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EXTRACT FROM U.S.A.F.
"DESIGN SPECIFICATION FOR A
LONG-RANGE INTERCEPTOR"

May 19, 1954.

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Classification cancelled/changed to.....

by authority of..... (date).....

Signature..... Rank.....

EXTRACT FROM U.S.A.F.

"DESIGN SPECIFICATION FOR A

LONG-RANGE INTERCEPTOR"

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AIRCRAFT ENGINEERING SUB-DIV.,
A. V. ROE CANADA LIMITED

Copy No: 16

15 May, 1954.

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EXTRACT FROM "DESIGN SPECIFICATION FOR A LONG-RANGE INTERCEPTOR"

This document is believed to have originated from ARDC in Baltimore. It is still in the O.R. discussion stage and has not yet been finally drafted for release to the industry. As it now stands, it is regarded as something of a pipe dream. Rumour has it that one U.S. manufacturer has proposed an aircraft to fulfil this role which grosses 75,000 lb.

1. PRIMARY MISSION.

(a) THE WEAPON SYSTEM SHALL :

- (1) BE EMPLOYED AS A LONG RANGE INTERCEPTOR.

The C-105 can be considered to fill this role.

- (2) OPERATE UNDER CONTROL OF GROUND WARNING SYSTEMS FOR VISUAL AND NON-VISUAL INTERCEPTS.

C-105 meets this using either the NG-3 or MX.1179 fire control system.

- (3) OPERATE UNDER CONTROL OF AIRBORNE CONTROL AND WARNING SYSTEMS FOR BOTH VISUAL AND NON-VISUAL INTERCEPTS.

Presume this refers to radar warning and control emanating from airborne Super Constellation aircraft. Although we have no information on the control procedures envisaged with this form of radar station, it is not considered that it will present any major problem with the C-105 or demand any extra electronic equipment.

- (4) OPERATE OUTSIDE OF BOTH GROUND AND AIRBORNE CONTROL AND WARNING SYSTEMS WITH HIGHEST POSSIBLE CAPABILITY OF DETECTION, INTERCEPTION AND KILL OF TARGET, INDEPENDENT OF GROUND AND AIRBORNE CONTROL.

Necessary to qualify this requirement by stating range required and target size. With MX.1179, the C-105 is capable of detecting a B.29 target round 25,000 yards range (12 naut. miles). C-105 can also be navigated to a prescribed area with R - S Doppler system which it is presently proposed to house at rear of armament bay.

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- (5) PROVIDE POINT DEFENSE, A PATROL AREA OR AREA COVER
AGAINST ENEMY AIRCRAFT.

The order of performance of the C-105 based on 37,500 lb.
operational empty weight, MIL-C-5011A and Mr. H.C. Oatway's
letter, ref. DBBS.700-515-85 (Aero) dated 4 May, 1954:-

Area Interception is based on adequate warning. Ground rules
are such as to make combat radius the
primary factor.

To MIL. Spec. Based on
MIL-C-5011.A R.C.A.F. Spec.

Combat Radius (19,500 lb. full
internal J.P.4 fuel) 525 n.m. 635 n.m.

Corresponding T.O. ground run,
57,000 lb., A/B off, zero wind
standard conditions. 1,950 feet

Corresponding landing ground run,
with parabreaks, 40,500 lb., zero
wind, standard conditions. Landing
weight corresponds to basic
operational empty weight plus
3,000 lb. unused fuel reserves. 3,000 feet

.....
Combat Radius (20,400 lb. full
internal J.P.1 fuel) 545 n.m. 665 n.m.

Corresponding T.O. ground run,
57,900 lb. A/B off, zero wind,
standard conditions. 2,050 feet

.....
Combat Radius (19,500 lb + 3,900 lb.
fuselage external tank, J.P.4) 635 n.m. 745 n.m.

Corresponding T.O. ground run,
61,350 lb. A/B off, zero wind,
standard conditions. 2,350 feet.

.....
Combat Radius (20,400 lb. + 4,080 lb.
fuselage external tank, J.P.1) 660 n.m. 780 n.m.

Corresponding T.O. ground run, 62,400
lb., A/B off, zero wind,
standard conditions. 2,450 feet.

