QCX
Avro
CF105
LOG
105 -
43 Add.

Classification cancelled / Changed to UNCLAS
By authority of CF-105 POWER PLANT AVCS
Date GROUND SUPPORT EQUIPMENT 27 Sept 56
Signature
Addendum to CONFIDENTIAL
LOG/105/43
Name / Rate / Appointment AVCS September 1956

AVRO AIRCRAFT

C O N F I D E N T I A L

ADDENDUM TO REPORT LOG/105/43

SEPTEMBER, 1956

AVRO ARROW

POWER PLANT GROUND SUPPORT EQUIPMENT

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Cont'd...

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1. INTRODUCTION

Avro Report No. LOG/105/43 was issued in September, 1956. The object of the report was to establish an informed basis for discussion with the R.C.A.F. with the purpose of arriving at a decision on what action should be taken to arrive at the best type of engine handling equipment to support the Arrow in Squadron operations.

The report covered in detail both the J75 and Orenda "Iroquois" installations together with associated ground handling equipment. It was recommended that as the J75 version of the Avro Arrow would not go into squadron service, the engine handling equipment proposed by Avro should be accepted and that the equipment required for the Iroquois should be the subject of further study. The R.C.A.F., through the medium of the Maintenance and Ground Equipment Sub-committee, has accepted the recommendation that the J75 ground equipment as proposed should be adopted and Iroquois ground equipment should be further investigated.

In order to broaden the scope of this investigation, Avro Aircraft Limited invited the Air Logistics Corp. of California to put forward a proposal using elements of their engine handling equipment known as the Air-Log system. Concurrently, Avro Aircraft Limited decided to investigate, independently, an engine handling method which would eliminate the necessity of employing engine slinging equipment in the vicinity of the aircraft during engine change procedure.

Introduction Cont'd...

The purpose of this Addendum is to present and review the Avro Aircraft Limited and Air Logistics proposals and to recommend to the R.C.A.F. a course of action.

2. DESIGN CONSIDERATIONS.

The aircraft design features, which in turn influence the ground equipment, are fully discussed in chapter 2 of report LOG/105/43. The following recapitulation is given to highlight the main features of the aircraft engine installation which directly affects the design of the ground handling equipment.

2.1 Engine Mounts.

It will be seen from Fig. 4 of report LOG/105/43 that the Iroquois engine is suspended from the underside of the wing by three struts, one on the front inboard side and two at the rear, which pick up on either side of the engine mounting ring at station 732. Horizontal forces are taken by the front and rear centre mounts which are located in the wing on the centre line of the engine; these normally pick up with sockets in the engine and are retracted during the engine change procedure. It should be noted that during installation, the relative position of these mounts and the engine sockets are not visible.

2.2 Engine and Air Frame Clearances.

As illustrated in Fig. 3 of Report LOG/105/43 the clearances between the engine and shroud are very limited, and possible points of interference are not readily visible during engine removal or installation. The diameter of the Iroquois afterburner is such that it is not possible to insert removable rails between the engine and

2.2 Engine and Air Frame Clearances Cont'd...

fuselage walls to support the engine during removal and installation as was the case with the J75 version.

2.3 Access.

With the exception of various service doors in the underside of the fuselage, the engine is completely enclosed in the Airframe structure forward of station 742. A removable door of 33 inches in width extends rearward from station 742 to station 783 which is the attachment point for the removable tailcone fairing. It will be appreciated therefore that the only part of the engine which is readily accessible for attaching ground equipment is through the 33 inch door opening aft of station 742. The rear engine mounting ring is situated at station 732, which is 10 inches forward of the access door and therefore cannot be used for supporting the engine in its installed position. The only point capable of supporting the weight of the engine aft of the door opening is the afterburner flange at 745. Two brackets have been provided at this position for attaching ground equipment. It should be noted that only limited loads can be applied to the brackets, which are restricted to 750lb thrust in the fore and aft direction.

2.4 Specification AIR - 7 - 4.

It is a requirement of R.C.A.F. Spec. AIR 7 - 4 that it is possible to change a complete power plant in 30 minutes. There is some reason to believe that this requirement will prove more difficult

2.4 Specification AIR - 7 - 4. Cont'd...

to meet with the Iroquois than with the J75 installation. It is, therefore, most important that the ground equipment is designed so as to require the minimum amount of time for its operation.

2.5 Summary of Design Limitations.

The following conditions are imposed on the design of the ground equipment by the aircraft engine installation.

a) Detachable rails cannot be used to support and guide the engine during the change procedure.

b) Owing to small clearances between the engine and fuselage it is essential to design the change-stand so that exact alignment is ensured.

c) Means must be provided to ensure that the engine is properly positioned in all directions, so that the engine mounts can be entered into their sockets.

d) The rear support brackets and afterburner flange are only capable of supporting the engine whilst it is being traversed slowly along the engine change-stand; under no circumstances can they be relied upon to support the engine if the stand were detached from the aircraft and manoeuvred.

e) The ground equipment must be designed for a minimum time of operation, if the requirement of AIR 7 - 4 is to be met.

2.6 Change Stand Design Requirements.

As the large diameter of the Iroquois afterburner precludes the use of removable rails, some alternative means of supporting and guiding the forward portion of the engine within the fuselage during removal and installation, had to be provided. This guide, therefore, must of necessity be fixed and remain in the airframe at all times. In order to minimize the weight penalty, it was decided to use one rail only for this purpose which is positioned on the outboard side of the fuselage, extending from a point 3 inches forward of the front engine mount to 5 inches aft of station 742. During removal and installation, the forward portion of the engine is supported by a roller, attached to the forward engine mount, which runs on the fixed fuselage rail. During engine removal and installation, the rear of the engine is supported by a carrier on the change-stand which is attached to brackets mounted on the afterburner flange. The torque resulting from the tendency of the engine to rotate about the front side roller must, therefore, be taken by the rear carrier. With the engine withdrawn to a point where the side roller is nearing the end of the fuselage rail, a second carrier must be positioned so as to support the front portion of the engine prior to it being fully withdrawn from the airframe.

3. CHANGE STAND CONFIGURATION.

From the foregoing, it will be seen that certain characteristics of the stand are determined by the aircraft engine installation. For example:-

(a) The change stand must be attached in a suitable manner to the airframe to ensure proper alignment between the engine and the shroud.

(b) Various limit stops must be provided to ensure proper forward and aft positioning.

(c) The engine must be supported by, and traversed on oarriers running in rails on the change-stand.

Having provided for the fixed requirements, the following choice remains open:-

(i) The change-stand to be in the form of a set of rails on wheels which is coupled to the airframe and remains statio throughout the change procedure. The engine when withdrawn from the airframe is lifted from the change-stand by a hoist or crane onto a low transport trailer whioh can also serve as a work-stand. The replacement engine is then hoisted from a second trailer onto the change-stand and installed.

(ii) The change-stand to consist of two units. The first unit to be a short version of the stand described in (i) above. The second unit comprising a trailer which is mounted on sprung, steerable pneumatic wheels. This trailer to be adjustable in height. When fully lowered, the centre of

3. Change Stand Configuration Cont'd....

gravity of the engine must be sufficiently low to ensure stability during towing of the trailer.

In this arrangement the engine change procedure is as follows:-

Attach first unit to fuselage. Position and attach trailer to rear of first unit. Withdraw engine from fuselage, uncouple trailer upon which the removed engine is now supported, and wheel clear. Position and attach second trailer complete with replacement engine, and install.

