EXHIBIT 'A' (X74-338)
PROPOSAL FOR THE MODIFICATION OF THE HYDRAULIC SYSTEMS TO ENABLE THE ASTRA HYDRAULICS POWER TO COME FROM THE UTILITY INSTEAD OF THE FLYING CONTROL 'A' SYSTEM

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March 10th 1958

1.0 INTRODUCTION

This proposal covers the changes required to the Utility and Flying Controls Hydraulic 'A' systems to fulfill the intent of the Arrow 2 Mock-Up Conference Change Request K.14. A Report # 72/Systems 32/50 issued September 1957, commented on the safety aspects of using the Flying Controls Hydraulic 'A' System to drive the Scanner Hydraulic Control System, and the reason for not using the present Utility System for this purpose.

In order to overcome this objection, and supply hydraulic power at the correct pressure for the Scanner from the Utility system, it is proposed to make a complete change to the Gear Box Driven Hydraulic Pumps from the present 20 G.P.M. Constant Delivery Type to Variable Delivery - Dual Pressure Type. These pumps are capable of pumping on low range, 1,500 psi for scanner operation and on high range, 4,000 psi for any of the services supplied by the Utility Hydraulic System. The 1,500 psi will drop to 1,000 psi at the scanner due to line losses.

A detailed description of the changes to the three systems affected Utility Hydraulics, Flying Control Hydraulics 'A' and ASTRA Hydraulic Control with their revised method of operation are contained in the subsequent paragraphs.

2.0 UTILITY HYDRAULIC SYSTEM

The following units will be deleted from the present system:

2 Constant Delivery Pumps
1 Pressure Regulator
1 By-Pass Control
1 thermal By-Pass
1 Charging valve and gauge
1 200 cu.in. accumulator

The following units will be added by the new system:

2 Variable Displacement Pumps with built in control valves
2 Check Valves
1 Pressure Reducing Valve
1 Thermal By-Pass
1 By-Pass Relief Valve
1 Stop Valve

The Utility compensator size will have to be increased, due to the larger fluid capacity of the system, the volume increasing to approx. 1050 cu. ins. from the existing volume of 935 cu. ins. This will result in a new unit of approx. $\frac{1}{2}$" larger diameter being required, and will mean minor changes to pipe runs in the vicinity.

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Deletion of one of the 200 cu. in. accumulators from the existing double unit will make this item easier to remove from, and install into the aircraft. Access to its forward end will be severely limited with the new pumps on the forward end of the gear box, however, since accumulator mount will have to be re-designed, it is proposed to make the forward end mounting a "plug-in" type, necessitating removal of bolts at rear end only where access is good.

The removal of the existing Thermal By-Pass and By-Pass Control Valves and replacement by the new valves will result in some bracketry changes in the area between the aft end of No.1 access door and Sta. 591.0

The new pumps will be the Vickers variable displacement dual range type, similar to that already in use on the Flying Control System, but modified for the dual range requirement, mounted on the forward end of the gear box using the same method of attachment as the Flying Control System Pumps. The Internal scavenge pump manifolds in the gear box will be modified to clear these pumps. Under normal flight conditions, the pumps will be on low pressure range and the radar scanner will receive oil directly from the pumps at 1,500 psi. Whenever one of the services supplied by the Utility System is selected for operation, the pumps are switched to the high pressure range, 4,000 psi and revert back when the demand is cancelled. When the pumps are on the high pressure range, the supply for the scanner passes through a pressure reducing valve and the pressure is maintained at 1,500 psi.

Positioning of the pump control valve is achieved by two methods. For Speed Brake Extensions and Armament Extension and Retraction the switch over is through electrical circuitry, these services being wired back to the control valve so that on selection, the valve is energized and switched over to high range. It is anticipated that Speed Brake Retraction can be achieved on low pressure range due to the assistance of air loads.

However, for undercarriage retraction and extension, brakes and nosewheel steering, the switchover is made hydraulically, the pump control valve being connected to the undercarriage selector valve by additional piping. When the selector valve is in the undercarriage DOWN or UP positions, hydraulic pressure is applied to the pump control valve to switch the pumps over to high range. The design features of the undercarriage selector valve are such that when DOWN is selected, the valve stays in that position, however, when UP is selected, the valve returns to neutral when the undercarriage is retracted and locked. Due to this feature when undercarriage DOWN has been selected, the pumps will be constantly on high range maintaining the high pressure supply for the undercarriage extension, and after this cycle is complete, for brakes and nosewheel steering. The pumps will remain on high range when undercarriage UP is selected but will revert to low range when the cycle is complete and the undercarriage selector valve returns to neutral.