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- (5) PROVIDE POINT DEFENSE, A PATROL AREA OR AREA COVER AGAINST ENEMY AIRCRAFT.

Area Interception (Continued)

	<u>To MIL. Spec.</u> <u>MIL-C-5011A</u>	<u>Based on</u> <u>R.C.A.F. Spec.</u>
Combat Radius (19,500 lb. + 3,900 lb. fuselage external tanks + 4,600 lb. wing external tanks, J.P.4)	755 n.m.	845 n.m.
Corresponding T.O. ground run, 66,270 lb, A/B off, zero wind, standard conditions.		2,850 feet.

Combat Radius (20,400 lb. + 4,080 lb. fuselage external tank + 4,730 lb. wing external tanks, J.P.1)	782 n.m.	885 n.m.
Corresponding T.O. ground run, 67,500 lb, A/B off, zero wind, standard conditions.		3,000 feet.

NOTE:- For description of area intercept missions and differences between MIL-C-5011A and R.C.A.F. Spec. refer to Appendix "A" to this report.

Point Interception is a mission based on minimum warning. For this type of mission, distance is secondary to time and altitude.

In this mission the aircraft takes off using military power without A/B, climbs at $M = .95$ using max. power with A/B on from sea level to 35,000 feet, loiters at 35,000 feet for the maximum time at maximum endurance speed ($M = 0.92$), following which the aircraft climbs from 35,000 feet to 50,000 feet at $M = .95$ employing maximum power with A/B on. At 50,000 feet the aircraft accelerates to a combat speed of $M = 1.5$ and is assumed to maintain combat speed until 5 minutes have elapsed from the start of the acceleration. The performance quoted here is the endurance at 35,000 feet associated with this mission and includes fuel reserves to cover 20 min. loiter at S.L. at max. endurance speed ($M = 0.45$) plus 5% overall increase in S.F.C.

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- (5) PROVIDE POINT DEFENSE, A PATROL OR AREA COVER AGAINST ENEMY AIRCRAFT.

Point Interception (Cont'd)

Endurance (19,500 lb. full internal fuel, J.P.4)	=	2.1 hours.
Endurance (20,400 lb. full internal fuel, J.P.1)	=	2.3 hours.
Endurance (19,500 lb. + 3,900 lb. fuse. ext. tank, J.P.4)	=	2.7 hours.
Endurance (20,400 lb. + 4,080 lb. fuse. ext. tank, J.P.1)	=	2.9 hours.
Endurance (19,500 lb. + 3,900 lb. + 4,600 lb. ext. wing tanks, J.P.4)	=	3.4 hours.
Endurance (20,400 lb. + 4,080 lb. + 4,730 lb. ext. wing tanks, J.P.4)	=	3.7 hours.

- (6) BE CAPABLE OF DETECTION, INTERCEPTION AND KILL OF ENEMY AIRCRAFT RANGING IN ALTITUDE FROM SEA LEVEL TO THE MAXIMUM ALTITUDE OF THE INTERCEPTOR.

Altitude interception already considered in 1.a.(5) above. At sea level the aircraft radar detection system is highly susceptible to ground clutter below 3,000 - 5,000 feet. Below this altitude optical sighting is necessary.

The C-105 sea level performance is of the following order:-

Speed restriction = 700 knots ($M = 1.06$)

Combat radius is quoted for two cases:-

- (a) Take-off using military power, A/B off. Cruise out at max. economical cruise ($M = 0.6$). Accelerate to $M = .95$ and combat at $M = .95$ for a period of 5 minutes from start of acceleration using military power, A/B off. Cruise back at max. economical cruise ($M = 0.6$).
- (b) As for (a) above, except that following max. econ. cruise out accelerate to $M = .95$ and combat at $M = .95$ for a period of 5 minutes from start of acceleration using maximum power, A/B on.

In both (a) and (b) full reserves are included to cover 20 minutes loiter at S.L. at max. endurance speed ($M = 0.45$) plus 5% overall increase in S.F.C. plus a further 5% overall fuel reserve.

