canada/yukon subsidiary
agreement on mineral resources

CONTRACT YEDA 87-02

PLACER MINING
MATERIALS HANDLING
FIELD TRIALS

PROJECT 1475 MARCH 1988

Canada

Yukon
Government

CONTRACT YEDA 87-02

PLACER MINING
MATERIALS HANDLING
FIELD TRIALS

PROJECT 1475

MARCH 1988

VRIGHT ENGINEERS LIMITED

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1444 Alberni Street, Vancouver, British Columbia, Canada, V6G 2Z4

March 30, 1988

Northern Affairs Program
Mineral Resources Directorate
200 Rouger Road
Whitehorse, Y.T.
Y1A 3V1

Attention: Mr. R.L. McIntyre
Minerals Projects Officer
Manager, EDA Placer Mining Research Program

Re: Contract YEDA-87-02 Materials Handling Field Test

Dear Sir:

We are pleased to submit our report covering the field trials conducted in 1987. It was unfortunate that the field tests were delayed in starting and not able to be completed in the one season as originally planned. However, the concept seems to have possibilities of success and the tests should be extended for this coming season.

We appreciate your understanding of our late delivery of our report and are grateful for your consideration. We trust this report will fulfill our obligation at this time and look forward to continuing with the work this coming season.

Yours very truly,

WRIGHT ENGINEERS LIMITED

W.F. Gilmore, P.Eng.
Vice President - Mining

WFG/la

PLACER MINING
MATERIALS HANDLING FIELD TRIALS
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PROJECT 1475-800

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PLACER MINING MATERIALS HANDLING FIELD TRIALS

MARCH 1988 INTERIM REPORT

COVERING THE 1987 FIELD TRIALS

Summary

This is an interim report concerning the 1987 operation of the Airgold and Beron Placer tailings pumping systems.

The operating time achieved on both pumping systems has been too low to assess the effects of wear on the overall economics of the projects. At Beron, however, the pump failed due to a hole through the liner and casing after only 150 hrs of operation. Wright's do not consider that the design/material selection has been optimized and steps have been taken to improve the life of the pump for 1988.

At Airgold the pumping system was used for a total of 62.5 hrs. The coupling connecting the pump to the diesel drive was replaced once and the replacement coupling has shown considerable wear. The failure of the coupling was probably due to misalignment which should be checked prior to reuse in 1988.

The test systems have proved that pumping of sluice tailings is practical, and may be economical, even when faced with the premature wear of the Beron pump.

BERON PLACERS

The report covering the 1986 operation of the tailings pump system indicated that the pump experienced considerable abrasive wear with the suction liner failing after only 74.5 hrs of operation. It was stated in the report that, "the goal for future operation will be to economically minimize the pump wear."

The pump installed for 1986 was a Furikawa SPL-150-C which has suction and gland side liners. The impeller is a semi-open design with pump out vanes on the shroud. Material of construction for the "wetted end" was high chrome cast iron (22 to 23% chrome). An analysis of the material indicated that it was 22% chrome with 2.47% of free carbon (carbon in chunks). Hardness was determined to be 525 Brinell.

The location of the hole in the suction liner was approximately 180 degrees opposite the pump discharge nozzle in the lower half of the pump.

Pump Selection

Meetings with the Furikawa pump representative (Toyo) and other pump manufacturers, i.e. Warman, Worthington, G.I.W. and ASH were conducted and bids solicited from each to supply a pump capable of miminum 500 hrs. life on this particular application.

The project steering committee indicated that they would like to see a rubber lined pump tested.

A review of the pump duty, i.e. discharge head less than 100 ft. and solid particle size less than 1/4 inch, indicated that rubber would be a reasonable selection for lining the pumps. It was also decided that a fully lined pump would be purchased which had the facility for readily changing materials of construction. G.I.W., at present, only supply hard metal pumps; ASH have different pump designs for hard metal and rubber which are not interchangable, hence only three bids were reviewed.

