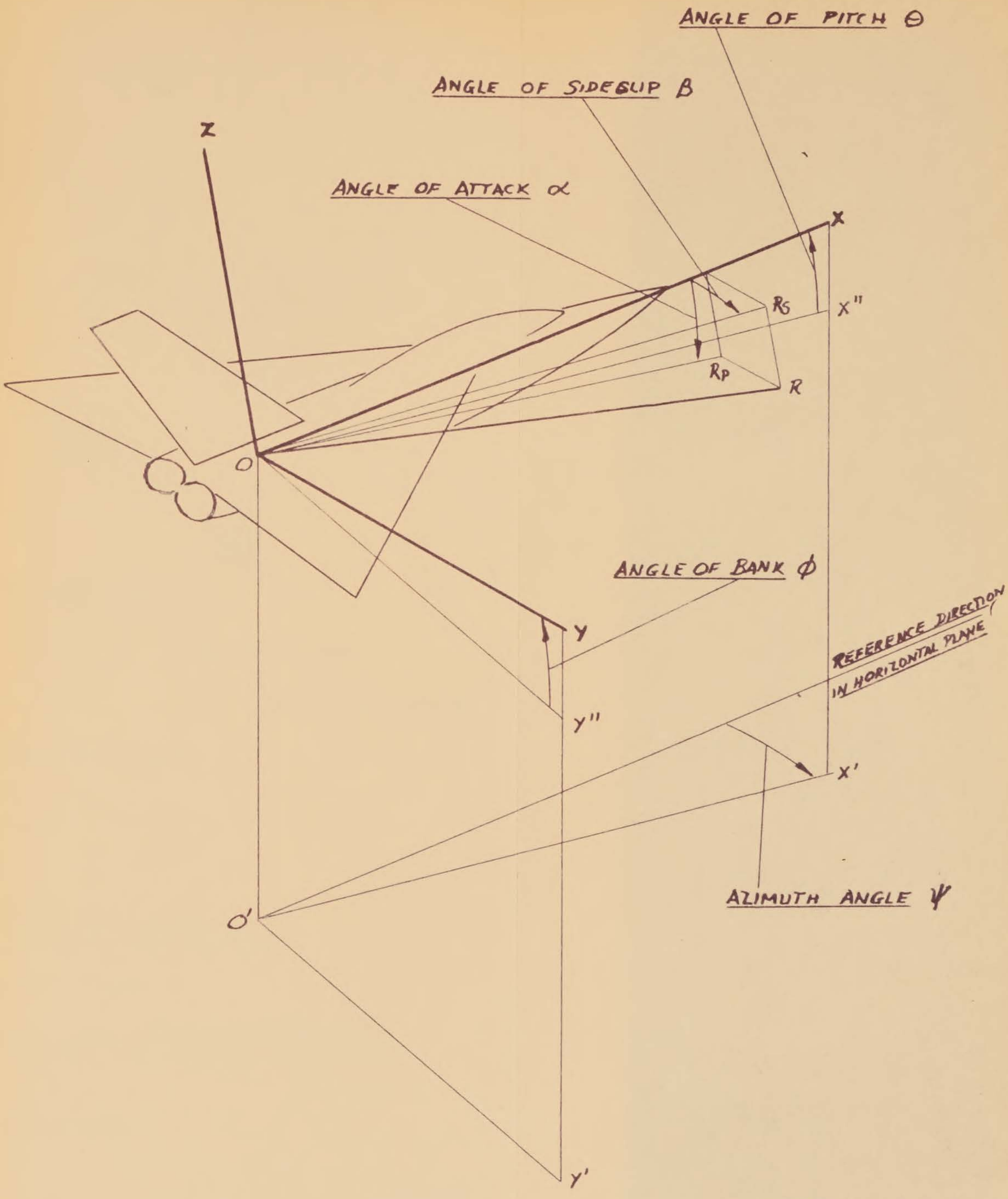
AZIMUTH ANGLE ψ = $\angle$COX', the angle between the reference direction and the projection of the longitudinal datum of the aircraft in the horizontal plane.

Further, let OR lie parallel to the direction of the relative wind, and let ORS and ORp be projections of OR in planes XOY and XOZ respectively, then,

ANGLE OF ATTACK α = $\angle XOR_p$, the component of the relative wind in the plane XOZ.

ANGLE OF SIDESLIP = $\angle XOR_S$, the component of the relative wind in the plane XOY.

ITEM	QUANTITIES TO BE MEASURED		
Angle of Pitch	θ	$\dot{\theta}$	
Angle of Bank	ϕ	$\dot{\phi}$	
Azimuth Angle	ψ	$\dot{\psi}$	$\ddot{\psi}$
Angle of Attack	α		
Angle of Sideslip	β		
Longitudinal Acceleration			$\ddot{X}$
Lateral Acceleration			$\ddot{Y}$
Normal Acceleration			$\ddot{Z}$



SKETCH DEFINING MOTION OF AIRCRAFT

FIG. 2

NOTE ON FLYING CONTROL MECHANISM

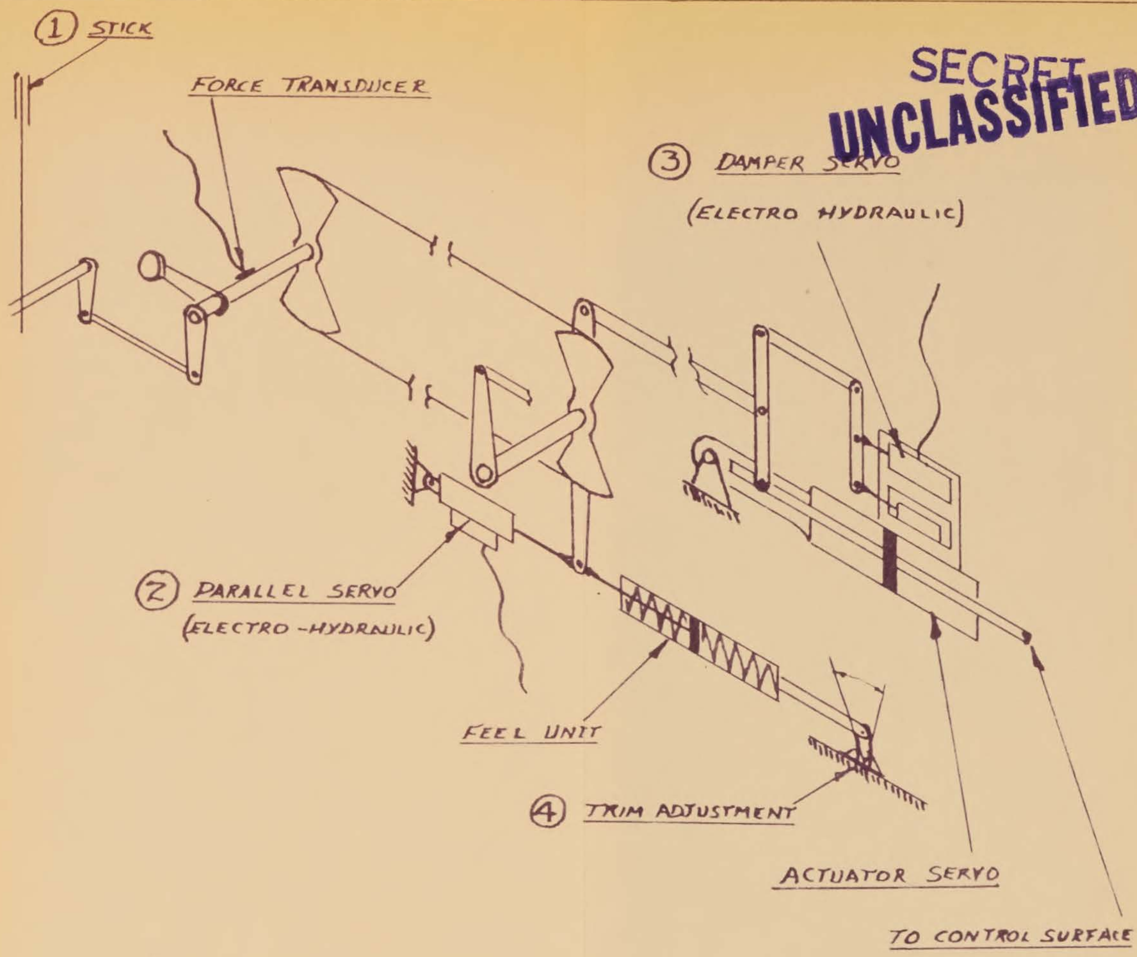
The sketch opposite, shows the elevator control system in its essentials, for the purpose of describing the instrumentation.

While the aileron system is practically identical to the elevator system, the rudder system has no parallel servo.