	(a)	(b)
Combat Radius (19,500 lb. full internal fuel, J.P.4)	250 n.m.	90 n.m.
Combat Radius (19,500 lb. + 3,900 lb. fuse. ext. 4,600 lb. wing ext. fuel, J.P.4)	390 n.m.	230 n.m.

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2. SPECIFIC CHARACTERISTICS

(a) THE WEAPON SYSTEM MUST HAVE :-

- (1) 1,000 N.M. RADIUS OF ACTION TO BE SHOWN IN ACCORDANCE WITH MIL. SPEC. MIL-C-5011A, DATED 4 NOVEMBER 1951, FOR INTERCEPTOR FIGHTER UNDER AREA INTERCEPT.

See Item 1.a.(5) for G-105 capability in this respect.

- (2) MAXIMUM SPEED OF MACH 2.0 AT BEST ALTITUDE

Maximum Design Mach No. $\geq$ 2.12 above 35,000 feet.

- (3) CEILING OF 60,000 FEET

At $M = 1.50$ and a combat weight of 47,000 lb. the 500 ft/min. rate of climb ceiling is 60,500 feet. This 47,000 lb. combat weight is the weight immediately prior to the start of the 5 min. combat period when full internal fuel is carried.

- (4) CAPABILITY OF OPERATING FROM 5,000 FOOT RUNWAYS IN ALL WEATHER CONDITIONS.

Refer to performance quoted in 1.a.(5). These figures refer to normal visibility and runway surface in average conditions. For blind landing conditions on icy runways, the landing distance over a 50 ft. obstacle is around 8,000 feet.

(b) A MINIMUM OF TWO ENGINES.

G-105 -- O.K.

(c) A MINIMUM CREW OF TWO

G-105 -- O.K.

(d) ALL-WEATHER CAPABILITY. SPECIFIC COMPONENTS NECESSARY TO MEET THIS CHARACTERISTIC ARE:-

- (1) COMPLETE ALL-WEATHER FLIGHT INSTRUMENT PRESENTATION TO THE PILOT.

G-105 -- O.K.

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- (d) ALL-WEATHER CAPABILITY. SPECIFIC COMPONENTS NECESSARY TO MEET THIS CHARACTERISTIC ARE:- (Cont'd)

- (2) COMPLETE DE-ICING PROVISIONS (ENGINE, AIRFRAME & WINDSCREEN)

C-105 specification calls for this plus anti-icing for the radome.

- (3) THE AUTOPILOT

C-105 -- O.K. Type K-10

- (4) APPROACH COUPLER

C-105 -- O.K.

- (5) DATA LINK (FOR AUTOMATIC GROUND CONTROL APPROACH)

C-105 -- O.K. with MX-1179.

- (6) THE ARN-21

Provision called for on C-105 spec. as alternative to Doppler navigation equipment.

- (e) A CAPABILITY FOR REPEATED ATTACKS. A HIGH KILL PROBABILITY MUST BE AVAILABLE AGAINST AT LEAST THREE SINGLE MANOEUVRING, NON-MANOEUVRING OR FORMATION AIRCRAFT.

For the C-105 using 8 Falcons against three single aircraft entails one pass at each aircraft, two of the passes with three missiles (78 - 85% kill probability) with the third pass of two missiles (64 - 75% kill probability). Combinations of missiles and rockets are, of course, another possibility, e.g., 6 Falcons plus 50 x 20 rockets.

- (f) A CAPABILITY FOR PERFORMING THE 'TRAILER' MISSION.

We do not know what a 'trailer' mission is.

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- (E) A CAPABILITY FOR EMPLOYMENT AS A POINT DEFENSE WEAPON.

C-105 -- O.K. See performance quoted in l.a.(5). What is the U.S.A.F.'s endurance requirement for this mission?

- (h) A HIGH PROBABILITY OF TARGET DETECTION AT RANGES OF 100 N.M.

NG-3/MX.1179 detection range up to 25,000 yards (12 naut.miles). Increases in this range demand larger antenna, i.e., 42 inch diameter, which would mean redesigning the nose of the C-105.

- (i) AN AUTOPILOT AND/OR CONTROL SURFACE TIE-IN, RADAR TIE-IN OR "CLOSED LOOP" FIRING FOR THE TERMINAL PHASE OF ATTACKS.