Toyo proposed a special hard 'tyre' rubber for their pump, however, it's initial price (and replacement parts) was very high and hence was not considered further.

Warman and Worthington offered natural soft rubber (durometer 35-40) hard rubber (durometer 60) and 28% high chrome.

Warman proposed a dynamic-centrifugal type seal for both rubber and metal linings. Worthington proposed a silicon carbide face mechanical seal for both linings with an optional dynamic-centrifugal seal for the metal pump (not available for the rubber lined pump).

Closed impellers were offered with sizes of 20 inches and 16.7 inches for Warman and Worthington respectively, indicating that the Warman pump would run slower with less wear for equivalent efficiencies.

The liners for the Warman pump were slightly thicker, indicating that, for equivalent materials and operation, they should last longer before replacement.

Worthington offered lower purchase and replacement parts cost. Beron also felt that it was "slightly easier to service".

It appeared that the lower cost of the Worthington counterbalanced the longer life of the Warman with a trade off in the overall economics. Downtime for pump maintenance was not of major significance in the analysis for Beron Placers, however, it may be more critical for other, in particular, larger operating plants, and the decision must be made accordingly.

Worthington were in the process of establishing dealers in Whitehorse which would significantly improve confidence in obtaining spare parts.

Worthington also have the ability to install ceramic wear parts.

Worthington was selected on the basis of lowest capital cost, their establishment of a distributor in Whitehorse, and their facility to install ceramics.

Hard rubber (to improve tear resistance) was selected for inital operation. Since the particles to be pumped were angular and greater than 1/8 inch in size, Worthington did <u>not</u> recommend the use of rubber for a 500 hrs. life. A spare metal impeller was purchased with spare rubber liners.

Operation

During 1987, Beron used the same classification plant and cyclone described in the March 1987 report.

On June 26th, the plant was relocated to the entrance of Nugget Gulch and operated there with the pumping system installed until mid-August. During this period, the cyclone was moved four times. Beron reports that each move took approximately 4-5 hours, consisting of 45 min. to disconnect pipe and lower cyclone support, 30 min.to lay out road to new location and the remainder to move and reconnect the polyethylene pipe to the cyclone.

The pumping distances and operating heads for the system were as follows:

Location	Distance Pumped (ft)	Static Elevation (ft)	Cyclone Press (psi)
1	250	25	10-14 psi
2	440	25	10-14 psi
3	200	15	10-14 psi
4	240	15	10-14 psi

Pump speed was adjusted (930-1050 rpm) to give a fairly constant discharge pressure of 25-35 psi.

Problems

The pump operated for 180 hrs before the casing wore through on the pump suction side, i.e. similar to the Furikawa failure location. A failure in this location in typically due to recirculation when a pump runs back on its performance curve, i.e. significantly less than the best efficiency point (B.E.P.). However, a review of the pump operating point indicates that this was not occurring, in fact, the pump was probably running slightly to the right of the B.E.P.

Worthington have experienced similar problems on pumps used in tin mines where operating life was only 120-150 hrs. They tried ceramic liners, however, the results were not encouraging. It is postulated that the high specific gravity particles are getting between the impeller and suction liner and grinding the material away. Tin ore has a specific gravity of 7 and pyrite, cassiterite, epidote and garnet, of which considerable amounts can be found in the Klondike, have specific gravities of 3.25 up to 7. Wright's proposed that a sleeve should be installed between the suction and impeller to prevent material dropping into the 'clearance' gap.

Worthington designed a 316 stainless steel, hard chrome plated suction sleeve for this application. A new suction side casing is required so that the suction sleeve can be pre-assembled in the factory. Worthington also recommend installing urethane liners and impeller in place of the rubber. They have experienced longer wear life with urethane than natural rubber on tests with coarse silica sand. Secondly, with the stiffer urethane material, they can form pump out vanes on the impeller shrouds. The rubber impellers do not have these vanes due to poor tensile stress capabilities of the rubber. Pump out vanes will prevent material entering the impeller/casing clearance gap.