In the elevator and aileron systems the feel unit and trim adjustment are employed only in Emergency Manual Mode of operation, when the parallel servo is by-passed and the damper servo locked in the central position by automatic means. The rudder damper servo is not provided with a centralizing and locking arrangement, but has duplicate electrical and hydraulic systems.

In Manual Mode of operation, the pilot's effort on the stick strains the mechanism from the stick grip to the rear quadrant against the parallel servo, which operates in response to an "error" signal. The strain is picked-up by a force transducer, the signal being balanced against the signal from the "feel" network which may consist of - stick position, q, stick force/g, etc., components.

The resulting "error" signal, suitably amplified, is fed to the parallel servo, which moves in such a direction as to reduce the error signal to zero.



SKETCH OF FLYING CONTROL MECHANISM

REF: BROCHURE F.C.

Key:

1. Stick Force - Elevator, Aileron, and Rudder Pedal Force.
   Stick Position - Elevator, Aileron, and Rudder Pedal Position.

2. Position of Parallel Servos - Elevator and Aileron.

3. Damper servo signal - Elevator, Aileron, Rudder and Emergency Rudder.
   Damper servo position - Elevator Port & Stb'd, Aileron Port & Stb'd, and Rudder.

4. Trimmer position - Elevator, Aileron, and Rudder.

FIG. 3

6

D.R. Pattie, October 1956.

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CF-105 - INSTRUMENTATION - ISSUE 5

FLYING CONTROL HYDRAULICS

In the following list, changes from Issue 4, Ref. 3533/22/J, are underlined.

The sketch, on the following page, indicates the location of instrumentation in the Flying Control Hydraulic System.

Item	System	Range	Accuracy	Accuracy % of full range	Sampling Frequency
Location (1) see sketch					
1) Port engine pump inlet temp.	B	-65 +300°F	± 5°F	± 2%	2/min
2) Port engine pump inlet press.	B	0 -2000 psi	± 5 psi	± 2%	10/sec
3) Port engine pump outlet press.	B	0 -5000 psi	± 100 psi	± 2%	10/sec
Location (2) see sketch					
4) Port Elevator valve inlet press.	A	0 -5000 psi	± 100 psi	± 2%	10/sec
5) Port elevator valve inlet press.	B	0 -5000 psi	± 100 psi	± 2%	10/sec
6) Port elevator jack return press.	B	0 -2000 psi	± 40 psi	± 2%	10/sec
7) Port aileron valve inlet press.	A	0 -5000 psi	± 100 psi	± 2%	10/sec
8) Port aileron valve inlet press.	B	0 -5000 psi	± 100 psi	± 2%	10/sec
9) Port aileron jack return press.	B	0 -2000 psi	± 40 psi	± 2%	10/sec
10) Rudder valve inlet pressure.	A	0 -5000 psi	± 100 psi	± 2%	10/sec
11) Rudder valve inlet pressure.	B	0 -5000 psi	± 100 psi	± 2%	10/sec
12) Rudder jack return pressure.	B	0 -2000 psi	± 40 psi	± 2%	10/sec
Location (3) see sketch					
13) No.1 Heat Ex. inlet temperature	B	-65 +300°F	± 5°F	± 2%	2/min
14) No.1 Heat Ex. outlet temperature	B	-65 +300°F	± 5°F	± 2%	2/min
15) No.2 Heat Ex. outlet temperature	B	-65 +300°F	± 5°F	± 2%	2/min
Location (4) see sketch					
16) Accumulator piston position	B	0 - 3.6"	± 0.1"	± 1%	10/sec
Location (5) see sketch					
17) Compensation piston position	B	0 -10.75"	± 0.2"	± 2%	10/min

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NOTE ON FLYING CONTROL HYDRAULIC (See Sketch Opposite).

The flying controls are operated by two independent but practically identical hydraulic systems, A & B, each system having in parallel a pump driven by the Port engine and a pump driven by the starboard engine.

Whereas each system contains a number of actuators and servo units in parallel, as detailed in the following table, only one actuator has been drawn in the sketch:-

System "A"	System "B"
Port Elevator Jack.	Port Elevator Jack.
	Port Elevator Damper Servo.
Stbd Elevator Jack.	Stbd Elevator Jack.
	Stbd Elevator Damper Servo.
Port Aileron Jack.	Port Aileron Jack.
	Port Aileron Damper Servo.
Stbd Aileron Jack.	Stbd Aileron Jack.
	Stbd Aileron Damper Servo.
Rudder Jack.	Rudder Jack.
Rudder Emergency Damper Servo.	Rudder Damper Servo.
	Elevator Parallel Servo.
	Aileron Parallel Servo.

The control surface actuator jacks are each composed of two units in tandem as indicated in the sketch, one unit being supplied by System "A", the other unit by System "B".

Key:

Location In Sketch	Quantities to be Measured
1.	Port engine pump - System "B" Pump inlet temp. and pressure: pump outlet pressure.
2.	Port elevator, port aileron, and rudder jacks. System "A" valve inlet pressure: System "B" valve inlet and outlet pressures.
3.	Heat exchangers System "B". Inlet temperature to H. Ex. No.1: outlet temp. H. Ex. No. 1: outlet temp, H.Ex. No. 2.
4.	Accumulator piston position, System "B"
5.	Compensation piston position, System "B".

D.R. Pattie - Dec. 19[illegible]

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CF-105 - INSTRUMENTATION - ISSUE 5

J-75 ENGINE INSTALLATION

Items which have been added or changed since Issue 4, Ref: 3533/22/J, are underlined in the following list.

The instrumentation required on the engine installation has been grouped under five headings as follows:-

1. LUBRICATION (No Sketch)

	Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
1.	Port engine oil pressure	0-50 psig	± 2 psi	± 4%	5/min
2.	Stbd engine oil pressure	0-50 psig	± 2 psi	± 4%	5/min
3.	Oil temp at Port engine inlet	0-500°F	± 10°F	± 2%	2/min
4.	Oil temp at Stbd engine inlet	0-500°F	± 10°F	± 2%	2/min
5.	Port engine gearbox oil heat exchanger inlet temperature	-65 +500°F	± 10°F	± 2%	2/min
6.	Stbd engine gearbox oil heat exchanger inlet temperature	-65 +500°F	± 10°F	± 2%	2/min

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2. ENGINE CONDITIONS (No Sketch)

Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
7. Port engine power lever position †			± 1%	2/min
8. Stbd engine power level position †			± 1%	2/min
9. Port engine L.P. compressor R.P.M.			± 0.5%	12/min
10. Stbd engine L.P. compressor R.P.M.			± 0.5%	12/min
11. Port engine H.P. compressor R.P.M. *			± 0.5%	12/min
12. Stbd engine H.P. compressor R.P.M. *			± 0.5%	12/min
13. Port engine intake static pressure	0-30 psia	± 0.3psi	± 1%	6/min &Cont
14. Stbd engine intake static pressure	0-30 psia	± 0.3psi	± 1%	6/min &Cont.
15. Port engine intake total head pressure.	0-30 psia	± 0.3psi	± 1%	12/min
16 .Stbd engine intake total head pressure.	0-30 psia	± 0.3psi	± 1%	12/min
17. H.P. compressor discharge press. Port.	0-400 psia	± 4 psi	± 1%	12/min
18. H.P. compressor discharge press. Stbd.	0-400 psia	± 4 psi	± 1%	12/min
19. H.P. compressor discharge temp. Port	0-1000°F	± 10 F°	± 1%	12/min
20. H.P. compressor discharge temp. Stbd	0-1000°F	± 10 F°	± 1%	12/min

3. FUEL FLOW (No Sketch)

Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
[illegible]. Mass flow to Port engine.	0-25,000lb/hr	±125 lb/hr	± 0.5%	12/min
[illegible]. Mass flow to Stbd engine.	0-25,000lb/hr	±125 lb/hr	± 0.5%	12/min
23. Fuel temp at inlet to Port engine burner.	-65 +300°F	± 5F°	± 2%	2/min
24. Fuel temp at inlet to Stbd engine burner.	-65 +300°F	± 5F°	± 2%	2/min

† To be measured on the airframe end of the flexible drive to engine.

* A visual indication of both Port and Starboard H.P. compressor speeds is required in the Pilot's cockpit.

