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AEROSPACE INFORMATION REPORT

AIR 984A

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AIR BLEED OBJECTIVE FOR HELICOPTER TURBINE ENGINES

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1. PURPOSE

This Aerospace Information Report (AIR) defines the helicopter bleed air requirements which may be obtained through compressor extraction and is intended as a guide to engine designers.

2. GENERAL

2.1 Bleed air on helicopter installations may be used as a source of heated air for the following purposes:

a. Engine inlet de-icing and anti-icing

b. Cabin conditioning and pressurization

c. Windshield de-fogging, de-frosting, and anti-icing

2.2 A secondary use is for a small power source for driving one to two accessories and possible cross starting for multi-engine installation.

3. DISCUSSION

3.1 It is recognized that, in general, compressor bleed air is an inefficient source or power. It is necessary, therefore, to limit bleed extraction to those uses in which an overall advantage to the helicopter will accrue. As a source of energy for those applications listed in 2.1 and 2.2, bleed air performs a service that could otherwise require considerably more equipment with increased weight, cost, size, and complexity; otherwise, its use should be limited to the ambient temperature conditions where the reduction in engine power is not detrimental to helicopter performance.

3.2 If the use of bleed air for cabin conditioning during hot weather proves desirable to overall helicopter optimization, it is recommended that engine designers consider anticipated compressor bleed air need.

4. DEFINITIONS

4.1 $BTU/hr = W_{BL} \times C_p (T_{BL} - T_{ambient})$

where W_{BL} = Weight of bleed air in lbs/hr

C_p = Specific heat at constant pressure in BTU/lb - °F (°C)

T_{BL} = Bleed port air temperature, °F (°C)

$T_{ambient}$ = Freestream air temperature, °F (°C)

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4.2 Assume sea level or note if otherwise.

4.3 SHP - 100% normal rated power.

5. QUALITATIVE OBJECTIVE

5.1 Ø To be acceptable for the purpose of cabin conditioning and pressurization, the bleed air must be free of detrimental contamination. The engine manufacturer should address the problem of bleed air contamination resulting from compressor bearing seal failures. This requirement is imposed on FAA certificated helicopters by FAR 29.831 (b) and (d). Approved test methods for assaying air samples may be obtained from one of the following:

a. American Industrial Hygiene Association, 14125 Prevost, Detroit, Michigan - Request "Hygiene Guide for (name of substance)."

b. "The Chemistry of Industrial Toxicology," 2nd edition - Henry B. Elkins, John Wiley and Son, Inc., 1959, Chapter 17, pp 280-416, Analytical Methods and Procedures.

c. "Analytical Chemistry of Industrial Poisons, Hazards and Solvents," M. B. Jacobs.

d. "Chemical Methods in Industrial Hygiene," F. H. Goldman, M. B. Jacobs, Interscience Publisher, 1953.

6. QUANTITATIVE OBJECTIVE

6.1 The primary requirements for bleed air is for heating purposes. It is expedient to specify the requirement in terms of BTU per hour per horsepower. This leaves the pressure temperature, and volume at which bleed air is supplied to the discretion of the engine designer.

6.2 Fig. 1 shows a range of heat requirements as a function of the ambient temperature. Curve A is a minimum requirement for de-icing or anti-icing for an airframe induction system. Curve B is cabin conditioning and pressurization. Curve C is the maximum requirement for a secondary power source.

6.3 It is considered that the objectives for future engine designs is to provide bleed capacity described by the total of curves A, B, and C. The quantities of energy recommended by curves A, B, and C may collectively amount to an impractically large flow of compressor bleed air when applied to certain low pressure ratio engines. In such cases, it is recommended that the engine designer provide at least sufficient air for curves A and C.

6.4 Generally, the extraction of bleed air for the purpose of driving accessories is not recommended, principally for the reason that helicopter hot day performance is affected adversely. Satisfactory installation may be possible in the case of accessories requiring bleed air only while on the ground or where the power required is very small. It is not considered necessary to stipulate an additional increment of bleed air for these purposes beyond the heating requirements. Any continuous power demand for running accessories is considered an individual installation problem and beyond the scope of this information report.

6.5 The engine manufacturer should take the responsibility of precluding surge or other engine malfunctions anywhere within the specified bleed air extraction range. It is desirable that the engine be provided with automatic safeguards to preclude detrimental engine overtemperature during bleed air usage.

6.6 Ø The engine manufacturer should provide a single bleed extraction port so as to minimize complexity of the airframe pneumatic plumbing.

6.7 Ø The engine manufacturer should establish a maximum bleed flow allowable for the failed airframe plumbing condition.

7. NOTES

7.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this information report.

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