Recommendation

Wright's recommend proceding with the installation of the suction sleeve and material change to urethane.

AIRGOLD

Operation

A description of Airgold's original concept for classification, sluicing and pumping is given in the March 1987 report.

Since that report, there were some changes for the 1987 season. The first change is in the location of the plant, requiring changes in pipe lengths. In the original design, the water supply pipe was 200 ft. of 10" diameter aluminum pipe and the slurry discharge 700 ft. of 11 inch Series 100 polyethelene pipe. Revised pipe lengths are 1000 - 1200 ft. of water pipe and 400 ft. for the slurry discharge pipe. To increase the water pressure at the spray nozzles, as well as overcome the increased static head (raised from 15 ft. to 30-40 ft.) and pipeline friction, the pump was changed to a CORNELL 10 RB 330L and the aluminum pipe to 12" diameter. With these modifications, the new pump running at minimum speed can supply the water required for the sluice box and slurry discharge pipe.

A reduction in the length of the slurry discharge pipe and a reduction in static discharge head resulted in a reduction in operating speed for the slurry pump.

The pumping system operated for total of 62.5 hours with both pumps at fairly constant speed.

The plant feed averaged 240 tons/hour with peaks up to 275 tons/hour (based on 2.25 cu. yd. per bucket and 2800 lb/cu.yd.).

The material fed to the plant was fine with an estimated 65-75% passing through the pump, i.e. 156 -180 tons/hour.

Data reported by the operator is given in Table 1.

There is a discrepancy between the actual data recorded and the theoretical prediction. From the data sheet with the slurry pump operating at 833 rpm (motor at 2500 rpm) the corresponding discharge pressure was 25 psi. However, for that to occur, the pump performance curve ignoring system resistance, would indicate a flowrate of over 7000 U.S. gpm.

The flow from the water feed pump operating at 1600 rpm at 35-40 psi, is approximately 4750 to 5250 U.S. gpm. The slurry pump drive motor output of 100 HP also indicates that the flowrate should be about 4500-5000 U.S. gpm for a discharge head of 25 psi.

Prior to operation in 1988, the following items must be checked:

1) Engine speed gauge
2) Pump pressure gauges.

Assuming that 70% of the plant feed reports to the sluice, then for optimum gold recovery, (from the UBC report on "Find Gold Recovery of Selected Sluicebox Configurations"), the water input should be 2952 U.S. gpm, i.e.[0.7 x 240 x 17.57 U.S. gpm/ton/hr] plus losses, say 10% max., which gives a total of 3250 U.S. gpm.

It appears that too much water is being used in the Airgold sluice with a consequent waste of power.

When the site location for 1988 is selected, the system should be reviewed to optimize water usage. This may require the installation of small orifices in the water spray/nozzles in conjunction with pump speed modifications.

Problems

The Airgold plant was assembled late in the season hence operational time was limited to only 62.5 hours. During this period there were three forced outages. Two resulted from a lack of water to the sluice due to a blocked suction intake on the water pump, whilst the third was due to a worn coupling between the slurry pump and its drive motor. When water is not available to the slurry pump, which obviously coincides with water being unavailable for sluicing, the liquid velocity in the slurry pipe line drops. As it drops, it is less able to carry the solids in suspension, they drop out and eventually block the pipe. When this occurs, the pipe must be disconnected and flushed, taking considerable time and effort.

The failure of the coupling was probably due to misalignment. It is recommended that the pump/water is realigned prior to the 1988 pump trials.

Recommendations

Check operation of 1) Slurry pump engine speed gauge
Water pump engine speed gauge

2) Slurry pump discharge pressure guage.
Water pump discharge pressure guage.

Check alignment of slurry drive motor and pump and realign as required.

Review 1988 operating parameters.

Discussion

The operating time at the Airgold site has been very limited. As a result, the life of the component cannot be reliably estimated. This obviously has a significant impact on overall costs, and perhaps project viability, hence at this time firm conclusions cannot be made.