4. ENGINE CHANGE-STAND TO AVRO SCHEME # 1.

In order that Avro Aircraft Limited should have some equipment available for installing the mock-up Iroquois engine in the interim Avro Arrow fuselage mock-up, it was decided to proceed with the manufacture of a prototype engine change-stand to the configuration referred to in para. 3, choice number (i).

This configuration was chosen primarily because it was by far the most simple and could be drawn and manufactured quickly. Secondly, it was felt that the basic concept had some merit and should be evaluated against equipment based on other concepts.

The main features of the scheme and its operation are illustrated on Figs. 1 and 2.

The advantages can be summarised as:-

(a) The stand is simple and should prove relatively inexpensive to produce on a production basis.

(b) As the stand is always manoeuvred less an engine, little effort is required to position and attach to the aircraft. Since the stand is not a transporter, the wheels can have steel rims which further increase its manoeuvreability.

(c) The total number of operations required during the change procedure is less than with other schemes.

(d) Work-stand also serves as transporter trailer.

4. Engine Change-Stand to Avro Scheme # 1 Cont'd...

(e) Both engines can be changed simultaneously.

The disadvantage is that a separate means of slinging the engine from the stand onto the trailer is required during engine change procedure. This may be accomplished with a mobile crane, or alternatively with a mono-rail structure, as shown in Fig. 1.

4.1 Detailed procedure.

In order to establish some comparison between the proposals, a step by step engine change procedure, together with estimated times, is given below. It will be appreciated that the described procedure covers only the main operations affecting the ground equipment.

With the aircraft supported on jacks, and all cowls and doors removed, proceed as follows:-

	Estimated Time. (Minutes)
1. With both carriers locked in the fully forward position lower (hydraulically) the front end of the change-stand and wheel into position under the rear of the engine.	1.00
2. Raise (hydraulic hand pump) forward end of stand until indexing lines on stand bracket correspond with marks on fuselage frame.	.50
carry forward	1.50

4.1 Detailed procedure Cont'd...

		Estimated Time. (Minutes)
	carried forward	1.50
3.	Engage pins securing stand to rear fuselage brackets, lock rear of stand by engaging screw jack with ground.	.50
4.	Unlock rear carrier, engage and secure carrier jacks with rear support brackets mounted on afterburner flange.	1.00
5.	Engage carrier lock.	.25
6.	Disconnect all engine mounts and services.	11.00
7.	Release carrier lock, withdraw engine until rear carrier engages stop in mid position of stand.	1.00
8.	Engage front carrier jack with pad situated on underside of engine, raise jack until engine roller is clear of rail mounted on outboard side of fuselage.	.75
9.	Release stop and fully withdraw engine.	1.00
	carry forward	17.00

4.1 Detailed procedure Cont'd...

		Estimated Time. (Minutes)
	carried forward	17.00
10.	Attach engine sling.	.50
11.	Operate lifting gear (overhead hoist or crane) remove pins securing rear carrier jacks to afterburner brackets.	.50
12.	Lift engine clear of change-stand.	.50
13.	Deposit and attach engine on transport/work trailer.	1.50
14.	Transfer sling to new engine to be installed.	.50
15.	Raise new engine from its trailer and place on change-stand.	2.00
16.	Insert pins in rear carrier jacks and after-burner brackets. Remove engine sling.	1.00
17.	Unlock rear carrier, traverse engine towards aircraft until first stop position is engaged with rear carrier.	.50
	carry forward	24.00

4.1 Detailed procedure Cont'd...

	Estimated Time. (Minutes)
carried forward	24.00
18. Check that engine roller is lined up with fuselage rail.	.25
19. Move rear carrier into second lock position which places the roller over the rail.	.25
20. Lower front carrier jack - ensure that roller is properly engaged with rail.	.25
21. Roll engine right home, lock rear carrier, connect engine struts and engine mounts.	4.00
22. Disengage rear carrier from afterburner brackets, remove pins attaching stand to fuselage.	.50
23. Lower, and remove stand.	.25
Estimated Total Time	29.50 minutes.

5. ENGINE CHANGE STAND TO AVRO SCHEME # 2.

At the time of requesting the Air Logistics Corp. to prepare a proposal for Avro Arrow/Iroquois engine change equipment, it was decided by Avro Aircraft Limited to investigate an alternative scheme which would not entail the use of a hoist or crane for removing and replacing engines. This then presents a third alternative for consideration by the R.C.A.F. The main features of this scheme and its operation are shown in Figs. 3, 4 and 5.

The advantages and disadvantages are summarised as follows:-

Advantages - No hoist or crane is required during the engine change procedure.

Disadvantages

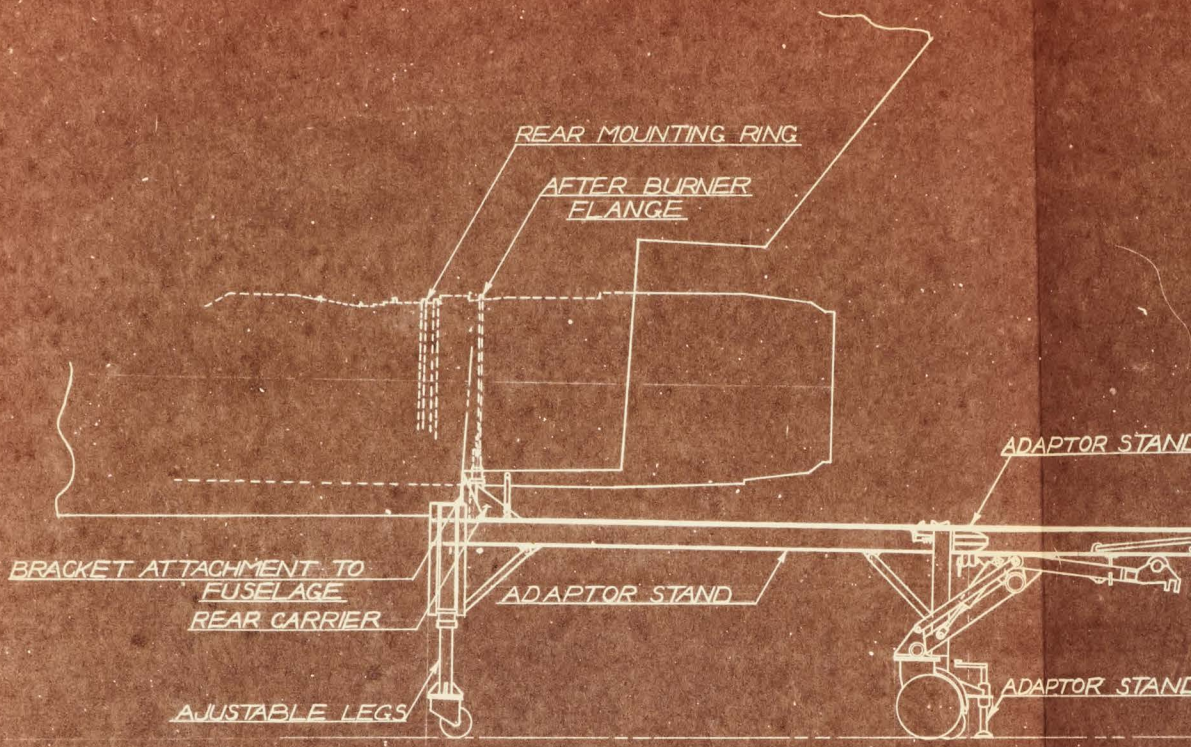
(a) The equipment is more complicated and expensive.