MX.1179 system O.K.

- (j) AIR ORDNANCE, i.e., GUIDED MISSILES WITH CONVENTIONAL WARHEADS, EITHER GUIDED OR UNGUIDED MISSILES WITH ATOMIC WARHEADS, UNGUIDED AIRCRAFT ROCKETS OR COMBINATIONS OF THE ABOVE WHICH PROVIDE THE BEST KILL PROBABILITY. A HIGH DEGREE OF INTER-CHANGEABILITY AND SELECTIVITY OF AIR ORDNANCE COMBINATIONS IS VERY DESIRABLE. THE PROBABILITY OF USING AIRCRAFT MACHINE GUNS TO PROVIDE A SUSTAINED HIGH KILL PROBABILITY SHOULD BE CONSIDERED AS AN ALTERNATIVE CONFIGURATION.

This is vague. What are the types and dimensions of weapons envisaged? The best answer to this is that the C-105 has an armament bay approx. 17.5 ft. long x 7.5 ft. wide x 2 ft. deep in which to house armament variations.

- (k) A VISUAL OPTICAL FIRING MODE AS A NORMAL FUNCTION. THE VISUAL OPTICAL MODE MAY BE CONSIDERED THE EMERGENCY STANDBY FIRE CONTROL SYSTEM AND SHOULD BE CAPABLE OF DIRECTING THE FIRE OF AS MANY OF THE COMBINATIONS OF ORDNANCE AS POSSIBLE. PRIMARY DESIGN EMPHASIS ON THIS MODE SHOULD BE DIRECTED TOWARD SIMPLICITY AND RELIABILITY OF OPERATIONS.

Catered for on C-105.

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- (l) THE ABILITY TO HOME ON ECM, NAVIGATIONAL AND BOMBING RADARS.
THIS CAPABILITY IS NECESSARY AS A PART OF THE TRAILER MISSION.

C-105 can home on E.C.M. if A.R.A.25 radar homer is installed.

- (m) STANDBY PROVISION FOR AIRCREW NAVIGATION IN THE EVENT OF FAILURE OF NORMAL MEANS OR THE NEED TO SQUELCH ACTIVE NAVIGATIONAL AIDS IN THE EVENT OF AN ATTACK.

R - Q does this.

- (n) PASSIVE DEFENSIVE MEASURES, i.e., ARMOUR PLATE, SELF SEALING TANKS, ETC., NEED NOT BE PROVIDED.

Equally applicable to C-105.

- (o) AIR-TO-GROUND IDENTIFICATION - APX-25.

APX-19 specified on C-105. APX-25 is specified for production.

- (p) AIR-TO-AIR IDENTIFICATION.

APX-26 & 27 specified on C-105.

- (q) GROUND-TO-AIR AND AIR-TO-AIR COMMUNICATION SHOULD INCLUDE THE U.S.A.F. (GENERAL ELECTRIC) DATA LINK.

Data link specified for C-105. General Electric Type O.K.

- (r) A LONG-RANGE GROUND-TO-AIR AND AIR-TO-AIR COMMUNICATION SET WITH A TRANSMITTING AND RECEIVING POTENTIAL CONSISTENT WITH THE INTERCEPTOR RANGE (1000 N.M. OVER ARCTIC AREA)

Not fitted to C-105. HF ARC-38 has 1000 n.m. range. Sizes are:-

Receiver	15.3/8" x 9.1/16" x 25.3/16"
Transmitter	13.3/8" x 6" x 10.5/8" x 20 lb.
P. Supply	18.5/8" x 8.1/4" x 5.5/16" x 20 1/2 lb.
Control Unit	3.9/16" x 2.1/4" panel space

Suppressed antenna required. Isolation of vertical tail required.

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- (s) A LONG RANGE NAVIGATION SYSTEM WHICH WILL ASSURE THE CAPABILITY OF MOVING TO A POINT IN SPACE 1,000 N.M. DISTANCE FROM HOME BASE WITH AN ACCURACY OF $\pm 5\%$. THIS IS MET BY R. Q $\pm$ DOPPLER TO $1 - 2\%$

R - Q equipment visualized for C-105 O.K.