4. COOLING - Port engine only (See Fig. 1)

Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
25. Top of No.1 wing spar beside engine mount	0-300°F	± 3F°	± 1%	1/min
26. Bottom of No.1 wing spar beside engine mount.	0-300°F	± 3F°	± 1%	1/min
27. Neck of engine mount.	0-750°F	± 8F°	± 1%	1/min
28. Structure below turbine *	0-400°F	± 4F°	± 1%	1/min
29. Top inboard shroud aft of Stn. 742 †	0-400°F	± 4F°	± 1%	1/min
30. Top inboard shroud aft of Stn. 742 †	0-400°F	± 4F°	± 1%	1/min
31. Top inboard shroud aft of Stn. 803 †	0-400°F	± 4F°	± 1%	1/min
32. Outer segment of shroud aft of Stn 803†	0-400°F	± 4F°	± 1%	1/min
33. Lower segment of shroud aft of Stn 803†	0-400°F	± 4F°	± 1%	1/min
34. Bottom shroud Steel-Al. junction at Stn. 803 †	0-400°F	± 4F°	± 1%	1/min
35. On the inner surface of sting on engine ℄	0-1000°F	±10F°	± 1%	5/min
36. Air temp top rear compressor Zone 1	0-500°F	± 5F°	± 1%	1/min
37. Air temp under turbine Zone 2.	0-300°F	± 3F°	± 1%	1/min
38. Air temp above turbine Zone 2.	0-300°F	± 3F°	± 1%	1/min
[illegible]. Air temp at Stn. 803 top Zone 2.	0-400°F	± 4F°	± 1%	1/min
[illegible]. Air temp at Stn. 803 Bottom Zone 2.	0-400°F	± 4F°	± 1%	1/min
41. Ambient air temp fwd. of parachute bay (Not shown in Fig).	0-300°F	± 3F°	± 1%	1/min

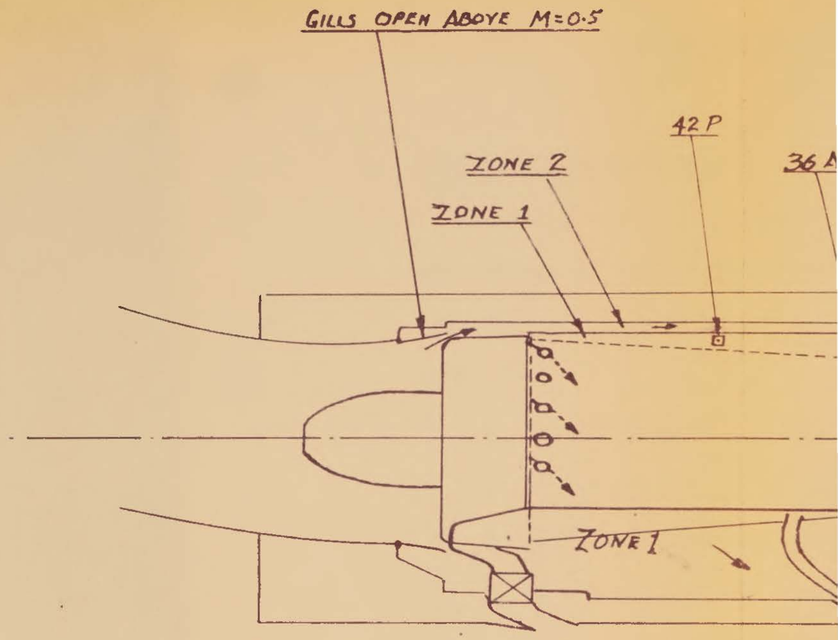
* On the inner face of the inner flange of the frame.

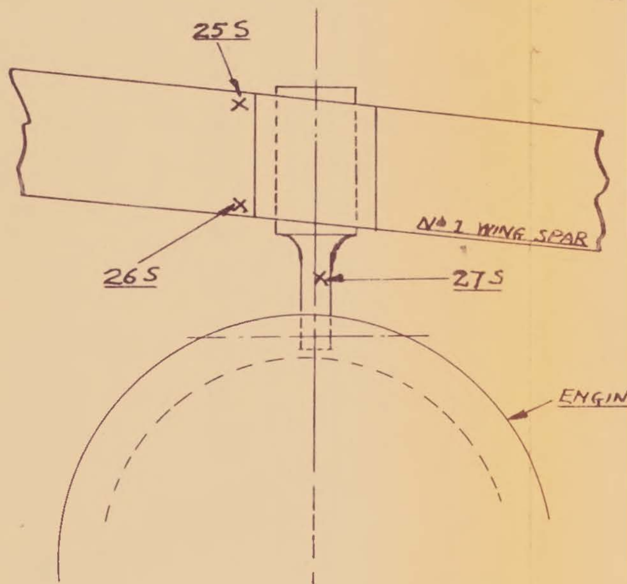
† On the outer surface of the shroud.

5. STATIC PRESSURES - Port engine only (See Fig.1)

Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
42. Zone 1, top centre compressor	0-20 psig *	± 0.2psi	± 1%	6/min & Cont.
43. Zone 2, top rear compressor	0-20 psig *	± 0.2psi	± 1%	6/min & Cont.
44. Zone 2, bottom mid-section tailpipe	0-20 psig *	± 0.2psi	± 1%	6/min & Cont.
45. Ambient between engines fwd. of parachute bay	0-5 psig *	± 0.2psi	± 1%	6/min & Cont.

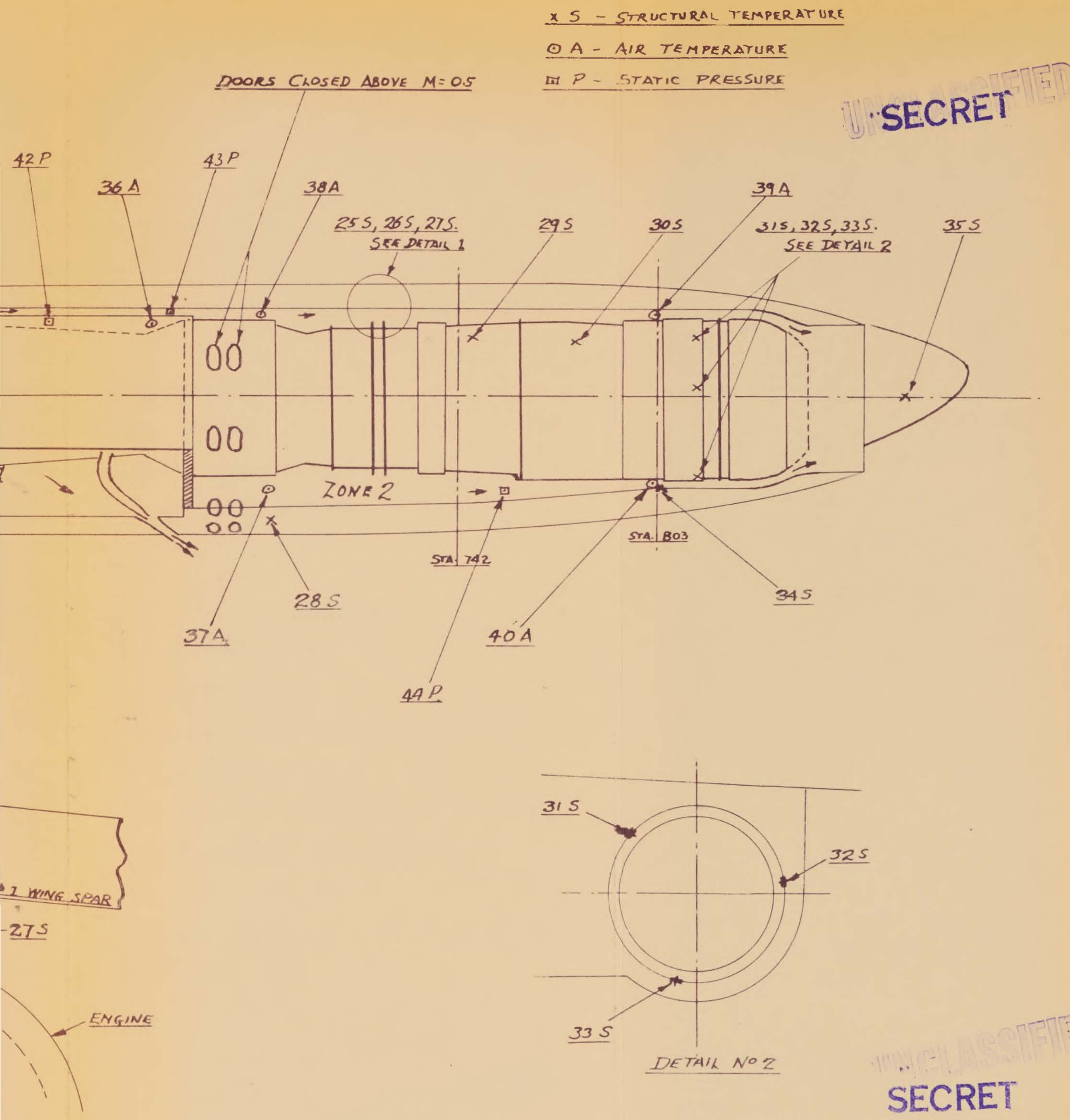
* With reference to aircraft static.





