

HIGH PRESSURE PUMP (U)

FINAL REPORT

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BY

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"DTIC USERS ONLY"

PREPARED UNDER CONTRACT NO0156-70-C-1150

FOR

AERO MATERIAL DEPARTMENT

NAVAL AIR DEVELOPMENT CENTER

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FOREWORD

The work covered in this report was authorized by the Naval Air Engineering Center, Philadelphia, Pa., under contract No. N00156-70-C-1150. The air task No. is A346 5303/202B/1F32433401 and the work unit No. is 05.

The work was performed by the Aerospace Division of Abex Corporation in Oxnard, California. The work was performed by C. T. Goethel, H. Taylor and J. J. O'Leary.

Work was started on September 4, 1969 and completed on July 28, 1970.

I SCOPE

This report is to summarize the work performed under this contract to develop and fabricate two prototype high pressure hydraulic pumps.

II PUMP SPECIFICATIONS

The design goals for these pumps were as follows:

Rated pressure	9000 psi *
Flow	14 gpm (approx.)
Speed	4000 rpm
Rated inlet temperature	240°F
Inlet pressure	50 psia

* To be adjustable between 6000 & 9000 psig

III DESIGN PROGRAM

As stipulated in the Abex proposal letter of November 20, 1968, definite cost savings could be realized by re-engineering an existing pump design rather than designing an entirely new pump structure. Accordingly, a design investigation and stress analysis was made on the Abex two CIPR pump model to determine the feasibility of using this frame size at a 9000 psig pressure level. A one CIPR capacity is needed to satisfy the design flow requirements. The investigation showed that at 9000 psig and one CIPR the trunnion bearings would be overstressed on this model.

Next a stress analysis was conducted on the 3.0 CIPR frame size. The analysis showed that the stress on all critical parts and bearings was a maximum of 35% higher and in some cases actually lower than at the normal 3000 psig pressure level. This basic model was selected for the 9000 psig pump structure. All critical parts were stressed within safe limits.

Design calculations were made to determine the pump basic parameters. A basic size of one cubic inch per revolution was used in a three CIPR frame size. A design layout of the pump rotating group and the pump port cap including the pump controls was completed.

A dynamic stability analysis was conducted which showed the pump to be marginally unstable with the parameters selected for the control circuit. Accordingly new parameters were selected which satisfied stability criteria and a new layout was made.

Design sheets for the IBM 360 computer were written and studies were conducted to optimize pump timing and trunnion offset parameters. The pump timing was designed for 6000 psi and MIL-H-27601 oil at 240°F. The trunnion offset was designed for average positive on stroke hanger torque at 9000 psi operation.

All new parts required were detailed and an assembly drawing, installation drawing, and parts list were completed. The pump model is AP6V-57 and the part number is 63022. Some standard parts from the Abex models AP15V-2 and the AP12V-17 were used.

Parts were fabricated for three pumps plus spare parts.

IV TEST PROGRAM

Two (2) pumps were assembled and filled with MIL-H-5606 hydraulic fluid. All tests were conducted with the MIL-H-5606 oil which is compatible with MIL-H-27601 which is the design fluid.

One pump was given a gradual break-in run to 4000 rpm, 3000 psig and 160°F. The compensator spring was inactive and all running time was at full displacement. Total operating time was 1 1/2 hours. The pump was then disassembled and inspected. All parts appeared as new with a light wear pattern.

The pump was reassembled and run in to 6000 psig, 4000 rpm and 160°F. The compensator was effective from 3500 psig and up. Disassembly inspection revealed that the piston shoes had a lightly spawled appearance altho no wear was measureable.

The shoes were lapped lightly and the pump reassembled for the next break-in phase. This phase increased the discharge pressure to 9000 psig. Pump operation was stable and normal throughout the full pressure range of 3500 psi to 9000 psi. The unit was cycled from zero flow to full flow at all pressure levels. Disassembly showed spawling of the bronze plated shoe faces and a small amount of bronze pick-up on the hanger wear plate. An analysis of the bronze plating (90% cu-10% sn) did not reveal anything out of specification.

The second pump was subjected to the same break-in schedule with almost identical results. In each case very light lapping or polishing removed the spawled appearance on the shoe face.

Each unit was operated at 9000 psi, 4000 rpm and the inlet temperature increased to 240°F. Each pump was operated for two hours at these conditions. At disassembly the shoes again had the spawled look.

It was believed that the spawled look resulted from too high a unit bearing load. Therefore the shoe face was redesigned to decrease the bearing load. It was possible by adding an outside land to almost double the bearing area.

New piston shoes were fabricated to the new face configuration. Hydraulic balance was kept the same. Subsequent testing showed that the spawling condition was eliminated as was the bronze pick-up on the hanger wear face.

Each pump was run for two hours at 4000 rpm, 240°F and cycled between 8850 psi (full flow) and 9000 psi (no flow). Disassembly showed all parts to be in excellent condition.

The pumps were reassembled, final calibrated and shipped to North American Rockwell at Columbus, Ohio.