Instrument Division of Ford Co. believed working on a similar type of equipment.

- (t) A FAST ACTION INFLIGHT DECELERATION DEVICE, I.E., SPEED BRAKES OR REVERSE THRUST WHICH WILL SLOW THE AIRCRAFT TO ATTACKING SPEEDS AGAINST LOW SPEED AIRCRAFT WITH A MINIMUM OF TRIM CHANGE.

Under-fuselage location of speed brake on C-105 is O.K. subsonically.

- (u) A CRASH LOCATOR BEACON.

Not installed in C-105.

- (v) INFLIGHT REFUELING PROVISION

Not installed in C-105.

3. TECHNICAL CONSIDERATIONS

- (a) THE AIRFRAME WILL BE CAPABLE OF SUSTAINING LOAD FACTORS OF 7.33 G WITH COMBAT GROSS WEIGHT AND WITH A SAFETY FACTOR OF 1.50

C-105 designed to load factor of 10.0 ultimate compared with above 11.0 ultimate.

- (b) THE ENGINES SELECTED SHALL HAVE SATISFACTORILY COMPLETED THE 50 HR. PRELIMINARY FLIGHT RATING TESTS PRIOR TO THE FIRST PROTOTYPE FLIGHT DATE OF THE INTERCEPTOR. SUCH "FLASH PERFORMANCE" DEVICES MAY BE SELECTED AS WILL MEET THE REQUIREMENT FOR THE POINT DEFENSE MISSION.

J.67 engine schedule will meet the Flight Rating Test requirement.

- (c) THE FIRE CONTROL SYSTEM SELECTED MUST PROVIDE FOR AUTOMATIC TERMINAL PHASE ATTACK CONTROL FOR DIRECTING THE FIRE OF ANY ONE OF THE COMBINATION OF AIR-TO-AIR ORDNANCE CARRIED ON INDIVIDUAL ATTACKS.

MX.1179 meets this requirement for the 'Falcon' missiles and rockets.

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- (d) AS ENVISIONED, THE INTERCEPTOR WILL OPERATE FROM WELL PREPARED AIR BASES WITH ADEQUATE LOGISTICAL SUPPORT. SINCE MUCH OF THE OPERATION OF THIS INTERCEPTOR WILL BE FROM AND OVER ARCTIC AREAS, THE COCKPIT DESIGN SHOULD BE SUCH AS TO ALLOW AIRCREW MANIPULATION OF SWITCHES AND CONTROLS WHILE WEARING BULKY CLOTHING AND SURVIVAL EQUIPMENT.

C-105 cockpit size and layout will meet this requirement.

- (e) THE WEAPON SYSTEM MUST POSSESS GOOD LOW SPEED HANDLING CHARACTERISTICS, PARTICULARLY AT LANDING PATTERN SPEEDS, AS WELL AS TO COMBAT A RELATIVELY LOW SPEED, LOW ALTITUDE THREAT.

Low altitude interception is the secondary role of the C-105.

- (4) PARAGRAPHS 1, 2 AND 3 ARE CLASSIFIED SECRET IN ACCORDANCE WITH PARAGRAPH 23c of A.F.R. 205-1.

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APPENDIX "A"

Comparison of the MIL-C-5011A and R.C.A.F. Missions for
Area Intercept.

MIL-C-5011A Mission

Area intercept mission with full internal fuel J.P.4 (19,500 lb.) and
take-off weight 57,000 lb.

<u>Phase of Operation</u>	<u>Engine Condition</u>	<u>Fuel (lb.)</u>	<u>Dist. (n.mls.)</u>
Start engines, T.O. & Accelerate)	2 mins. Normal	535	-
to climb speed)	1 min. Military	410	-
Climb to 40,000 ft., 545 kts.	Military	1,650	59.5
Cruise out, 40,000 ft. M = 0.95	Optimum Cruise	5,390	455.7
Climb to 50,000 ft., M = 0.95	Military + Max. A/B	950	9.8
Combat 50,000 ft. incl. accel.)	Military + Max. A/B	2,600	-
to M = 1.5)			
Cruise back, 40,000 ft., M = 0.95	Optimum Cruise	4,950	525
Loiter, 20 mins. @ S.L.	Optimum Endurance	2,440	-
5% Initial fuel reserve.	-	975	-
		<u>19,500</u>	<u>525 Radius</u>

NOTE:- MIL-C-5011A requires specific fuel consumptions to be
increased by 5%.

