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INVESTIGATION OF THE NEED FOR
AN ALL WEATHER TRAILER A/C
WATER SUPPLY

Report No. 72/GEQ/13.
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ARROW 2

AN INVESTIGATION OF

THE NEED FOR AN ALL WEATHER TRAILER AIRCRAFT WATER SUPPLY

Report No. 72/GEQ/13.

May, 1958

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ABSTRACT

A trailer, aircraft water supply, ARROW, is called up on the ground support equipment list (Item 191, AVRO Report 70/GEQ/2).

This study examines the necessity for this equipment in light of the operational concept of the ARROW. The water consumption rate, method of replenishment and problems associated with all weather operation at forward bases are reviewed.

A preliminary outline of the main features of an all weather trailer are discussed.

CONCLUSIONS

1. Replenishment at Main Bases

The proposals contained in AVRO Report 72/GEQ/3 "A Study of Turnaround and 1st Line Maintenance Facilities" meet the operational concept. These proposals consist of replenishment from a softened domestic supply in heated turnaround hangars via an overhead delivery system. An automatic shut-off nozzle is recommended to prevent overfilling.

2. Replenishment at Forward Bases

Under the present concept of operations defined in Specification Air 7-4, the forward base activity is an emergency operation only. There will only be occasional demands for small quantities of water depending on the speed and altitude of the flight to and from the forward base. If these flights are made at cruise conditions at heights not exceeding 30,000 ft. no water replenishment is required.

The occasional demand for water may be met from any clean domestic source with replenishment being made by hand. A funnel incorporating a float indicator is proposed to prevent overfilling. Fig. 1.

In very cold weather, hot water could be obtained from any domestic camp boiler. It therefore appears that an expensive all weather water tanker for occasional use is not warranted.

1. INTRODUCTION

The air conditioning system in the ARROW consists of a simple air cycle system using bleed air from the main engine compressors.

The air is cooled by means of an air-to-air heat exchanger, and expansion turbine and a water evaporator.

Water is boiled off under high speed conditions at altitudes in excess of 30,000 ft.

1. INTRODUCTION (continued)

Periodic ground replenishment is necessary depending on previous flight conditions. The rate of water consumption varies with flight speed and altitude. The various rates are quoted in AVRO Report 72/Systems 22/48 - "Arrow 2 Air Conditioning System". The figures are not quoted, as reference to aircraft performance would unnecessarily classify this document as secret.

2. WATER BOILER INSTALLATION

The water boiler installation is shown in AVRO drawing 7-2254-15007. The boiler is an aluminum tank of 28.5 gallon capacity of which 26 gallons are useable. The tank contains a heat exchanger coil in stainless steel through which the bleed air passes. The tank is designed to withstand freezing. (Avrocan Specification E-486).

The tank is located just aft of the navigator's cockpit with access to the filler cap through a removable dorsal fairing. The filler pipe, 2 inches diameter is approximately 22 inches long. The distance from the filler cap to the highest permissible water level is 23.5 inches.

The boiler must not be filled above the permissible level as siphoning through the steam vent could result in total loss of water.

3. METHOD OF CONTROLLING WATER LEVEL WHEN REFILLING

No quantity gauging system is fitted to the water boiler so some means of ensuring that the tank is not overfilled, is essential.

In the turnaround hangar it is recommended that an automatic shut-off nozzle should be used.

This type of nozzle may be manually controlled or set to discharge at a constant rate. The long filler spout has a level sensing orifice near the discharge end. When the liquid level covers the sensing orifice, the flow is automatically shut-off.

A modification to presently designed nozzles would be necessary to suit the ARROW. This would consist of extending the discharge pipe and fitting an adjustable stop to the pipe for abutment on the tank filler. This would be adjusted so that the level sensing orifice is at the predetermined maximum water level.

In cold weather, freezing may occur at the sensing orifice causing premature shut-off, hence an alternative method is required for field use.

A proposal is made to use a special funnel incorporating a float indicator. Indication of correct level would be apparent by the height of the indicator rod against a datum secured in the funnel.

3. METHOD OF CONTROLLING WATER LEVEL WHEN REFILLING (continued)

The float indicator has advantages over the dipstick as it reads directly and filling may be controlled with little possibility of overfilling.