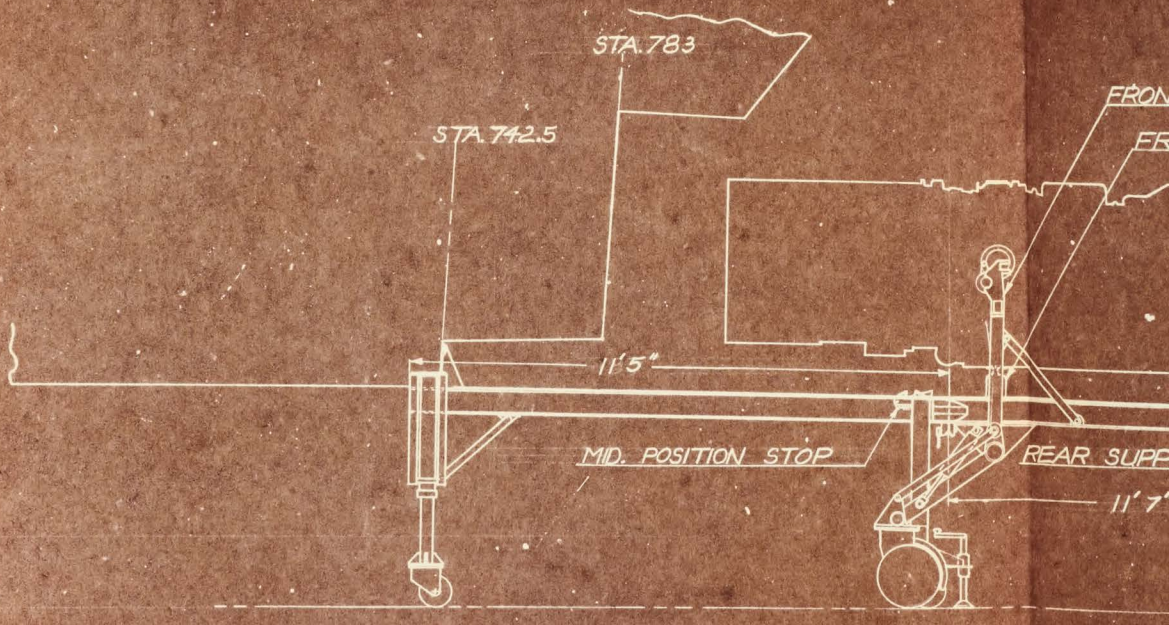
(b) More effort and time is required to position the trailer to the adaptor stand, firstly because of the additional weight of the engine on the trailer, and secondly because of the greater drag of the pneumatic tyres.

(c) The total number of operations is more than required in Avro Aircraft Scheme # 1.

(d) The wide track of the trailer which is required for stability during towing rules out the possibility of changing both engines simultaneously.

(e) The trailer cannot serve as work-stand, and a separate work-stand is necessary.





AVRO SCHEME 2 FIG. 4

5.1 Detailed Procedure.

With the aircraft supported on jacks and cowls removed, proceed as follows:-

		Estimated Time. (Minutes)
1.	Position the adaptor stand under the rear of the engine, adjust height (hydraulically) of the front legs so that the index marks on the stand brackets correspond with the rear fuselage frame.	1.00
2.	Secure stand to fuselage, lock rear of stand to floor with screw-jack.	1.00
3.	Manoeuvre the engine trailer into position at the rear of the adaptor stand, level trailer until it corresponds in height and attitude with the adaptor stand.	1.50
4.	Couple stand and trailer together, raise rear of trailer until the top portion of the stand and trailer rails are tightly butted.	1.00
5.	Traverse both carriers from the trailer to the forward end of adaptor stand.	.50
	carry forward	5.00

5.1 Detailed Procedure Cont'd...

		Estimated Time. (Minutes)
	carried forward	5.00
6.	Attach rear carrier screwjack to support brackets mounted on engine afterburner flange, and lock cradle.	1.00
7.	Disconnect all engine mounts and services.	11.00
8.	Withdraw engine until mid position stop is engaged.	1.00
9.	Engage front carrier jack with jacking pad on engine, raisejack until engine roller is clear of fuselage rail.	.75
10.	Release stop and fully withdraw engine, both carriers supporting the engine are now on the trailer and clear of the adaptor stand.	1.00
11.	Raise both support struts on forward end of trailer, adjust height of engine with front carrier jack, until struts are engaged with front engine mounts.	.75
12.	Secure struts and lower front carrier jack.	.75
	carry forward	21.25

5.1 Detailed Procedure Cont'd...

	Estimated Time. (Minutes)
carried forward	21.25
13. Raise both rear support struts and attach to rear engine mount ring, the correct height is obtained by means of a screwjack mounted in the top end of the struts.	.50
14. Remove the weight of the engine from the rear carrier by operating the support strut screw jacks.	.25
15. Uncouple the trailer from the adaptor stand, and pull clear. (The trailer must be lowered prior to towing)	.25
16. Wheel seoond trailer, upon which is mounted the engine to be installed, into position.	1.00
17. Adjust height and attitude to agree with adaptor stand.	.50
18. Couple trailer to stand, ensure that rails are correctly butted.	1.00
19. Conneot rear carrier jacks to rear support brackets on engine afterburner.	1.00
carry forward	25.75

5.1 Detailed Procedure Cont'd...

		Estimated Time. (Minutes)
	carried forward	25.75
20.	Transfer weight of engine from rear support struts to carrier by operating screw jacks in struts.	.25
21.	Fold struts clear of engine.	.25
22.	Support front of engine by raising front carrier jack, disconnect and fold front support struts.	.50
23.	Traverse engine forward until first mid position stop is engaged, check that engine roller is in line with rail.	1.00
24.	Move engine forward until second stop is engaged, lower front carrier jack, ensure that roller is engaged with rail.	.50
25.	Release stop and traverse engine to its installed position.	1.50
26.	Lock rear carrier, connect engine struts and engage engine mounts.	4.00
27.	Disengage rear carrier, and traverse both carriers rearward onto trailer.	.25
	carry forward	34.00

5.1 Detailed Procedure Cont'd...

	Estimated Time (Minutes)
carried forward	34.00
28. Disconnect trailer from change stand and remove.	.25
29. Disconnect adaptor stand from rear fuselage.	.25
Estimated Total Time	34.50 minutes

6. AIR LOGISTICS CORP. PROPOSAL # DP/23-56.

6.1 The Air Log System Analysis for Avro Arrow Aircraft Engine Handling.

The Air Log System Analysis deals primarily with changing the Avro Arrow Iroquois engine, using as many elements of standard Air-Log equipment as possible.

Secondly suggestions are made concerning the possible use of this equipment for performing other servicing operations on the Avro Arrow Aircraft.

These latter suggestions are reviewed in Chapter 7 of this addendum.