DETAIL Nº 1

ENGINE MOUNT



SKETCH SHOWING ENGINE INSTALLATION COOLING SYSTEM

INSTRUMENTATION FOR J75

FIG. 1

D.R. Pattie
Nov./55.

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FUEL SYSTEM

1. LIST OF INSTRUMENTATION

Numbers refer to location in system, see Figs. 1, 2 and 3, which show Layout of Fuel Tanks, Fuel Transfer System, and Fuel Tank Pressurization System, respectively. Locations 1 to 8 correspond to fuel tanks 1 to 8.

T - instrument to measure temperature.

P - instrument to measure pressure.

Q - instrument to measure fuel contents of tank.

M - instrument to measure mass flow of fuel.

Location See Sketches	Instruments Required			Description
1			Q	forward fuselage tank.
2		P	Q	rear fuselage tank.
3			Q	port & stbd. wing tanks.
4			Q	port & stbd. wing tanks.
5	T	P	Q	temperature and pressure in stbd. tank only. Contents in port & stbd. tanks.
6			Q	port & stbd. wing tanks.
7		P	Q	pressure in stbd. tank only. Contents port & stbd.
8			Q	port & stbd. tanks.
9	T			fuel entering H.E., stbd. line.
10		P	M	fuel to port engine/AB combination.
11	T	P	M	fuel to stbd. engine/AB combination.

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2. SUMMARY

2.1 Temperature

Instrument	Range (°F)	Accuracy (F°)	Accuracy (% of Range)	Recording Frequency
T5	-65 +160	±5	2%	2/min
T9	-65 +200	±2	1%	2/min
T11	-65 +250	±5	2%	1/min

2.2 Pressure

Instrument	Range (psia)	Accuracy (psi)	Accuracy (% of Range)	Recording Frequency
P2	0-30	±0.5	2%	1/min
P5	0-30	±0.5	2%	10/min
P7	0-30	±0.5	2%	1/min
P10	0-75	±2	2%	2/min
P11	0-75	±2	2%	2/min

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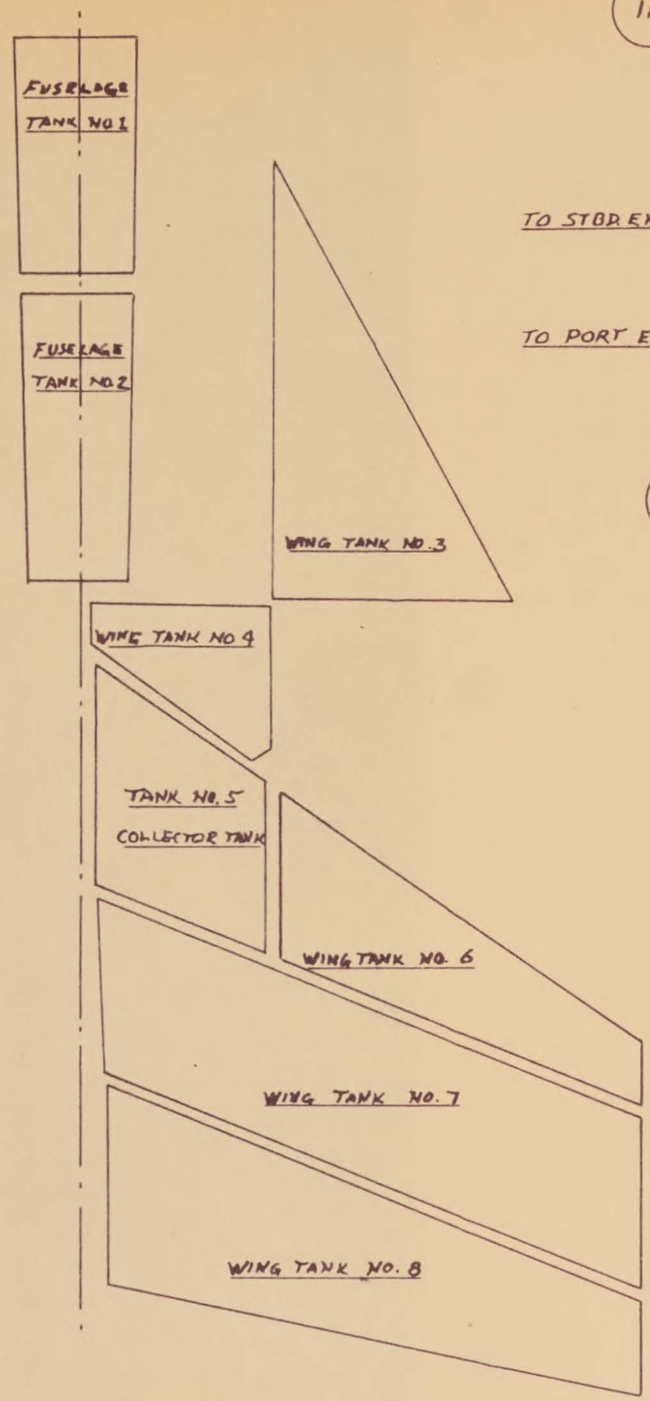
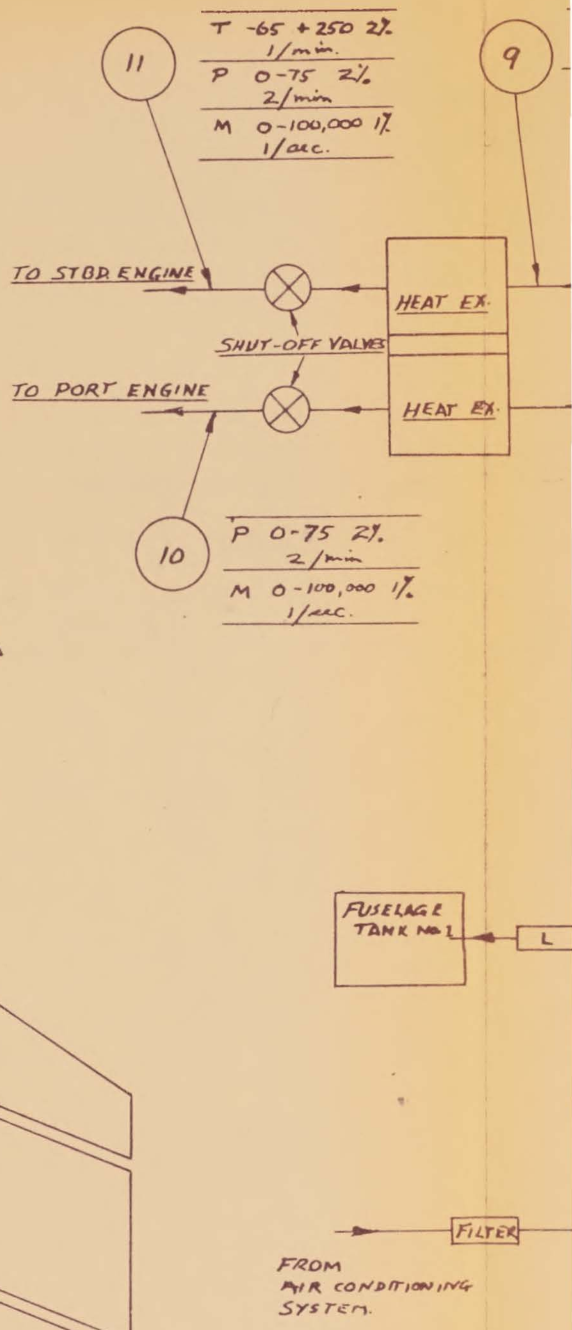
2.3. Fuel Contents (This information has been added since Issue 4)

Instrument	Range (Gals.)	Accuracy (Gals.)	Accuracy (% of Range)	Recording Frequency
Q1	0-277	± 6	± 2%	1/Min.
Q2	0-281	± 6	± "	1/Min.
Q3 Port	0-151	± 3	± "	1/Min.
Stbd	0-151	± 3	"	1/Min.
Q4 Port	0-90	± 2	"	1/Min.
Stbd	0-90	± 2	"	1/Min.
Q5 Port	0-146	± 3	"	6/Min.
Stbd	0-146	± 3	"	6/Min.
Q6 Port	0-154	± 3	"	1/Min.
Stbd	0-154	± 3	"	1/Min.
Q7 Port	0-279	± 6	"	1/Min.
Stbd	0-279	± 6	"	1/Min.
Q8 Port	0-173	± 4	"	1/Min.
Stbd	0-173	± 4	"	1/Min.

