Highly Reliable Liquid Oxygen (LOX) Pump for Vehicle Loading

Propellant Loading Servicing/Storage

The current Shuttle LOX loading pumps have several maintenance issues that result in relatively low reliability. The proposed LOX pump system would mitigate NASA's reliability concerns in this critical application by virtue of the seal arrangement tested in Phase I and of each pump's ability to meet the current launch pad fill rates in the event of one unit's failure.

Phase I focused on reliability issues surrounding the primary sealing arrangement in the LOX pumps and demonstrated the feasibility of a noncontacting combination of a dynamic seal and a purged labyrinth seal set as a highly reliable sealing solution for the primary seal for LOX transfer pumps. This arrangement eliminates the present configuration wherein the face seal is a wearing component. Additionally, Phase I efforts produced a unique concept for a new LOX pumping system for vehicle loading operations. In the proposed new system, two pumps could operate in parallel, providing an increase in LOX transfer rate of 50 percent.

The Barber-Nichols, Inc. (BNI) common pump design using a single shaft to drive both the motor and pump impeller facilitates the use of a noncontacting, radial seal in this application. The current Shuttle LOX pump uses a bellows-type face seal arrangement, which is prone to bellows cracking, wear from fatigue, premature seal wear from freezing moisture on the face of the closed seal, and poor sealing from misalignment of seal mating rings. The current LOX pump configuration also utilizes a two-shaft system, with the pump drive shaft coupled to the motor shaft through a universal joint drive shaft. This system developed vibration issues that had detrimental effects on the seals in the pump. BNI's pump design will replace the seals and add reliability.

Phase II will include the design and manufacture of a complete pump system composed of two pumps, pump performance testing using water, and cryogenic testing at KSC's Advanced Technology Development Center (ATDC).

The proposed pumping system (incorporating the new seal arrangement) can be applied immediately to retrofit the existing Shuttle LOX loading pumps at KSC. The system was designed to have minimal impact to existing mechanical, piping, and electrical infrastructures used for vehicle loading at launch pads. Furthermore, there are a great number of LOX transfer pumps currently employed by NASA (e.g., Stennis Space Center) and in the Department of Defense that could be replaced by this more reliable pump. With some modifications, this pump concept could also be utilized by NASA to transfer liquid hydrogen or other propellants.

Technology developed in the Phase II effort can be applied to any low-viscosity, hazardous fluid pumping application. Potential markets include the chemical and petrochemical industry, where nearly all pumped fluids meet these criteria. Another large market for this pump technology would be in liquefied natural gas transfer and ship off-loading. Because it is not submersible, this pump would be more efficient and cost less to install and maintain. This large pump would offer an attractive alternative to submersible pumps and would be cost-competitive in this growing market. A smaller market that perhaps should be counted in long-term plans is that of commercial space vehicles. As more private space vehicle firms achieve success, this pump could be marketed to support the ground test and launch facilities of private and commercial space industries.

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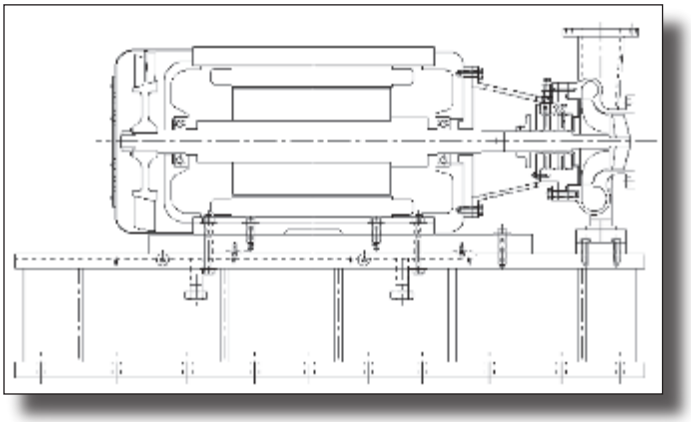
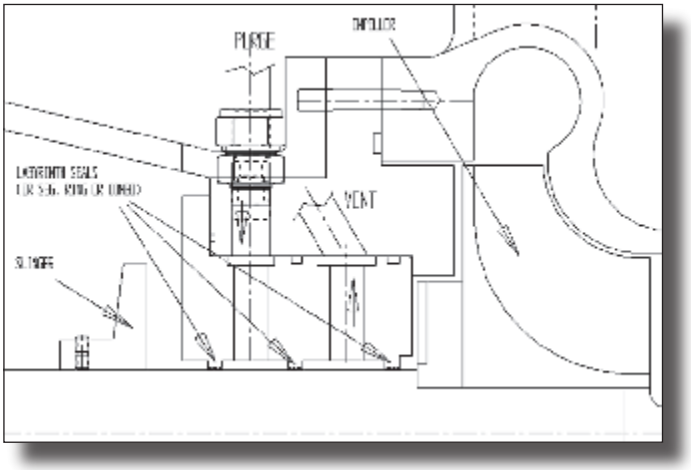


Preliminary LOX pump layout.



Close-up of seal area.