NASA TECH BRIEF
Ames Research Center

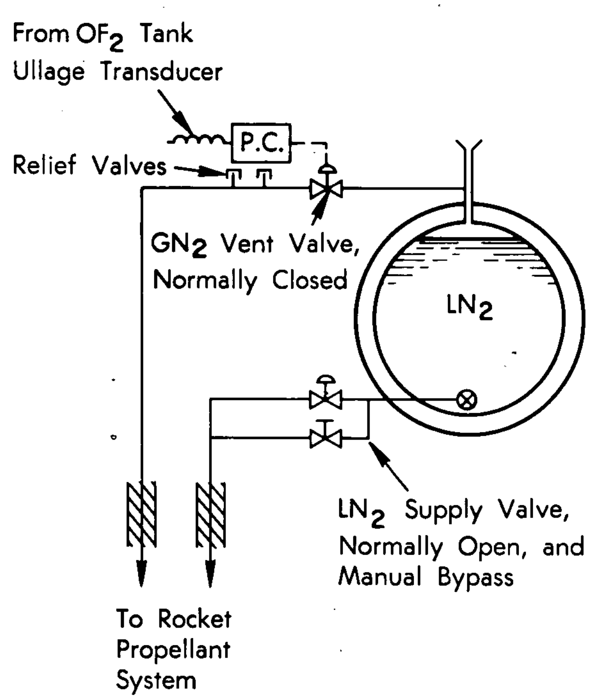
Thermal Control for Storage of Cryogenic Propellants in a Common-Bulkhead Tank — A Concept

The storage of toxic, cryogenic propellants in spacecraft propulsion modules presents a problem in ground equipment design for spacecraft support during the prelaunch period, especially if the spacecraft must remain in a loaded ready-for-launch condition for periods up to 30 days. Design criteria for ground-hold refrigeration systems usually require that hazardous propellants be held within a given low temperature range corresponding to reasonably low vapor pressures, and that there be no venting of vapor. Design objectives also include the use of non-toxic refrigerants, readily available consumables, no electromechanical refrigeration, no dependence on electric power except for sensing, and no dependence on pneumatic power (unless power valves are installed in a power-failure—system-safe mode).

During a study of the problem, consideration was given to a thermal control system which would meet design criteria and objectives for groundhold of oxygen difluoride (OF_2) and diborane (B_2H_6) stored in a common-bulkhead tank.

A simple, reliable ground-hold refrigeration system for the common-bulkhead tank is shown in the diagram. The elevated liquid-nitrogen storage tank provides a positive head of liquid nitrogen (LN_2) to the spacecraft and to the heat exchanger coils of the OF_2 tank. The LN_2 storage tank is vented to atmosphere, and there is no dependence on a pressurization system for the liquid nitrogen supply. The supply valve to the spacecraft fails open (safe) on loss of pneumatic power or loss of electrical power to the pneumatic system. An emergency bypass valve is provided in the event the remote controlled valve should for some reason stick or freeze in the closed position.

The vent side of the refrigeration line is controlled by a vent valve and pressure controller which is activated by signals from an ullage pressure transducer



in the OF_2 tank as the liquid temperature and vapor pressure of the OF_2 rises or falls. The vent valve cycles slowly between an open and closed position to maintain OF_2 temperature somewhat above or below the setpoint.

Once loaded, the propellant tanks can be disconnected from ground loading systems and locked to

(continued overleaf)

assure a 100-percent propellant load and a leak-free operation during space residency. Also, there is no propellant flow between spacecraft and ground systems; only LN_2 is vented. For any component failure short of rupture of the LN_2 line, the system is fail-safe, and malfunctions can be rectified without interruption of basic system functions.

The common-bulkhead tank arrangement has also been considered for fluorine-oxygen/methane designs, where details would be different, but the thermal control concept is applicable to achieve a common propellant temperature of 100°K.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA CR-109833 (N70-27095), Prelaunch Operations for A Space Storable Propellant Module.
2. See also Tech Briefs B72-10277 and B72-10278.
3. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
   Moffett Field, California 94035
   Reference: B72-10276

Patent status:

No patent action is contemplated by NASA.

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