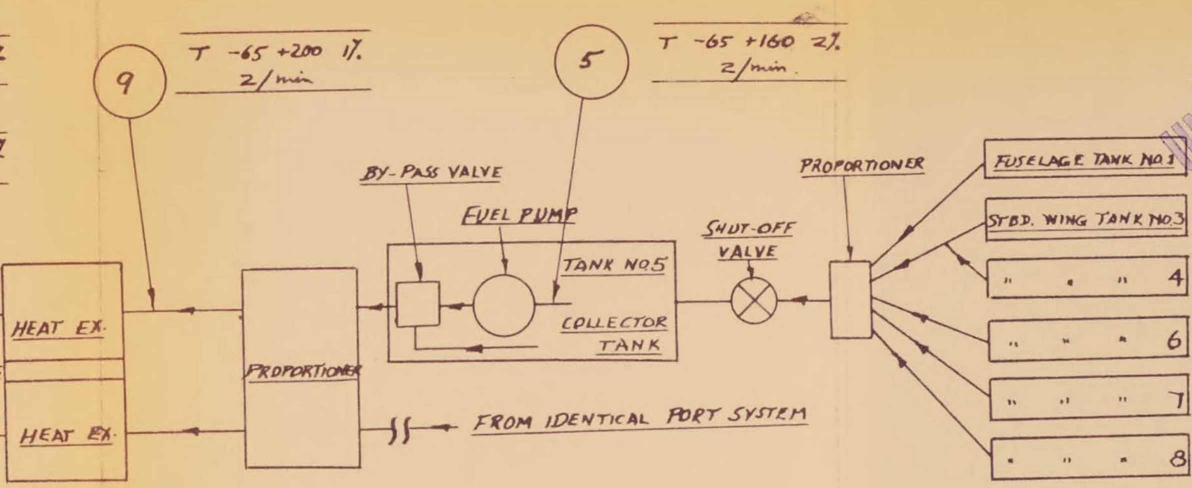
2.4 Mass Flow

Two mass flow meters are required, see locations 10 and 11, in sketch, with a range of 0-100,000 lb/hr and accuracy of ±1000 lb/hr or 1% of range. The recording frequency in both cases will be 1/sec.

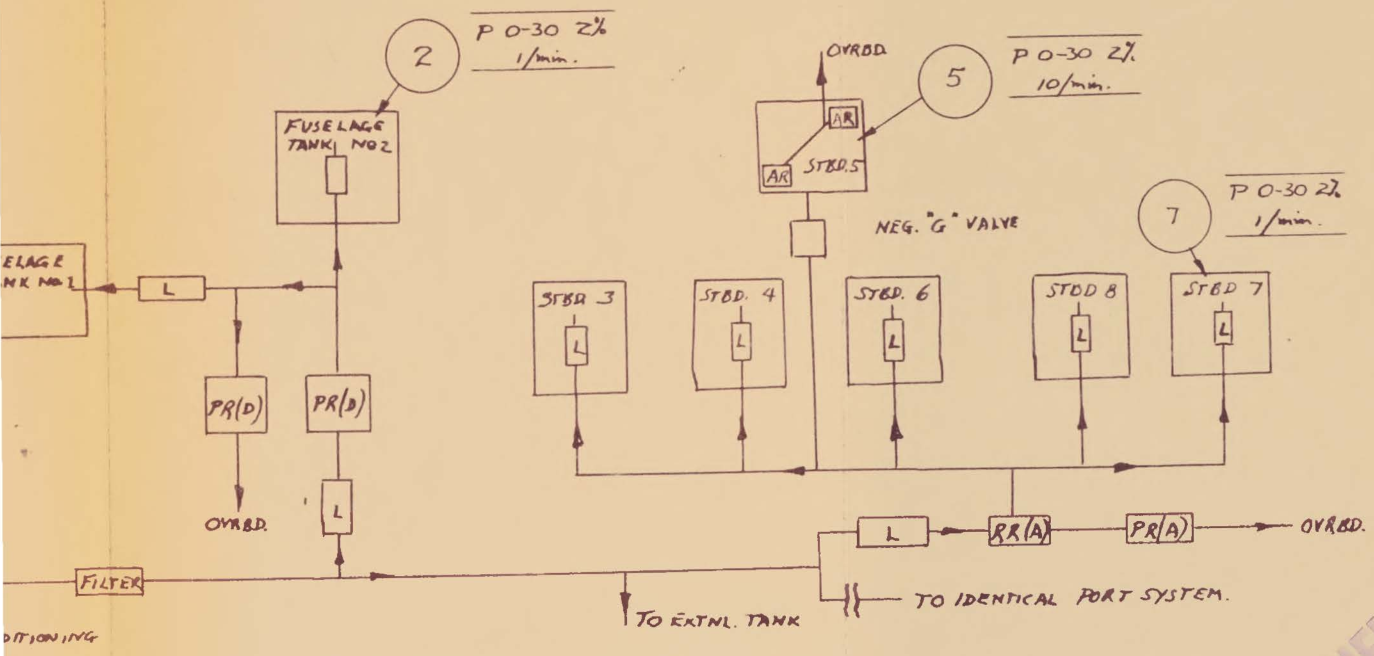




LAYOUT OF FUEL TANKS SHOWING STBD. WING ONLY - FIG 1



FUEL TRANSFER SYSTEM – FIG. 2



L - AIR FLOW LIMITER

PR(D) - PRESSURE REDUCING VALVE (DIFFERENTIAL)

PR(A) - PRESSURE REDUCING VALVE (ABSOLUTE)

AR - AIR RELIEF VALVE

FUEL TANK PRESSURIZATION SYSTEM – FIG 3

REF: DWGS. 7-1600-38, 39, & 40.

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UTILITY HYDRAULICS

	Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
1.	Pump inlet pressure (one pump)	0-200 psia	± 10psi	± 5%	10/sec
2.	Pump inlet temperature (one pump)	-65 +300°F	± 5F°	± 1%	2/min
3.	Brake cylinder return temperature (one off)	-65 +500°F	± 10F°	± 2%	1/sec

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November, 1955.

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AIR CONDITIONING SYSTEM

1. LIST OF INSTRUMENTATION

Number indicates location in system, see sketch.

T - instrument to measure temperature.

P_s - instrument to measure static pressure.

P_t - instrument to measure total head pressure.

ΔP - P_t - P_s.

Location See Sketch	Instruments Required			Description
1	T	P_s		as close to Port engine bleed as possible.
2		P_s		immediately after reducing valve on Port engine line.
3	T	P_s	ΔP	mass flow for fuel pressurization system.
4	T		P_t	turbine inlet conditions.
5	T	P_s		turbine outlet conditions.
6	T	RPM		bearing temperatures and shaft R.P.M.
7	T	P_s	ΔP	mass flow to cabin (at temperature sensor).
8	T	P_s		cabin conditions. Temperature to be measured at six points.
9	T			at inlet to fan.
10	T	P_s	P_t rake	mass flow of exhaust from fan (exit conditions).*
11	T	P_s	P_t rake	mass flow at ram air exit.*

* Items under-lined are added or changed from Issue. 4., Ref. 3533/22/J.

(Continued/...

2. SUMMARY

2.1 Temperature

Instrument	Range (°F)	Accuracy (F°)	Accuracy (% of Range)	Recording Frequency
T1	+100 +1000	±10	1%	1/sec
T3	-20 +400	±5	1%	5/min
T4	-20 +250	±5	2%	5/min
T5	-130 +100	±4	2%	5/min
T6	Instrument to be built into turbine unit.			2/min
T7	-20 +130	±5	3%	5/min
T8 - 6 off	0 +200*	±2	1%	
T9	0 +500	±10	2%	5/min
T10	0 +600	±10	2%	5/min
T11	0 +500	±10	2%	5/min

2.2 Static Pressure

Instrument	Range (psia)	Accuracy (psi)	Accuracy (% of Range)	Recording Frequency
P_s1	0-360	±10	2%	1/sec
P_s2	0-100	±1	1%	1/sec
P_s3	0-100	±1	1%	5/min
P_s5	0-20	±0.2	1%	5/min
P_s7	0-20	±0.2	1%	5/min
P_s8	0-20	±0.1	0.5%	1/sec
P_s10	0-20	±0.2	1%	5/min
P_s11	0-20	±0.2	1%	5/min

* Items under-lined are added or changed from Issue 4., Ref. 3533/22/J.

(Continued/...

(Continued/...