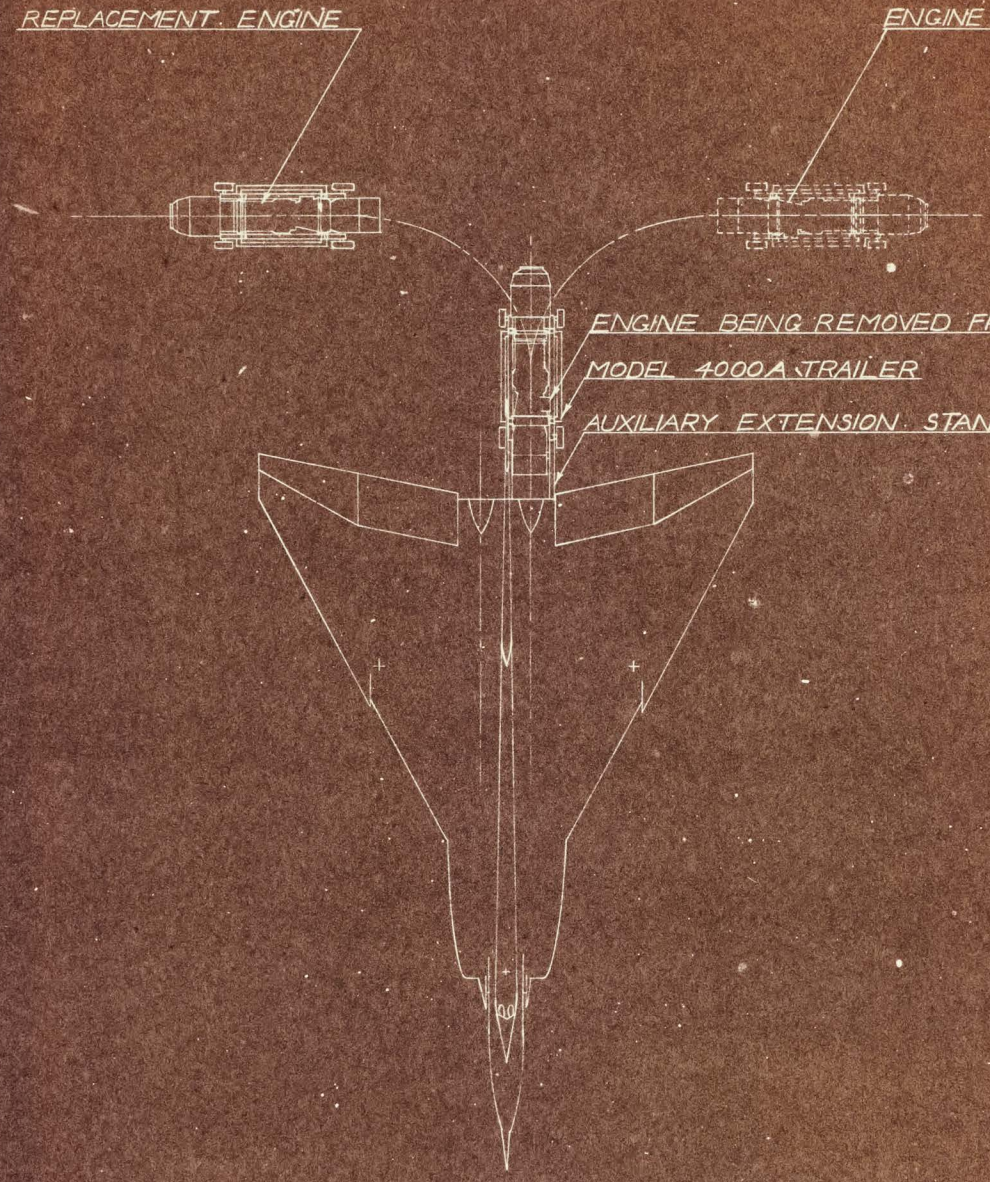
The main features of the proposed engine changing scheme and the equipment involved are illustrated on Figs. 6, 7 and 8.

It will be seen that the principle items of equipment are standard Air-Log units, the special equipment required in conjunction with the Avro Arrow Iroquois installation is confined to:-

(a) The Extension Stand.

(b) Fore and Aft Positioning Adaptors.

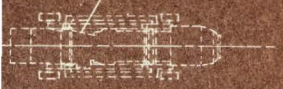
(c) Fore and Aft Transport Adaptors.