4. GROUND EQUIPMENT REQUIRED FOR TURNAROUND HANGARS

AVRO Report 72/GEQ/3 "A Study of turnaround and 1st Line Maintenance Facilities" makes recommendations for fixed facilities for use in turnaround hangars. For ease of reference the main features are restated.

A supply of soft water at a flow rate of 8 to 12 gallons per minute is required to each of 4 turnaround bays. This is based on completing a replenishment of each aircraft in 2 to 3 minutes.

Pure softened water is required to prolong the boiler life and maintain heat exchanger efficiency. A water softening plant installed in the domestic water supply capable of reducing the scale forming content to 5 parts in a million will be satisfactory.

Specification for this type of equipment will vary with the quality of water in each locality.

Delivery to each turnaround bay via an overhead delivery line is recommended. A flexible delivery hose to each bay could normally be stowed in a spool fixed in the hangar roof. The delivery nozzle should be accessible from the upper walkway on the aircraft. It would be extended manually when required and returned automatically when not in use.

5. GROUND EQUIPMENT FOR FORWARD BASE

If water is required at forward bases, ambient temperatures down to -65°F. must be considered. (ARDCM 80-5 Section 14.2.2.6).

A supply of hot water will, therefore, be necessary. This might be obtained from any source such as the domestic water supply which must be available for personnel.

As the anticipated water requirements are small and this is an emergency operation anyway, it is assumed that hand filling will be satisfactory.

However, a filling funnel will be required. This might be suitably adapted to carry a float indicator as shown in Fig. 1.

A mobile water tanker would be of little use for all weather operation unless a heater unit were fitted. This, in turn, necessitates igniters, fuel supply, battery and generator. A gas motor would also be required to drive the generator and water pump. A delivery hose of 25 feet will be required to reach

5. GROUND EQUIPMENT FOR FORWARD BASE (continued)

from the tanker to the aircraft filler. Considerable nuisance is likely to be experienced from water freezing in this pipe in extremely cold weather.

The size of the heater unit, plus the associated ancilliaries, will ultimately mean an expensive package which might only see occasional use. It appears, therefore, that ad hoc replenishment should be made at forward bases if, and as required.

6. ALL WEATHER TRAILER - MAIN FEATURES

6.1 Water Tank

Minimum capacity for one ARROW 2 replenishment = 30 Imp. gallons
Recommended capacity to cover subsequent developments in aircraft evaporator size = 50 Imp. gallons

Size - Cylindrical 2 feet diameter, 3 feet long.
The tank should be capable of holding frozen contents.

6.2 Heating requirements.

(a) Assume a water delivery temperature 100°F, initial temperature of 32°F and warm up time of one hour.

Heat required = 50 galls. x 10 lbs. x 68° x 1 hr.
= 34,000 BTU/Hr.

(b) Assume a water delivery temperature of 100°F; initial temperature of -65°F and warm up time of one hour.

Heat required = 50 galls. x 10 lbs. x 165° x 1 hr.
= 82,500 BTU/HR.

6.3 Typical Heaters

Fresh air heaters are commercially available, a typical unit being type E-500-24 by the Perfection Stove Company of Cleveland, Ohio. This unit puts out 45,000 BTU/HR. Two would be required for case 6.2(b).

Each unit requires 24V DC electrical power for ignition and fuel pump drive as follows:-

Ignition (30 - 45 secs.) - 456 watts.
Fuel Pump (continuous) - 168 watts.

6.3 Typical Heaters (continued)

Thus for case 6.2(b) a generator of minimum 336 watts continuous rating would be required. A 20 amp. continuous rated generator would be suitable.

The heaters operate on gasoline or diesel fuel. The consumption rate is approximately one gallon per hour for two units. Thus, a five gallon tank appears necessary.

6.4 Water Pump

The pump must raise 12 Imp. gallons per minute through 14 feet to the tank filler.

$$\text{HP required} = \frac{12 \text{ GPM} \times 10 \text{ lbs.} \times 14 \text{ ft.}}{33{,}000}$$

$$= .05 \text{ HP}$$

6.5 Hose Length

The length of hose required is 25 feet. This will reach from the water tank to the aircraft filler point.

6.6 Gas Engine

Power to drive the generator and water pump will be derived from a small gas engine.

Power required for generator = .67 HP
for water pump = .05 HP

Thus, a 1 HP unit would be suitable. The unit could be supplied with fuel from the heater tank.