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The schematic for the new hydraulic system is enclosed. There will be modification and re-routing of pipes in the duct bay area, and additional piping in the nosewheel well area to tap the existing system for pressure and return lines to run forward to the scanner system in the radar nose.

The present pressure warning system will be changed to a dual pressure type to indicate failure whether on low or high range.

The stop valve transferred from the Flying Control 'A' system, is energized when the hinged lid of the ASTRA GO-NO-GO Tester Panel operates a micro-switch to isolate the Scanner Circuit from the Utility System when the tester is being used.

3.0 FLYING CONTROL HYDRAULIC 'A' SYSTEM

The following units will be deleted from the present system:

1 Transformer unit, comprising of Hydraulic motor, Pump and Flow Control Valve
1 Check Valve
1 Stop Valve
1 N_2 Charge Valve
1 80 cu. in. Accumulator
1 Reservoir and portion of the RCA Heat Exchanger

These units will be deleted from the areas just aft of the Navigator's bulkhead and the Radar Nose along with pipes in these areas and through the Nosewhell Well. The pressure and return lines from the system to the hydraulic motor will also be deleted.

These changes will result in minor structural revisions to Bulkheads, frames, etc.

4.0 ASTRA HYDRAULIC CONTROL SYSTEM

The main changes to the system have been outlined in paragraphs 2 and 3 above, however, the ASTRA ground charging panel will be simplified. The air charging valve and gauge will be deleted, also the changeover switch for fluid level indication (since only one reservoir, i.e. coolant, will be used). The air pressurization line from the waveguide compressor to the ASTRA reservoir will be removed. This change will result in some minor structural revisions in the Radar Nose and Front Fuselage.

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5.0 ESTIMATED WEIGHT ANALYSIS OF PROPOSED CHANGES

Utility Hydraulics System		Wt. Added	Wt. Deleted
Units Deleted	2 Pumps at 16 lbs.	-	32.0 lbs
	1 Pressure Regulator	-	5.5 lbs
	1 By-Pass Control Valve	-	3.0 lbs
	1 Thermal By-Pass Valve	-	1.9 lbs
	1 200 cu. in. accumulator (Incl. oil)	-	18.0 lbs
	1 Charging Valve and gauge	-	.75 lbs
Units Added	2 Pumps at 32 lbs	64.0 lbs	-
	2 Check Valves at 0.75 lbs	1.5 lbs	-
	1 Pressure Reducing Valve	1.8 lbs	-
	1 Thermal By-Pass Valve	1.0 lbs	-
	1 By-Pass Relief Valve	1.5 lbs	-
	1 Stop Valve	1.0 lbs	-
FLYING CONTROL 'A' SYSTEM			
Units deleted	1 Hydraulic Motor	-	2.10 lbs
	1 Pump	-	4.90 lbs
	1 Flow Control	-	.60 lbs
	1 80 Cu. in, accumulator	-	8.25 lbs
	1 Reservoir	-	8.30 lbs
	1 Check Valve	-	.40 lbs
	1 Stop Valve	-	1.0 lbs
	1 N_2 Charge Valve and gauge	-	.75 lbs
	1 Heat Exchanger	-	3.0 lbs
ASTRA HYDRAULIC CONTROL SYSTEM			
Units Deleted	1 Air Charging valve and gauge	-	.75 lbs
	1 Changeover switch	-	.25 lbs
		70.8 lbs	91.45 lbs

The apparent weight saving of 20.65 lbs indicated by the above figures will be absorbed by the larger compensator, increased fluid capacity, electrical wiring and hydraulic piping that will be added to the Utility Hydraulic System.

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CONCLUSION

As described, the new systems will result in eight less hydraulic items of equipment, but no substantial weight savings are foreseen. The system will not cater for the nitrogen compressor power under discussion for the I.R. guidance system, however, it will be possible to provide this power without a major change in concept.

It is not ancitipated that there will be any difficulties in the procurement and development of the new items of equipment as the pumps will be the same as the flying control system pumps with the addition of dual range modification and the remaining valves are of a conventional type.

It is also anticipated that the existing heat exchangers used by the Utility Hydraulic System will be unchanged.

It is assumed that the hydraulic power required to drive the scanner for warn up during the readiness state, will still be supplied through the ASTRA GO-NO-GO Tester.