The operating time a Beron has been adequate to prove that the life of the pump is not acceptable. Costs (for the pump) could be analysed, however, in this case, Wright's do not feel that the design has been optimized, i.e. the pump life can be increased. As a minimum requirement, another pumping season is needed in order to optimize the system. For the purposes of this report, however, it should be recognized that this could be a continuing process.

To-date, the project has proven that a tailings pumping system works and there are strong indications that it can improve productivity whilst coincidentally reducing operating costs. Operators at both plants have stated that the classification/pumping plant has increased throughput with a reduction in mobile equipment (and operators) when compared to the conventional sluicing plants. The pump replaces one piece of mobile equipment, i.e. front-end loader or bulldozer.

It is not intended, however, that this report addresses the various options and arguments for pumping system versus mobile equipment - that will be provided in the final report.

Submitted by:

K. Lamb, P. Eng.

WRIGHT ENGINEERS LIMITED

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
KENNETH LAMB

TABLE 1

1987 FIELD TRIALS - AIRGOLD

DATE	HOURS OPERATED	SPEED (RPM) ENGINE	PUMP	TEMPERATURE EXHAUST	AMBIENT	HORSE POWER	FUEL CONSUMPTION	PRESSURE SLURRY P.S.I.	WATER P.S.I.	LOADS (2.25 CU.YD. EACH)	AVERAGE T/HR	DESCRIPTION
AUG. 24	5	2500	833	550	+2	99		25	35	335	211.1	
SEPT. 1	3	2500	833	550	+1	99		25	35	250	262.5	
2	8	2500	833	550	+4	99		25	35	588	231.5	COUPLER WORN OFF - REPLACED
3	4	2500	833	550	+2	99		25	35	327	257.5	125 HOURS ON METER
4	3.5	2500	833	550	+9	99		25	35	230	207.0	
5	7	2500	833	550	+5	99		25	35	611	275.0	COUPLER WEARING
6	DAY OFF	----	---	---	--	--		--	--	---	-----	
7	MACHINERY DOWN		---	---	--	--		--	--	---	-----	CHANGED SUCTION INTAKE
8	5.5	2500	833	550	+6	99		25	35	428	245.1	
9	4.5	2600	867	550	+5	94		25	35	303	212.1	
10	9.5	2300	767	550	+10	EST 104		30	40	738	244.7	INCREASED WATER PUMP SPEED DECREASE SLURRY PUMP SPEED
11	DAY OFF	----	---	---	---	--		--	--	---	-----	
12	8.5	2500	833	550	-1	99		25	35	617	228.7	
13	4	2500	833	550	-2	99		30	35	336	264.6	
14												
15												
16												
TOTAL	62.5										AVERAGE 240	