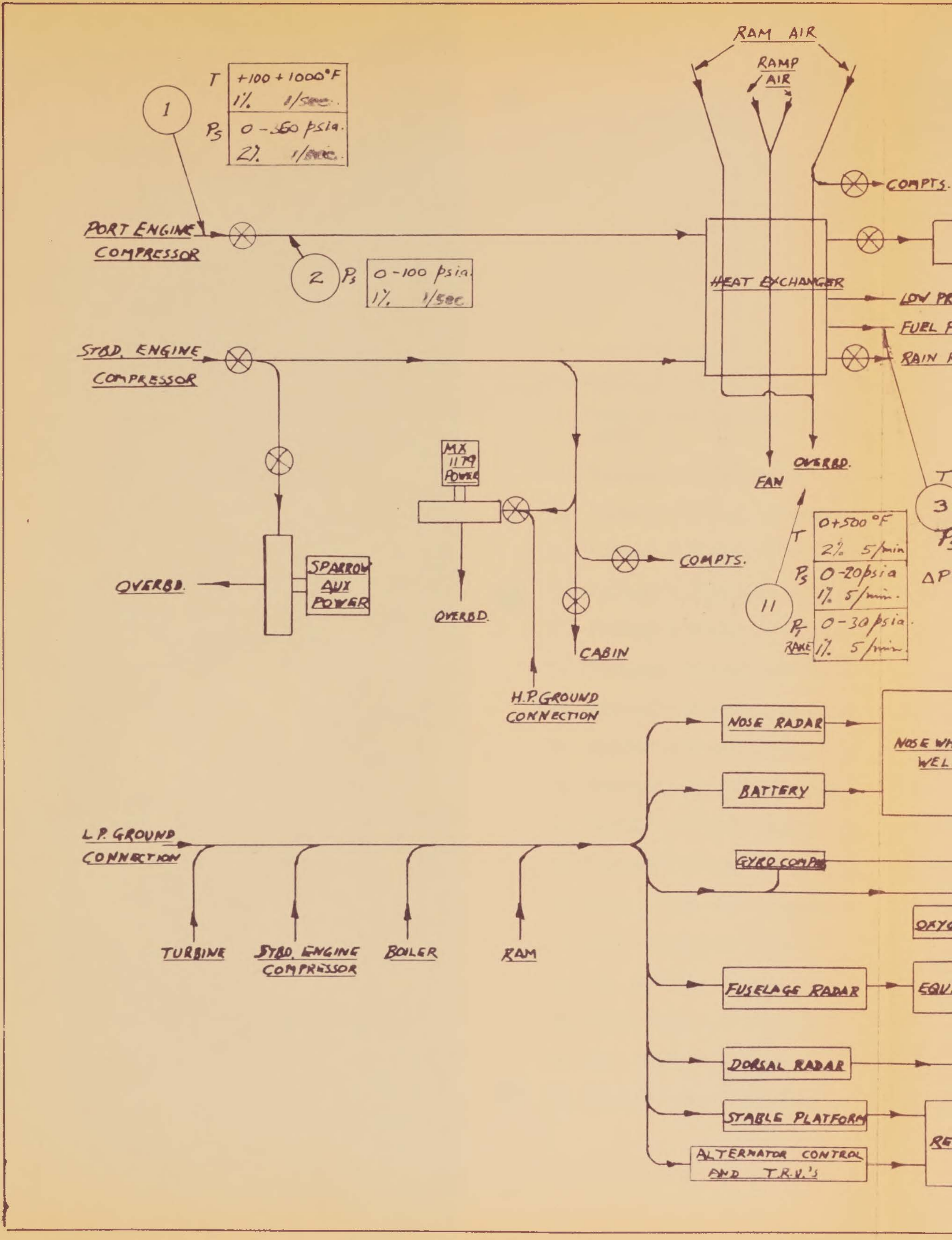
2.3 Total Head Pressure

Instrument	Range	Accuracy (psi)	Accuracy (% of Range)	Recording Frequency
Δ P 3	0-10 psi	±0.2	2%	5/min
P_t4	0-100 psia	±1	1%	5/min
Δ P 7	0-10 psi	±0.2	2%	5/min
P_t10 rake	0-30 psia	±0.3	1%	5/min
P_t11 rake	0-30 psia	±0.3	1%	5/min

2.4 Miscellaneous

In addition, it is required to measure turbine R.P.M., see location 6 in sketch. As in the case of bearing temperature, transducers will be built into the unit, by AIRsearch.

The sampling rate required for turbine R.P.M. is 5/sec.


RAM AIR
RAMP AIR
T +100 + 1000°F 1% 1/sec.
P_S 0 - 350 psia. 2% 1/sec.
1
PORT ENGINE COMPRESSOR
2 P_S 0 - 100 psia. 1% 1/sec
COMPTS.
HEAT EXCHANGER
LOW PR
FUEL F
RAIN R
STBD. ENGINE COMPRESSOR
MX 1179 POWER
FAN
OVERBD.
3
T 0+500 °F 2% 5/min
P_S 0-20psia 1% 5/min.
P_T RAKE 0-30psia. 1% 5/min.
11
ΔP
SPARROW AUX POWER
OVERBD.
COMPTS.
CABIN
H.P. GROUND CONNECTION
NOSE RADAR
NOSE WH WEL
BATTERY
L.P. GROUND CONNECTION
GYRO COMPAS
OXYG
TURBINE
STBD. ENGINE COMPRESSOR
BOILER
RAM
FUSELAGE RADAR
EQU
DORSAL RADAR
STABLE PLATFORM
RE
ALTERNATOR CONTROL AND T.R.U.'s

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ELECTRICS

Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
1. Temp of aft bearing - port alternator.	-70 +450°F	±10F°	± 2%	2/min
2. Voltage A Ø port alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
3. Voltage B Ø port alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
4. Voltage C Ø port alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
5. Voltage A Ø stbd alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
6. Voltage B Ø stbd alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
7. Voltage C Ø stbd alternator.	0-130VAC	± 0.75V	± 0.5%	1/min
8. Current A Ø port alternator.	0-80A	± 0.4A	± 0.5%	1/min
9. Current B Ø port alternator.	0-80A	± 0.4A	± 0.5%	1/min
10. Current C Ø port alternator.	0-80A	± 0.4A	± 0.5%	1/min
11. Current A Ø stbd alternator.	0-80A	± 0.4A	± 0.5%	1/min
12. Current B Ø stbd alternator.	0-80A	± 0.4A	± 0.5%	1/min
13. Current C Ø stbd alternator.	0-80A	± 0.4A	± 0.5%	1/min
14. D.C. voltage of trans rect unit port.	0-32VDC	± .16V	± 0.5%	1/min
15. D.C. voltage of trans rect unit stbd.	0-32VDC	± .16V	± 0.5%	1/min
16. D.C. current of trans rect unit port.	0-135A	± .75A	± 0.5%	[illegible]
17. D.C. current of trans rect unit stbd.	0-135A	± .75A	± 0.5%	1/min
18. Exhaust temp of T.R.U.S.	0-300°F	± 6F°	± 2%	1/min

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Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
19. Temp of N.W. well, above circuit breaker	0-200°F	± 4F°	± 2%	1/min
20. Temp of N.W. well, above master warning box	0-200°F	± 4F°	± 2%	1/min
21. Temp of electrical bay.	-70 +275°F	± 7F°	± 2%	1/min

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UNDERCARRIAGE

	Item	Range	Accuracy	Accuracy % of full range	Sampling Frequency
1.	Temp of brake plates	0-2000°F	± 40F°	± 2%	1/sec)
|					)4 off
4.	Temp of brake plates	0-2000°F	± 40F°	± 2%	1/sec)
5.	U/C leg acceleration fore & aft port.	-75 +75g	± 6g	± 4%	50/sec
6.	U/C leg acceleration fore & aft starboard.	-75 +75g	± 6g	± 4%	50/sec

November 1955.
D. R. Pattie.

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STRUCTURAL INTEGRITY

Structural Strain Gauges. (Ref. Letter 3770/22/J)

Figs. 1 to 4 show the approximate positions of 52 channels of strain gauges to be installed in aircraft 1, 2 and 3:-

Fig. 1 -	One channel on each strut at stations 485, 591, 644 and 697.	
	10 Channels on frame at Station 697	18
Fig. 2 -	6 Channels on lower longeron	6
Fig. 3 -	12 Channels on inner wing	
	4 Channels on aft box	16
Fig. 4 -	12 Channels on fin	12
	Total number of Channels	52

The frequency of sampling in each channel is provisionally 5/sec.

Strain gauges are not to be placed close to joints, doublers, rivet holes or bolts.

Final position of all strain gauges to be approved by F.P. Mitchell, Chief Stress Engineer.

Vibration Pick-Up Accelerometers. (To be installed in aircraft 1 and 2 only)

Fig. 5 shows the approximate locations of 57 vibration pick-up accelerometers, exact locations to be confirmed with J.McKillop of Aerodynamics Dept.

The required range is -10 to +10G, accuracy ± 0.25G, recording up to 60cps.

Airborne continuous trace recording of all accelerometers is required, and provision should be made to telemeter each accelerometer, only ten accelerometers being telemetered at any one time, these being selected at the ground station. Flight Test Dept should report any complication in the instrumentation arising from the requirements of ground selection of channels.