As shown in the report referenced on the opening paragraph of this report, the vulnerability of the present system is not considered to be serious and the safety effects of the proposed change are nullified somehwat by the fact that due to developments in the Flying Control System its supply and return lines will still have to be run to the forward end of the fuselage even if this change is made.

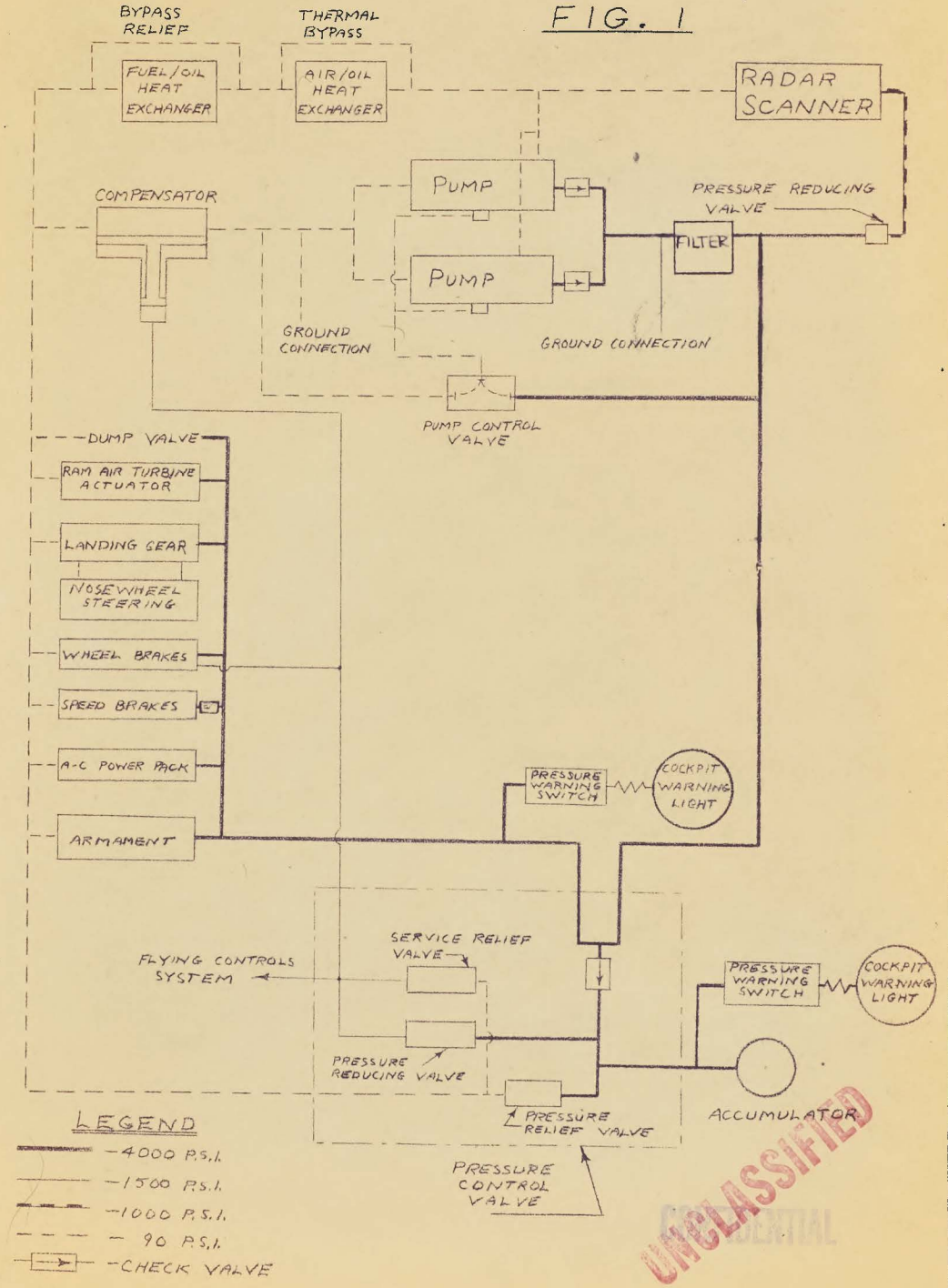
AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT No 72/SYSTEMS 19/80
SHEET No. 6

AIRCRAFT:		PREPARED BY	DATE
ARROW 2	SCHEMATIC — UTILITY HYDRAULICS SYSTEM	G EYOLFSON W.M. VANCE	16 DEC. '57
		CHECKED BY	DATE

FIG. 1



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