MODEL 4

AIR LOGISTICS CORPORATION'S PROPOSAL

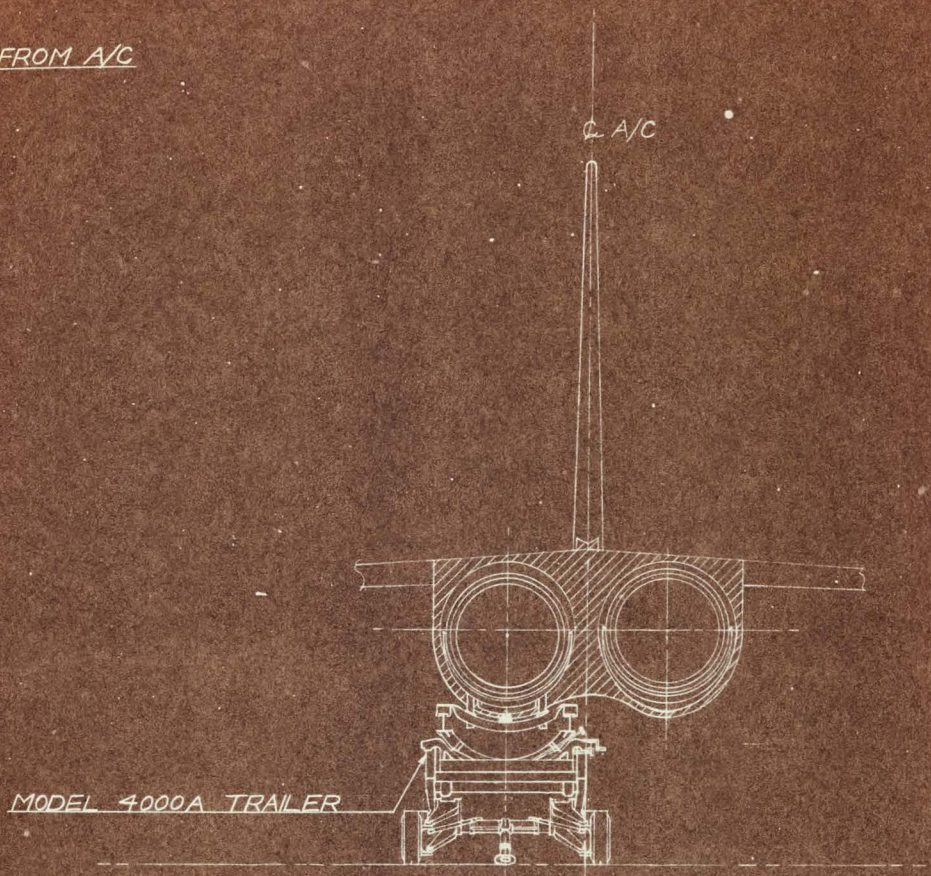
ENGINE REMOVED FROM A/C



BEING REMOVED FROM A/C

4000A TRAILER

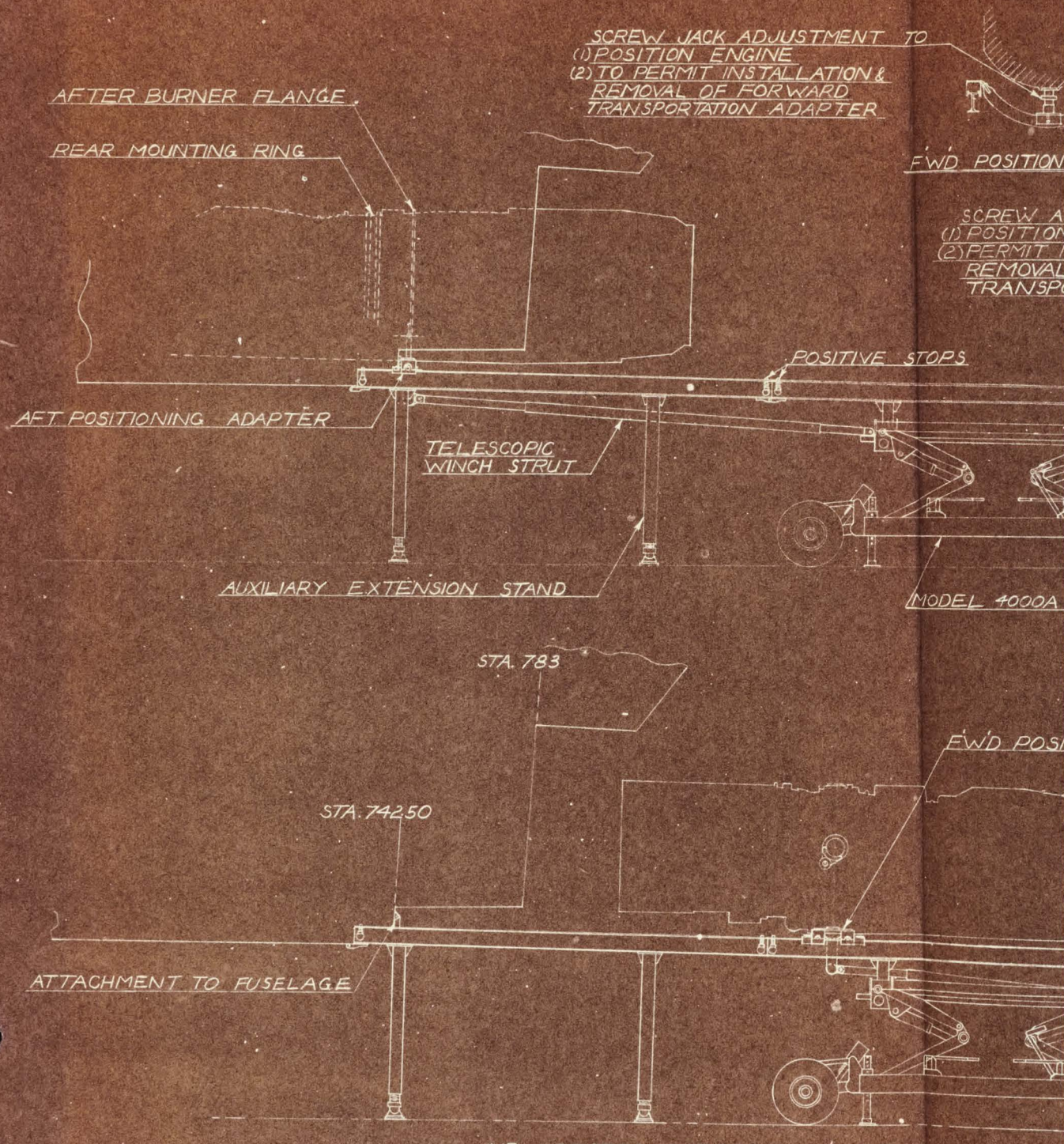
EXTENSION STAND



VIEW ON REAR OF A/C SHOWING
MODEL 4000A TRAILER IN POSITION

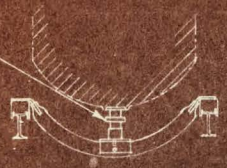
OGISTICS CORPORATION'S PROPOSAL

FIG 6



AIR LOGISTICS CORPORATION'S PROPOSAL

REW JACK ADJUSTMENT TO
SITION ENGINE
PERMIT INSTALLATION &
MOVAL OF FORWARD
NSPORTATION ADAPTER



FWD POSITIONG ADAPTER

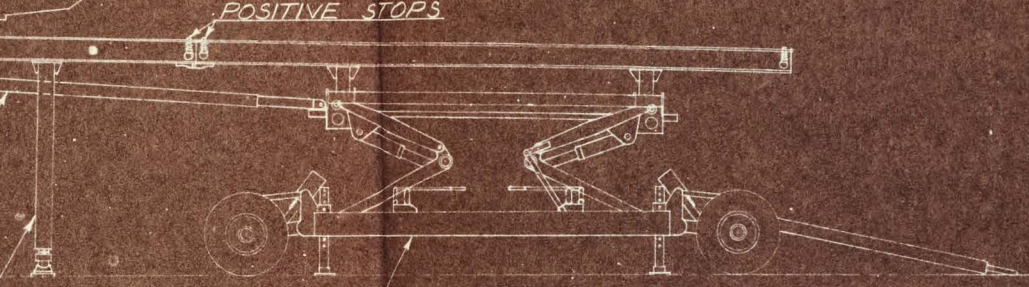
REVERSE LOAD ROLLER

PULL PINS TO DROP SUPPORTS TO CLEAR FUSELAGE

SCREW ADJUSTMENT TO
(1) POSITION ENGINE
(2) PERMIT INSTALLATION & REMOVAL OF AFT TRANSPORTATION ADAPTERS

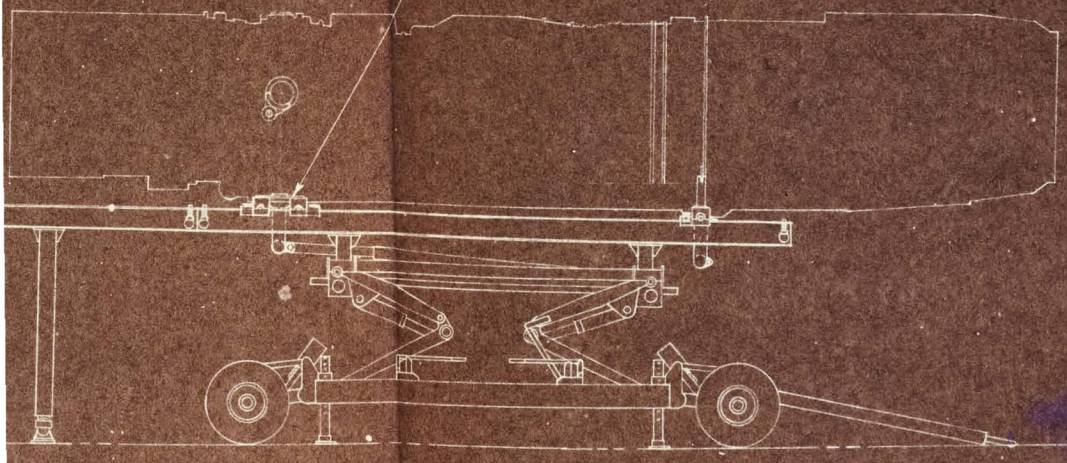
AFT. POSITIONING ADAPTER

POSITIVE STOPS



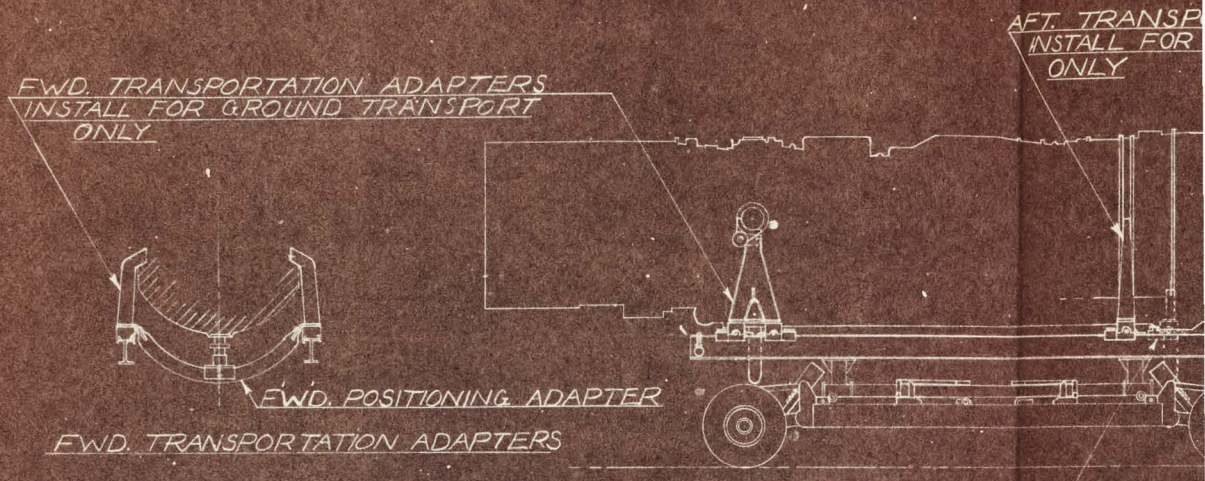
MODEL 4000A TRAILER IN RAISED POSITION

FWD POSITIONING ADAPTER

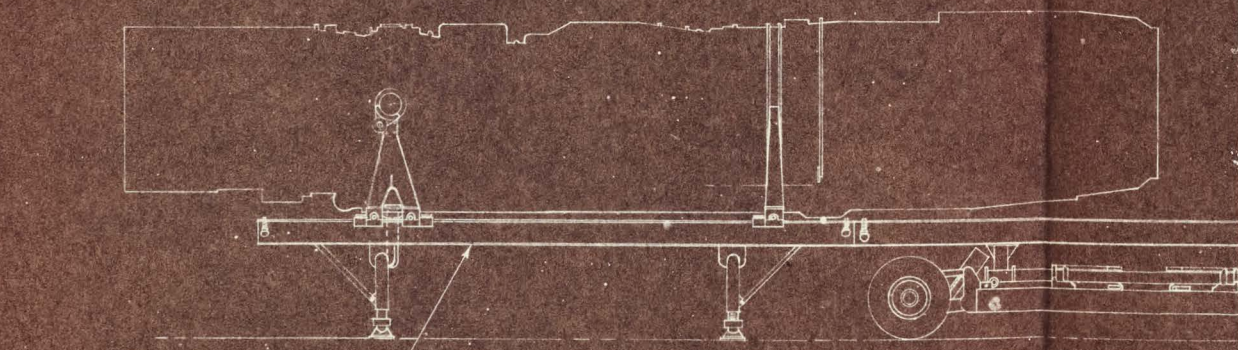


CS CORPORATION'S PROPOSAL FIG. 7

CONFIDENTIAL

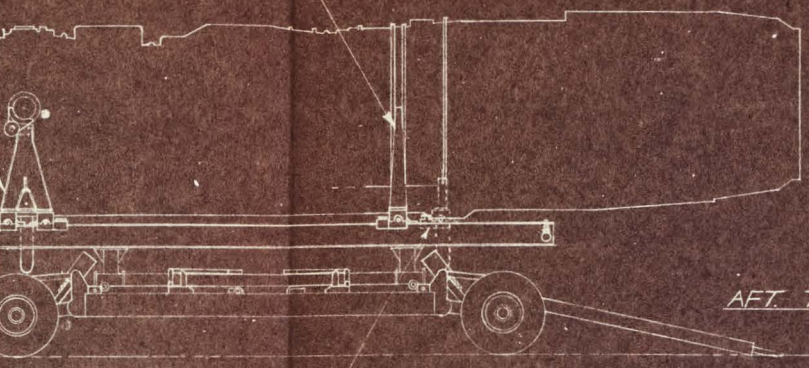


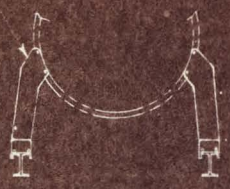
MODEL 4000A TRAILER IN TOWING POSITION



AIR LOGISTICS CORPORATION'S PROPOSAL

AFT. TRANSPORTATION ADAPTERS
INSTALL FOR GROUND TRANSPOIRT
ONLY

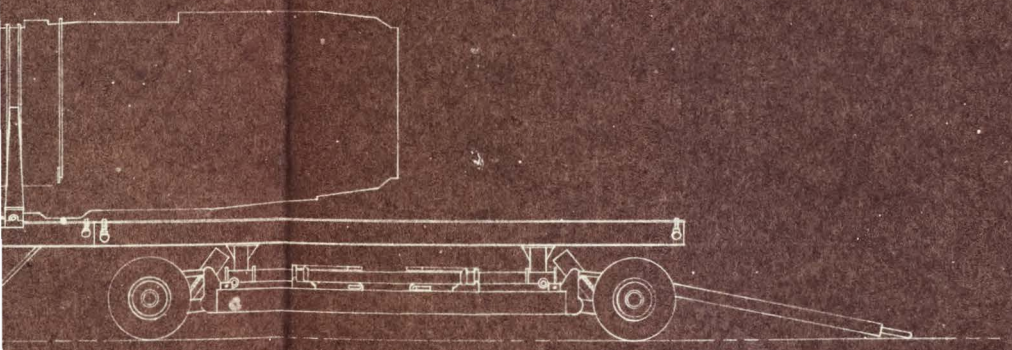




AFT. TRANSPORTATION ADAPTERS

AFT. POSITIONING ADAPTER REMOVED WHEN
AFT. TRANSPORTATION ADAPTERS ARE USED

RAILER IN TOWING POSITION



NSFERED FROM 4000A TRAILER TO 3100A WORKSTAND

CS CORPORATION'S PROPOSAL FIG. 8

6.1 Cont'd...

The engine change procedure proposed by the Air Logistic Corp. is very similar in principle to the Avro Scheme # 2 and, it is estimated, will take the same amount of time to perform.

6.2 Detailed Procedure.