C/S FRAME & STRUTS AT STATION 697

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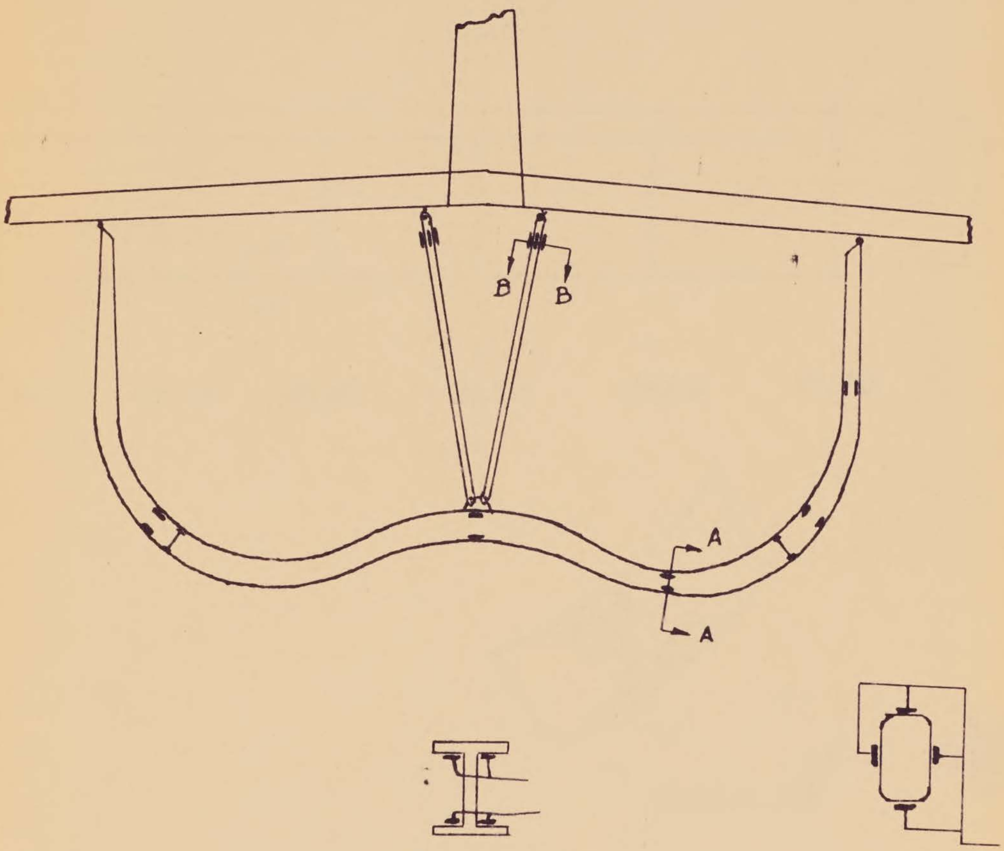
ALSO STRAIN GAUGE STRUTS AT STATIONS - 485, 591, & 644



SECTION A-A

SECTION B-B

NUMBER OF CHANNELS ON FRAME - 10

TOTAL NUMBER OF CHANNELS ON STRUTS - 8

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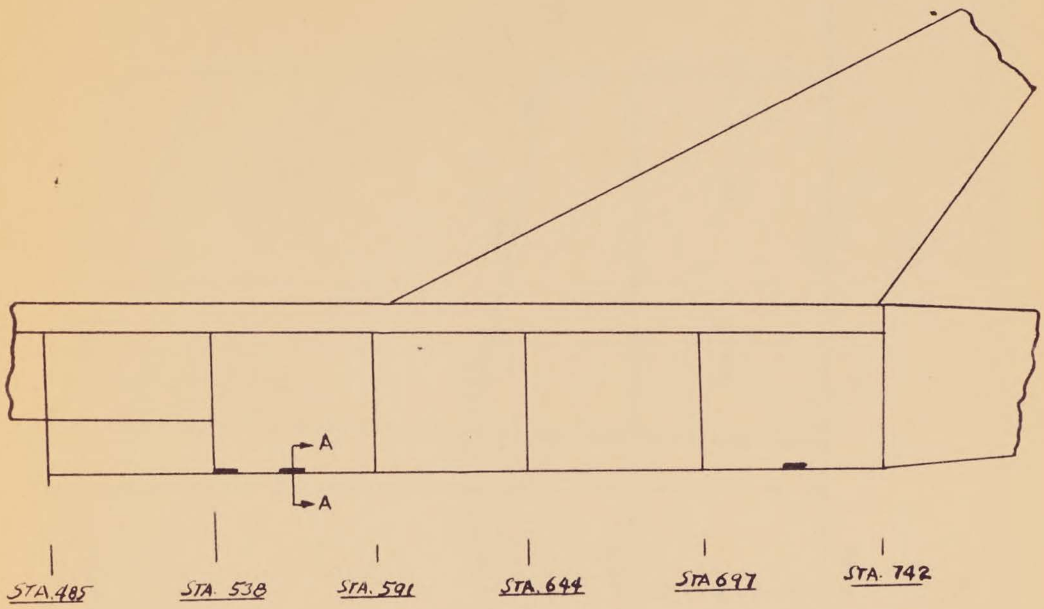
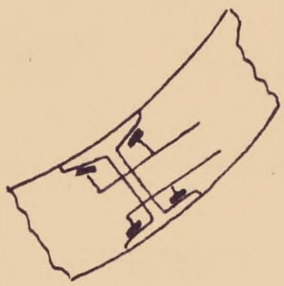
FIG. 1