6.7 Other Equipment

1. Hose reel and heated stowage compartment.
2. Heated compartment for battery.
3. Flowmeter.
4. Chassis.

The overall size of the package, less chassis is estimated at 8 feet long 4 feet wide 4 feet high. Total weight including chassis, estimated at 1500 lbs.

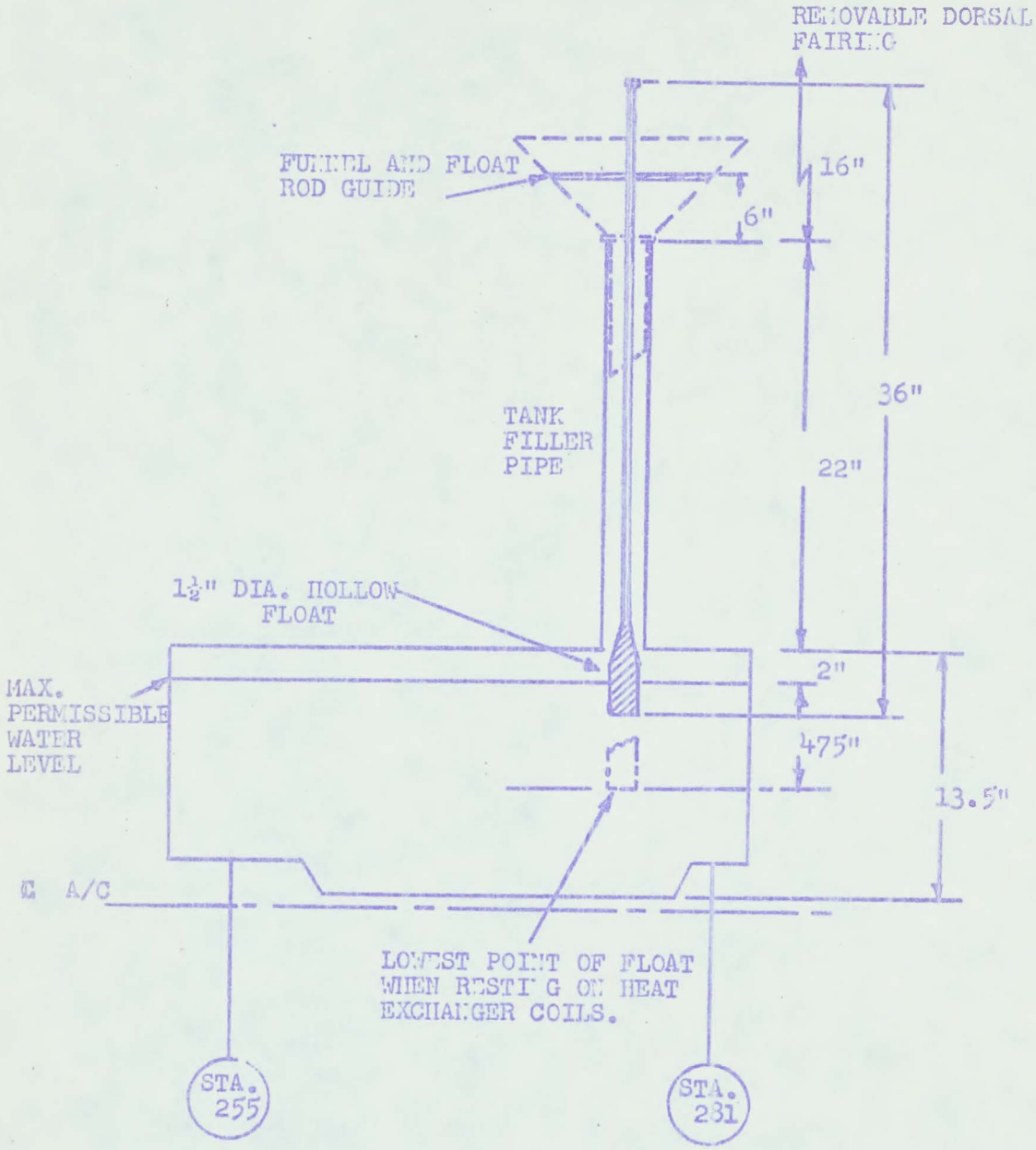

FIG. 1

PROPOSED FUNNEL AND WATER LEVEL INDICATOR FOR REPLENISHING.