With the Aircraft supported on jacks and cowls removed, proceed as follows:-

(1) Position the Auxiliary Extension Stand under the rear of the engine, raise and pin stand positioning brackets. Adjust rail height of Auxiliary Stand until brackets pick up with rear fuselage frame.

(2) Secure stand to fuselage.

(3) Mount aft positioning adaptor on stand, with engine pick up extensions lowered, position adaptor under engine afterburner brackets, raise and pin extensions.

(4) Adjust screw jacks as required, insert pins securing adaptor extensions to afterburner brackets and lock adaptor to stand.

(5) Manoeuvre 4000A trailer into position. Adjust height and angle so that the rails of the extension stand and trailer correspond. Lower trailer steady rests (ground locks). Lock rails of stand and trailer together.

(6) Disconnect all engine mounts and services.

(7) Attach telescopic winch strut to aft positioning adaptor.

(8) Unlock aft adaptor and withdraw engine until aft adaptor reaches stop on rear of extension stand.

(9) Mount forward positioning adaptor on front end of extension stand.

6.2 Detailed Procedure Cont'd...

(10) Adjust screw jack until engine roller is clear of fuselage rail.

(11) Fully withdraw engine so that both fore and aft adaptors are clear of the extension stand and supported by the 4000A trailer.

(12) Mount transport adaptors to forward positioning adaptor, release screw jack.

(13) Install aft transport adaptor, disengage aft positioning adaptor from afterburner brackets.

(14) Release trailer steady rests (ground locks).

(15) Uncouple trailer from extension stand and pull clear.

(16) Wheel second trailer, upon which is mounted the engine to be installed, into position, and reverse the sequence 1-15.