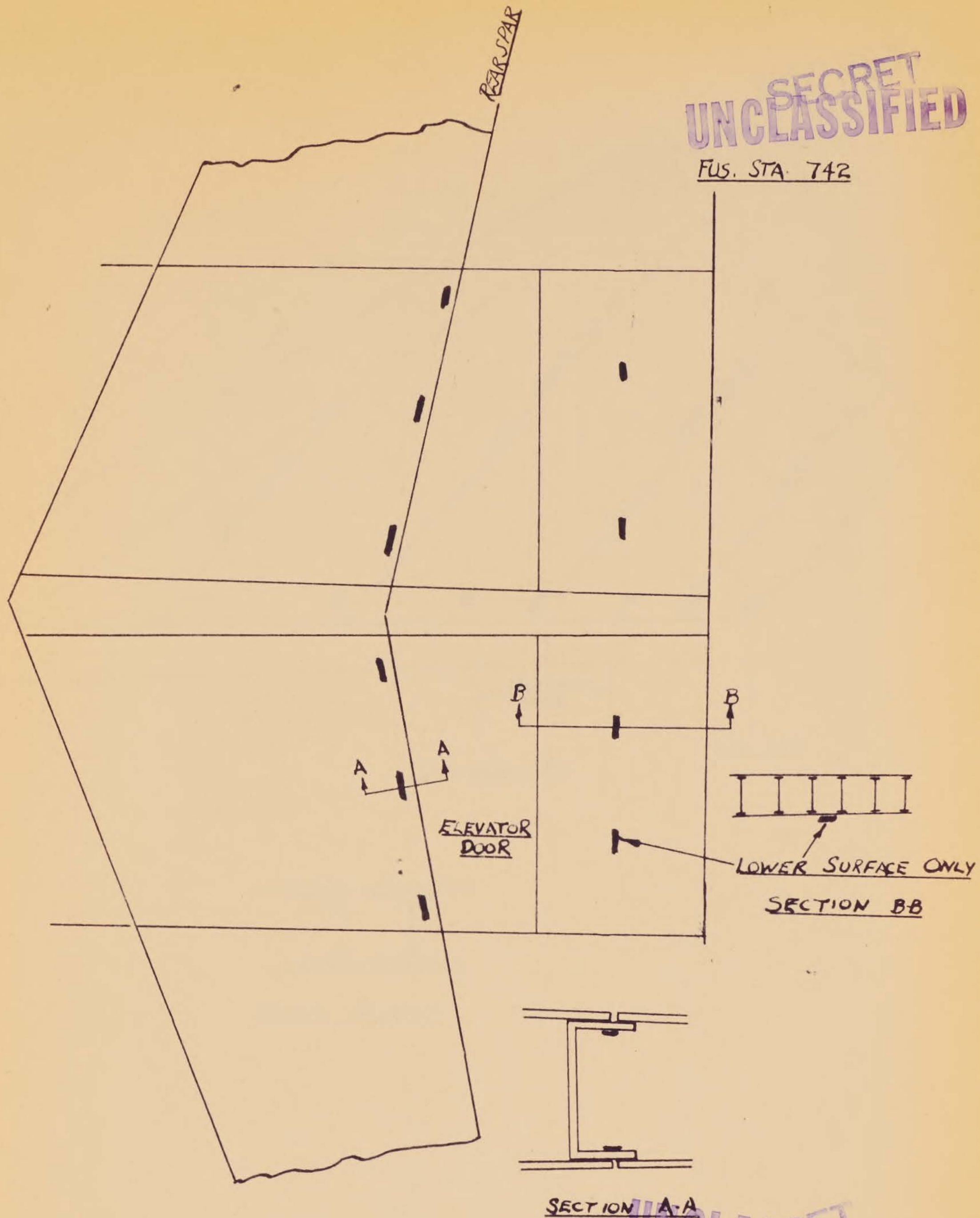


SECTION A-A

LOWER LONGERON - ONE SIDE ONLY

NUMBER OF CHANNELS - 6

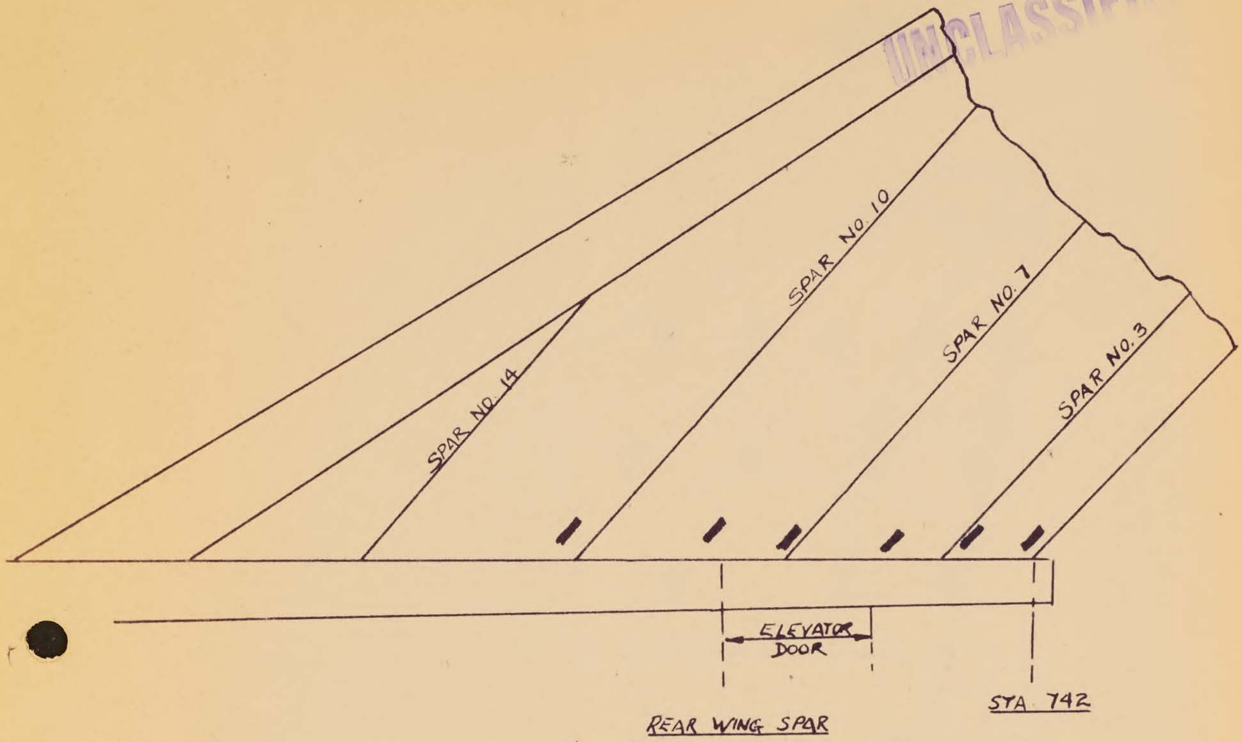
FIG. 2

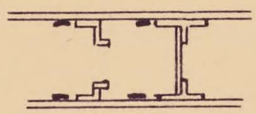


INNER WING & AFT BOX

TOTAL NUMBER OF CHANNELS - 16

FIG. 3



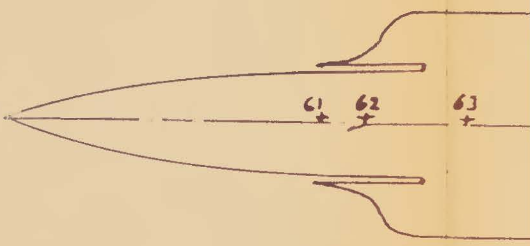


TYPICAL SECTION

FIN

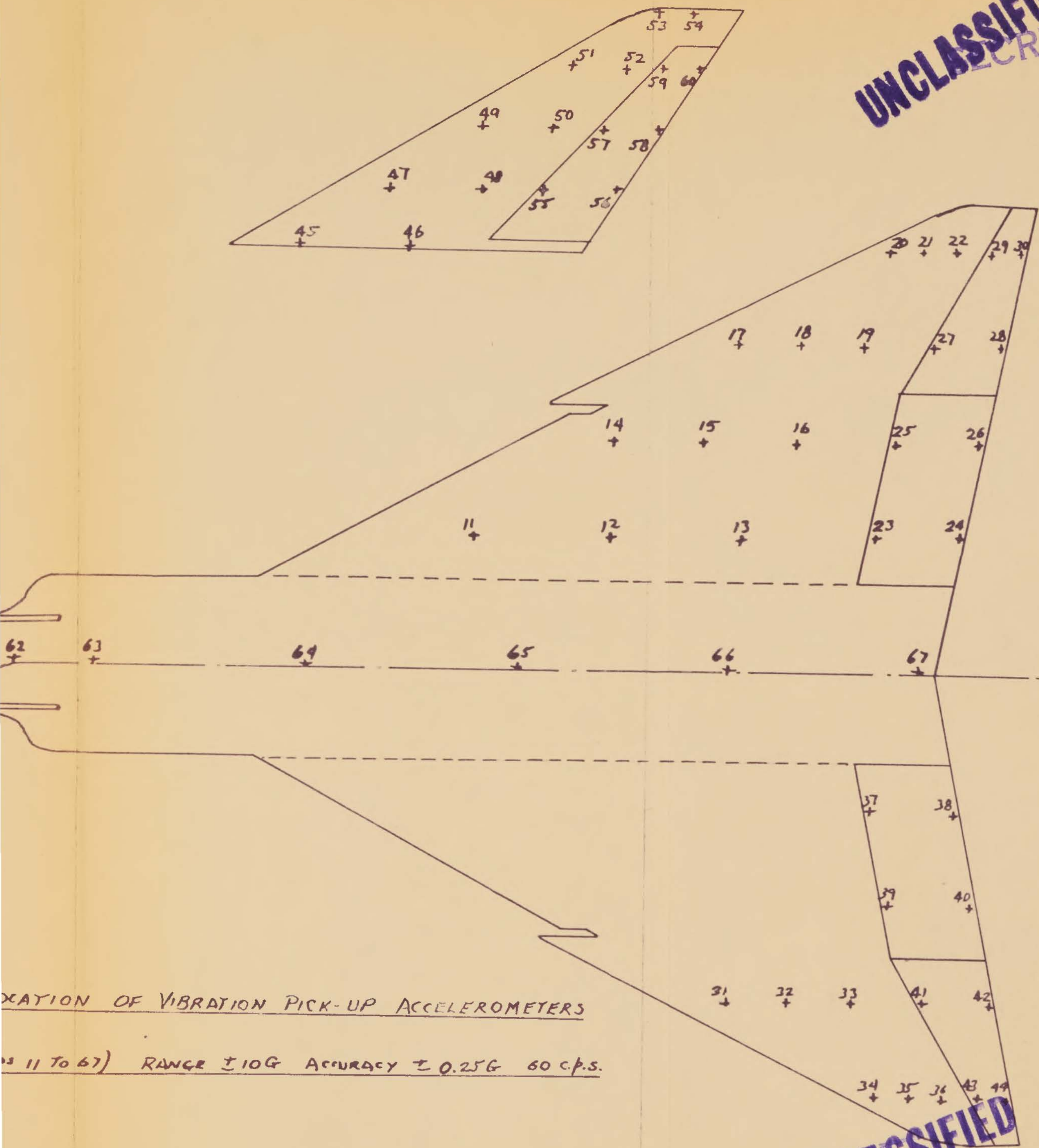
NUMBER OF CHANNELS - 12

FIG. 4



SKETCH SHOWING LOCATION OF

57 ACCELEROMETERS (NOS 11 TO 67)



...XATION OF VIBRATION PICK-UP ACCELEROMETERS

...S 11 TO 67) RANGE ± 10G ACCURACY ± 0.25G 60 C.P.S.

FIG. 5