R.C.A.F. Mission

Area intercept mission with full internal fuel J.P.4 (19,500 lb.) and
take-off weight 57,000 lb.

<u>Phase of Operation</u>	<u>Engine Condition</u>	<u>Fuel (lb.)</u>	<u>Dist. (n.mls.)</u>
Engine start	Normal	100	-
T.O. to unstick	Military	165	-
Accel. M = 0.75 - 4825	Military	780	13.5
Climb to 40,000 ft. 545 kts.	Military	1,550	59.5
Cruise out, 40,000 ft., M = 0.95	Optimum Cruise	5,780	536.4
Accelerate to M = 1.5, 40,000 ft.	Military + Max.A/B.	900	15.8
Climb to 50,000 ft., M = 1.5	Military + Max.A/B.	450	9.8
Combat M = 1.5	Military + Max.A/B.	2,540	-
Descend to 40,000 ft.	Idling R.P.M.	36	-
Cruise back, 40,000 ft., M = 0.95	Optimum Cruise	5,427	635.0

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APPENDIX "A"

R.C.A.F. MISSION (cont'd)

<u>Phase of Operation</u>	<u>Engine Condition</u>	<u>Fuel (lb.)</u>	<u>Dist. (n.mls.)</u>
Loiter, 40,000 ft., 15 mins.	Optimum Endurance	1,000	-
Descend to S.L.	Idling R.P.M.	192	-
Landing reserve - 5 mins. S.L. loiter.	Optimum Endurance	580	-
		<u>19,500</u>	<u>635.0 Radius</u>

Considering, from L.A.(5), the case of a combat radius with full internal fuel (J.P.4), the difference between 525 n.m. for MIL-C-5011.A. and 635 n.m. for the R.C.A.F. mission is accounted for as follows:-

- (i) The mission pattern to MIL-C-5011.A. does not credit the fuel used during the sea level acceleration to climb speed to the range. 13.5 n.mls. is estimated for the R.C.A.F. mission.

On this account approximately 135 lb. more fuel would be required for MIL-C-5011.A.

- (ii) The mission to MIL-C-5011.A. allows acceleration to combat speed (without credit to range) to be included in the 5 minutes total combat time. This means that from the end of the long range cruise out to the end of 5 minutes combat approximately 3,150 lb. of fuel is used to MIL-C-5011.A. and 3,900 lb. of fuel for the R.C.A.F. mission pattern.

Excluding the 5% increase in specific fuel consumption and allowing for the range which is credited to the R.C.A.F. mission during acceleration and climb to combat speed and altitude there is a saving of approximately 650 lb. of fuel using MIL-C-5011.A.

- (iii) After cruising back to base, MIL-C-5011.A. requires fuel for 20 minutes loiter at sea level amounting to 2,440 lb. Against this the R.C.A.F. mission uses 1,800 lb. of fuel in 15 minutes loiter at 40,000 ft., descent to sea level and 5 minutes landing reserve.

Excluding the 5% increase in specific fuel consumption, there is a fuel increase of 500 lb. using the mission pattern to MIL-C-5011.A.

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APPENDIX "A"

- (iv) Two large outstanding fuel items applicable only to MIL-C-5011.A. are a fuel allowance for reserve equal to 5% of the initial fuel weight and increased specific fuel consumption of 5% as a service tolerance.

The initial fuel weight in this case is 19,500 lb., and approximately 1,850 lb. of fuel is required for MIL-C-5011.A for these items.

Performance estimates for the R.C.A.F. are normally based on a specific gravity of 0.75 for J.P.4 fuel, whereas the corresponding MIL-C-5011.A. requirement is 0.78

In this report, the combat radii for MIL-C-5011.A. and R.C.A.F. missions are based on the Mil.Spec. fuel specific gravities of 0.78 for J.P.4 and 0.816 for J.P.1.

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