

SURFACE VEHICLE INFORMATION REPORT

J1775

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Bleed-Air Pneumatic Systems for Gas Turbine Equipped Marine and Amphibious Craft

RATIONALE

Revised to complete document conversion from (Aerospace) Hydrospace Information Report HIR 1559 to Surface Vehicle Information Report SAE J1775; References were updated, Section 2.2 was added for related (but not directly cited) references, Section 3.1 was updated to add reliability improvements using PLC controlled air valves. Section 3.4.1 was updated to add reference to SAE J1781 to replace listing of nitrogen strengthened and precipitation hardened alloys, and to suggest consideration of heat pipe (tube) materials to reduce scaling in salt water cooling. Section 3.5 was updated to add reference MIL-STD-1472 for guidelines for maximum effective environmental temperature in manned spaces.

1. SCOPE

This Information Report provides a description of bleed-air pneumatic system elements and identifies parameters required to define the requirements for a detailed specification. Specific design requirements are dependent on the application and should be incorporated in a detailed specification.

1.1 Purpose

This Information Report is intended to provide basic design considerations with respect to bleed-air pneumatic systems for marine craft equipped with gas turbine propulsion engines or gas turbine service power units with compressor bleed-air capability. It is not considered within the scope of this Information Report to cover the equipment driven by this bleed air or other sources of pneumatic power such as power driven compressors.

1.2 Classification

This report is applicable to marine surface craft, air cushion vehicles, captured air bubbles, surface effect ships, hydrofoils and other advanced marine craft, such as small water area twin hull (SWATH), equipped with gas turbine propulsion or gas turbine power units.

2. REFERENCES

2.1 Applicable Documents

The following referenced publications form a part of this specification information report to the extent specified herein. Unless otherwise indicated, the latest issue of SAE and all referenced publications shall apply when developing requirements for incorporation into a design specification.

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Documents

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2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE ARP699 High Temperature Pneumatic Duct Systems for Aircraft

SAE J1781 Ship Systems and Equipment - Materials for Fluid Systems.

2.1.2 Military Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>.

MIL-S-901 Shock Tests, H.I. (High Impact), Shipboard Machinery, Equipment and Systems, Requirements for (Navy)

MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)

MIL-STD-777 Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships

MIL-STD-1472 Human Engineering

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this information report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE ARP1796 Engine Bleed Air Systems for Aircraft

2.2.2 Military Publications

Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6396, <http://quicksearch.dla.mil/>.

MIL-C-19713 Coolers, Fluid, Bleed Air, Gas Turbine, Naval Shipboard

MIL-STD-740-2 Structure Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment

MIL-STD-1474 Noise Limits

3. BLEED-AIR PNEUMATIC SYSTEM

System elements and design parameters are identified and discussed in this section. Careful consideration must be given to bleed air system efficiencies and penalties. These factors are discussed only briefly in this information report and the designer should consult the gas turbine manufacturer and other sources to ensure that a bleed air system is appropriate for that particular application.

3.1 Bleed Airflow

The term "bleed-air" identifies the airflow used to drive pneumatic systems and that is available from a gas turbine used as propulsion or auxiliary power unit and is used to drive pneumatic systems. Bleed airflow limitations are specified in the gas turbine specifications and are normally 5 to 10 percent of the total airflow through the engine. To minimize the use of the bleed-air flow is important to avoid adverse effects on fuel consumption and useful power. The reduction of bleed-air extraction can be attained by proper selection of the driven equipment, a suitable distribution system and controls, and the appropriate management of the power available, like scheduling and/or intermittent duty cycle. Some gas turbines require surge avoidance valves to vent a portion of compressor airflow during certain engine operating conditions. The requirements of this surge avoidance bleed system are independent of the pneumatic system bleed. The surge avoidance vents must be discharged overboard to avoid adverse effects to the local environment and adjacent equipment. Development of Programmable Logic Controller (PLC) controlled bleed air valves to monitor and control air flow has improved bleed air system flexibility and system reliability.

3.2 Pressure

Bleed-air pressure level is dependent on engine power setting and ambient air temperature. The pressure is minimum at idle and maximum at full power. The distribution system should be designed to withstand a proof pressure of 150 percent of the maximum engine bleed port pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs during operation. Distribution system components should be designed to withstand a burst pressure of 250 percent of the maximum engine bleed pressure, with the component at the associated temperature for the most adverse pressure and temperature condition that occurs during normal operation.

3.3 Temperature

Bleed-air temperature level is dependent on engine power setting and ambient air temperature; it increases with higher engine power settings. Bleed-air temperature levels of marine gas turbines approach 540 °C (1000 °F). The use of heat exchangers to limit the bleed-air temperature to the specified system temperature becomes a requirement. The maximum temperature level must be compatible with the controls and equipment of the system and, most important; it must be maintained below that limit to avoid critical effects on other systems (fuel, hydraulic and lube) and accessories. The safety devices selected must be of the redundant and fail safe type.

3.4 Ducting

Ducting includes runs, joints, control components and supports. The geometry of the system, as well as the type of craft in which the system is used, dictates the type of supports: rigid or elastic to minimize dynamic interaction between the primary and secondary structure of the craft and the ducting; i.e., the hot air ducting must be structurally independent of the ship or craft structure. A thorough analysis is recommended, economic and operational factors should be brought together to arrive at the selection of system or systems. The use of insulation could be mandatory in some areas, and the selection must be based on safety and reparability.

3.4.1 Materials

The high temperature and the marine salt-air environment significantly increase the corrosion susceptibility of the material selected. In the case of amphibious craft, the erosive effect of the sandy environment must be added to the important parameters considered when selecting the materials. The selection of fastener type and material is as important as the selection of materials for the ducting and supports.

The gas turbine bleed-air section of MIL-STD-777 may be used as guidance in the selection of piping and component materials. Additional guidance for selecting corrosion resistant materials for fluid systems is provided in SAE J1781. SAE ARP 699 presents useful information concerning the materials available for design of the ducting and some components.

Where salt water is used as the coolant for high temperature bleed air, heat pipe cooler technology can reduce scaling. The heat pipe coolers control tube wall temperatures below salt water scaling temperature (less than 65 °C (150 °F)).