7. ALTERNATIVE USE OF AIR-LOG EQUIPMENT.

The Air Logistic Corp. Proposal states that many advantages would be derived by standardizing on their equipment; among the advantages claimed are increased servicing efficiency and reduction in capital outlay. It is claimed that this is due in part to the multi-purpose capability of the equipment which allows it to be used for several different servicing operations in addition to engine handling. Several possible alternative uses for this equipment are shown in connection with the Avro Arrow Aircraft.

Before reviewing these individually the following comments are offered for consideration.

The Air-Log equipment was primarily developed for handling large jet engines weighing up to 8000 lbs, and in this connection the equipment undoubtedly has merit, its use for other servicing operations is to some degree a compromise which does not necessarily lead to the most economical use of the equipment or the efficient performance of the servicing operation.

A lengthy study would be required to review all aspects of this subject. As this is not the purpose of this Addendum, it is proposed to review the main features of one example only.

It is considered that 2 sets of engine changing equipment would suffice to support a Squadron of Aircraft of the Avro Arrow class. The equipment would operate in the second line maintenance area and must be on hand at all times to deal with unscheduled engine changes, and also to cater for

7. Continued...

engine removal for access to equipment in rear equipment area. If, as the Air-Logistic Corp. claim, the equipment is suitable for performing other servicing functions, additional equipment must be scaled for this purpose.

It is suggested in the Air-Log System Analysis that their model 4000A Trailer could be used for loading missiles onto aircraft. Under service conditions this would be done at an arming or turn round point which could be some distance from the second line maintenance area. Current R.C.A.F. operational requirements call for 5 aircraft to be turned round in a period of 15 minutes. This would require the use of 5 trailers which are in addition to those required for engine handling. It will be appreciated, therefore, that it is not a matter of using the same equipment to handle engines and load missiles in a dual capacity, but to provide equipment primarily designed for engine handling to load missiles, and more than twice the "engine handling" number of trailers would be required for the purpose of loading missiles. This poses the following questions.

(a) As a missile loader can the 4000A trailer perform the operation as efficiently as equipment designed specifically for the purpose?

(b) Is it economical to provision it for this purpose?

The first requisite for any ground equipment required for the "turn round" of an aircraft is that it can perform its function in the most convenient manner, the shortest time, and requires a minimum of personnel for its operation.

7. Continued...

It is considered that the most suitable equipment for installing missiles would be a light trailer incorporating a winch. The trailer would transport the missiles from the "Ready Use Store" to the aircraft, and raise the missile from the trailer to the aircraft by means of cables attached to the launcher rail. In this manner the missile is free to swing into position and the proper relation of the missile to the rail is assured, thus eliminating the necessity of accurately positioning the trailer with respect to the aircraft. The trailer described would weigh about 400lbs and be relatively inexpensive to manufacture on a production basis. The Air-Log Trailer Model 4000A, because of its engine handling capability is somewhat cumbersome, measuring 12'6" X 6'6" and weighing 2500lbs. The production cost of each of these trailers complete with adaptors is in the order of $8,000. An aircraft of the Avro Arrow type is expected to be in Squadron service for a period of from 6 to 8 years. During this time each aircraft can conceivably be armed and disarmed some 1,500 times. It follows that each missile loader will probably be operated several thousand times.

To summarize it would require a higher capital outlay to provision 4000A Trailers for missile handling than to design and produce more simple equipment for this purpose. It would perform the arming functions very inefficiently. It is claimed by the Air-Log Corp. that as their equipment can be readily converted to serve any aircraft it never becomes obsolete. On the other hand it should be borne in mind that any ground equipment which has been in continuous use for a period of 6 to 8 years will have

7. Continued...

greatly deteriorated and would undoubtedly prove expensive to recondition so that it would be capable of a further period of several years service with a later aircraft.

7.1 Proposal 1. Air-Log Equipment used for handling Avro Arrow Armament Pack.

It is probable that the Avro Arrow Aircraft will be re-armed by changing the Armament Pack. Upon removal from the aircraft, the discharged pack will be conveyed upon its Hoist/Trailer to an armament building where it will be raised with the Hoist/Transport into a servicing stand. This supports the pack in approximately the same relationship to the ground that it occupies when in the aircraft. The pack will be checked out and re-armed while supported in the service stand; upon completion of this operation the pack is lowered from the work stand by the Hoist/Transport and conveyed to the ready use armament store.

If this arming method is adopted it becomes a matter of prime importance that the packs can be changed during aircraft turn round in the shortest possible time.

The alternative between flight re-arming procedure of the Avro Arrow would be to load each missile individually, and this will require that an external hydraulic power supply be coupled to the aircraft to extend and retract the missile launcher rails.

Even if this latter re-arming procedure were adopted it is still necessary to frequently remove the armament pack for servicing, and also in order to gain access to the armament bay area for inspection and maintenance of

7.1 Continued...

other aircraft services.

Ground equipment capable of rapid and convenient removal and re-installation of the armament pack is therefore a necessity.

The Avro Arrow armament pack measures approximately 16' in length by 8' in width and 2' in depth, its armed weight is 4000lbs. The pack nests into the underside of the aircraft fuselage and is attached to the aircraft by 4 toggle action fasteners, one of which is situated in each corner of the pack.

The ground equipment designed by Avro Aircraft Ltd. for removing and replacing the pack is in the form of a box frame measuring 9' X 8' and weighing 1000lbs. The frame is supported on 4 spring castor wheel assemblies which are equipped with direction locks and parking brakes. Tow bars are provided which allow the Hoist/Transporter to be towed in both a fore and aft and sideways direction. This feature was incorporated at the express request of the R.C.A.F. so that the pack assembly is normally towed with the pack in the fore and aft direction between the aircraft and armament building, and can also be towed sideways for positioning under the aircraft. The hoist frame contains a pneumatically operated cable assembly with an automatic balancing arrangement.

Hoisting the pack into the aircraft is achieved by hooking 4 cables from the hoist onto points on the aircraft fuselage and operating the

7.1 Continued...

self contained pneumatic system. This retracts the cables and raises the Hoist/Transporter, complete with the armament pack, up to the aircraft. The fact that the pack and hoist assembly is suspended from the aircraft ensures proper position so that the packs will line up with the fuselage guide rails or that minor mal-alignment is corrected by the assembly swinging over on the cables. In this manner it is possible to have the pack as much as 15 inches out of position under the aircraft initially, and still achieve satisfactory installation.

It was demonstrated during the Avro Arrow Mock-up evaluation conference that an armament pack can be changed in under 5 minutes using the ground equipment described.

It is considered that the Air-Log Trailer Model 4000A is not suitable as ground equipment for changing the Avro Arrow Armament pack for the following reasons:-

(a) The model 4000A Trailer is designed for towing in one direction only, the wheels can be set at 90° to the normal direction travel. This is a cumbersome procedure which entails supporting the frame of the trailer on its extension legs, relieving all weight from the wheels, disconnecting the steering arms and radius rods, and locking the wheels to 90° to their former position. In this condition the Trailer cannot be steered and therefore, cannot be accurately positioned.

A model 4000A Trailer complete with an armament pack will not pass under the rear fuselage and therefore cannot be accurately positioned

7.1 Continued...

from this direction. An approach from the front is also restricted in this case by the nose undercarriage. It would appear extremely difficult if not impossible to accurately position the trailer under the aircraft unless the pack were mounted transversely, which means that it would always be towed sideways, which is not in accordance with R.C.A.F. stated requirements.

(b) The use of the model 4000A Trailer for raising aircraft components into position requires that the trailer is very accurately positioned in the first instance. Some adjustment is provided in the stand for final positioning, this is, however, limited to 2" in one direction.

Assuming that the difficulties in positioning the trailer under the aircraft as outlined in (a) above were overcome by transversely mounting the pack on the Trailer, it is considered that inserting the armament pack into the Avro Arrow fuselage would prove to be a very tedious and slow operation. It is also considered that there is every possibility of damaging the pack or aircraft structure by either interference caused by mal-positioning, or exerting a side load on the pack during its insertion, which would result in damage to the armament pack guide rails. This could occur without being readily apparent to the ground crew while inserting the pack. In short it is considered that the 4000A Air-Log Trailer is a most unsuitable piece of ground equipment for the frequent and rapid changing of the Avro Arrow armament pack.

7.2 Proposal 2. Air-Log Equipment used for loading Missiles - Avro Arrow Aircraft.

Some basic disadvantages in using the Air-Log model 4000A Trailer for

7.2 Continued...

loading missiles have been discussed earlier in this chapter; the remarks were not confined to any particular aircraft and were put forward to indicate that it is neither economical or desirable to use the equipment for this purpose. As applied to the Avro Arrow configuration the possibility of using the Air-Log trailer for loading missiles is further complicated by the fact that it is difficult to position the trailer under the aircraft in a fore and aft direction. Secondly the launcher rails are staggered both in height and in a fore and aft plane. Taking all things into consideration the Air-Log trailer is not suitable for this task.

7.3 Proposal 3. Air-Log Equipment Replacing Fork Lift Truck.

The Fork Lift Truck was originally shown on the Avro Arrow ground equipment list as general purpose equipment for handling crated stores and other items with no specific aircraft servicing operation in mind.

7.4 Proposal 4. Air-Log Equipment - Rudder Storage Cradle.

Although this item is included in the Avro Arrow ground equipment list it is not intended to design a cradle especially for this purpose.

7.5 Proposal 5. Air-Log Equipment - Engine Removal Crane.

The acceptance of the Air-Log equipment for engine handling would eliminate the use of a crane during the engine change procedure. Some form of engine lifting will however, still be required to remove and replace the engine in the shipping case.

7.6 Proposal 6. Air-Log Equipment - Auxiliary Fuel Tank Handling.

It would appear that the Air-Log Trailer Model 4000A could be used for installing and removing the Auxiliary Fuel Tank scheduled for the Avro

7.6 Continued...

Arrow 2 Aircraft.

7.7 Proposal 7. Air-Log Equipment - Radome and Probe Dolly.

A light trailer for transporting the Radome and Probe assembly has been included in the Avro Arrow ground equipment list. Pending a study of the requirements of the Astra 1 system as a whole, it is not possible to determine what form this equipment should take.

7.8 Proposal 8. Air-Log Equipment - Liquid Oxygen Converter Trailer.

This equipment is intended as a means of conveying the aircraft oxygen converters from the area where they are charged to the aircraft. Each converter will be housed in an insulated compartment, the total weight carried will be in the order of 200lbs. The container will therefore be in the nature of an egg crate on wheels, and could be mounted on any suitable flat top hand truck, or have its own wheels. It is thought that as the equipment will be in continuous use, it is advisable that it should be mounted on its own wheels, as any other trailer allocated for the purpose of carrying the crate would be tied up for the life of the equipment.

7.9 Proposal 9. Air-Log Equipment - Outer Wing Removal Dolly.

It is considered that the Air-Log Model 4000A Trailer with suitable adaptors would prove satisfactory for this function.

7.10 Proposal 10. Air Log Equipment - Fin Dolly.

It is considered that the removal and replacement of the Avro Arrow Aircraft fin is a major operation and will in all probability be performed by a contractor working party; this view has also been expressed by the R.C.A.F. maintenance sub-committee, who have recommended that no R.C.A.F. ground

7.10 Continued...

equipment should be selected for this purpose.

7.11 Proposal 11. Air-Log Equipment - Armament Pack Test Stand.

A stand is required to support the armament pack while undergoing maintenance and functional checks. The pack will be hoisted into the stand by the Hoist/Trailer in the same manner as it is raised into the aircraft, the underside of the pack must remain clear so that the launcher rail extension mechanism can be operated. It is thought that the Air-Log Corp. included this stand among the uses to which their equipment could be put due to a lack of understanding of its function.

7.12 Proposal 12. Air-Log Equipment - Aileron, Elevator and Control Box Removal Stand

It is considered that the Air-Log Model 4000A Trailer with suitable adaptors, would prove satisfactory for this function.

7.13 Proposal 13. Air-Log Equipment - Outer Wing Storage Cradle.

Remarks as in 7.4 above.

7.14 Proposal 14. Air-Log Equipment - Aircraft Components Slings.

Component slings for major portions of the Avro Arrow fuselage have been included in the ground equipment list. These are required during the production and assembly stage of the air frame, but will not be required by the R.C.A.F. for maintenance. In any case most of the components are too large to be supported by one Air-Log Stand.

7.15 Proposal 15. Air-Log Equipment - Engine Removal Stand.

Air-Log equipment can be considered suitable as discussed in previous chapters of the Addendum.

7.16 Proposal 16. Air-Log Equipment - Engine Stand.

Remarks as in 7.15 above.

7.17 Proposal 17. Air-Log Equipment - Fin Cradle.

Remarks as in 7.10 above.

7.18 Proposal 18. Air-Log Equipment - Missile Lifting Tackle.

With the exception of arming aircraft all lifting and individual handling of the missiles will be confined to the missile handling facility. The equipment for this area is presently being proposed by Canadair to the R.C.A.F. if, as is believed, slinging of missiles is required suitable equipment will be included in Canadair's proposal.

7.19 Proposal 19. Air-Log Equipment - Armament Pack Sling.

In general the Avro Arrow armament pack will either be:-

(a) In an aircraft.

(b) On the Hoist/Transporter.

(c) In the Test Stand.

A sling will however be required for the occasion where a pack has been shipped in a packing case, or if major structional repairs have been carried out which could not be done in the Test Stand.

7.20 Proposal 20. Air-Log Equipment - Engine Sling.

The Air-Log engine handling system would reduce the number of engine slings required. Engine slinging will be required for removing and replacing engines in their shipping containers.

7.21 Proposal 21. Air-Log Equipment - Radome Sling.

Remarks as in para. 7.7 above.

8. CONCLUSIONS AND RECOMMENDATIONS.

The Air Logistic Corporation's preliminary engineering proposal had not been submitted at the time that Avro Aircraft Limited had completed its Scheme # 2. It is therefore interesting to note that the general concept and technical details of these two schemes are very similar. As for initial cost and availability, the Air Logistics proposal has every advantage, because the main items of equipment included in their proposal are already in existence.

With regard to Squadron operation of the Avro Arrow the R.C.A.F. will therefore have to decide between two concepts. These concepts are the Avro Aircraft Limited Scheme # 1 and the scheme submitted by the Air Logistics Corporation at the request of Avro.

The theoretical pros and cons of these two concepts have been stated in the text of this Addendum. We believe that these theoretical considerations are not sufficient to reach a conclusion, and for the R.C.A.F. to base a rather far reaching decision on.

It is therefore recommended that one set of the equipment proposed by the Air Logistics Corp. be obtained for evaluation purposes. It is further recommended that during the mock-up conference of the Avro Arrow/Iroquois installation, scheduled for July 1957, a demonstration be conducted using (a) Air-Log equipment and (b) Avro Aircraft prototype equipment conforming to Scheme # 1.

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