SEPT. 26, 1987	LINER FROM SLURRY PUMP	591 POUNDS
	SUCTION END LINER	216 POUNDS
	IMPELLER FROM SLURRY	394 POUNDS

CHART II

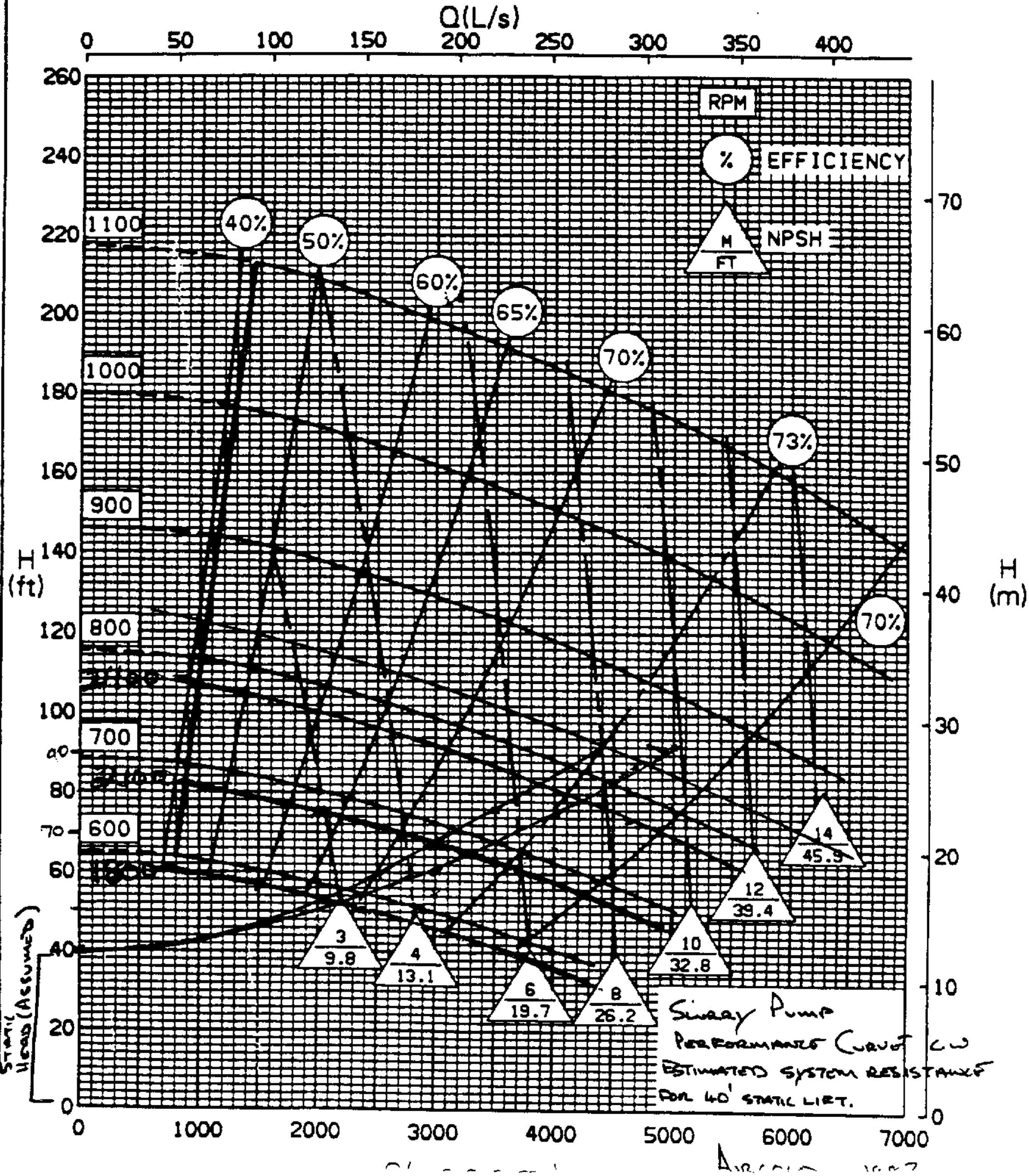
400 FT DISCHARGE PIPE — STATIC HEAD 40 FT.

WARMAN INTERNATIONAL CORP.

PUMP			IMPELLER F8147				SHAFT SEAL	GLAND	PERFORMANCE CURVES
SIZE	FRAME	TYPE	VANES	TYPE	MAT'L	VANE DIA	LINER MAT'L	METAL	WPA 200A21U
200	F/E	M	5	CLOSED	METAL	21.6 ins 549 mm			EFFECTIVE FROM AUG 1984

APPROXIMATE PERFORMANCE FOR CLEAR WATER	NORM MAX RPM*	NORM MAX HP*	MAX PARTICLE SIZE
CORRECTIONS MUST BE MADE FOR THE SPECIFIC GRAVITY AND VISCOSITY OF THE MIXTURE TOGETHER WITH OTHER EFFECTS OF SOLIDS	1100	HP=250/150 KW=185/110	ins mm SPHERE

*GUIDE LINE ONLY, CONSULT FACTORY WHEN APPROACHING THESE LIMITS 4U



A1-544/10

TESTS 65A & 78, A4-P216 &

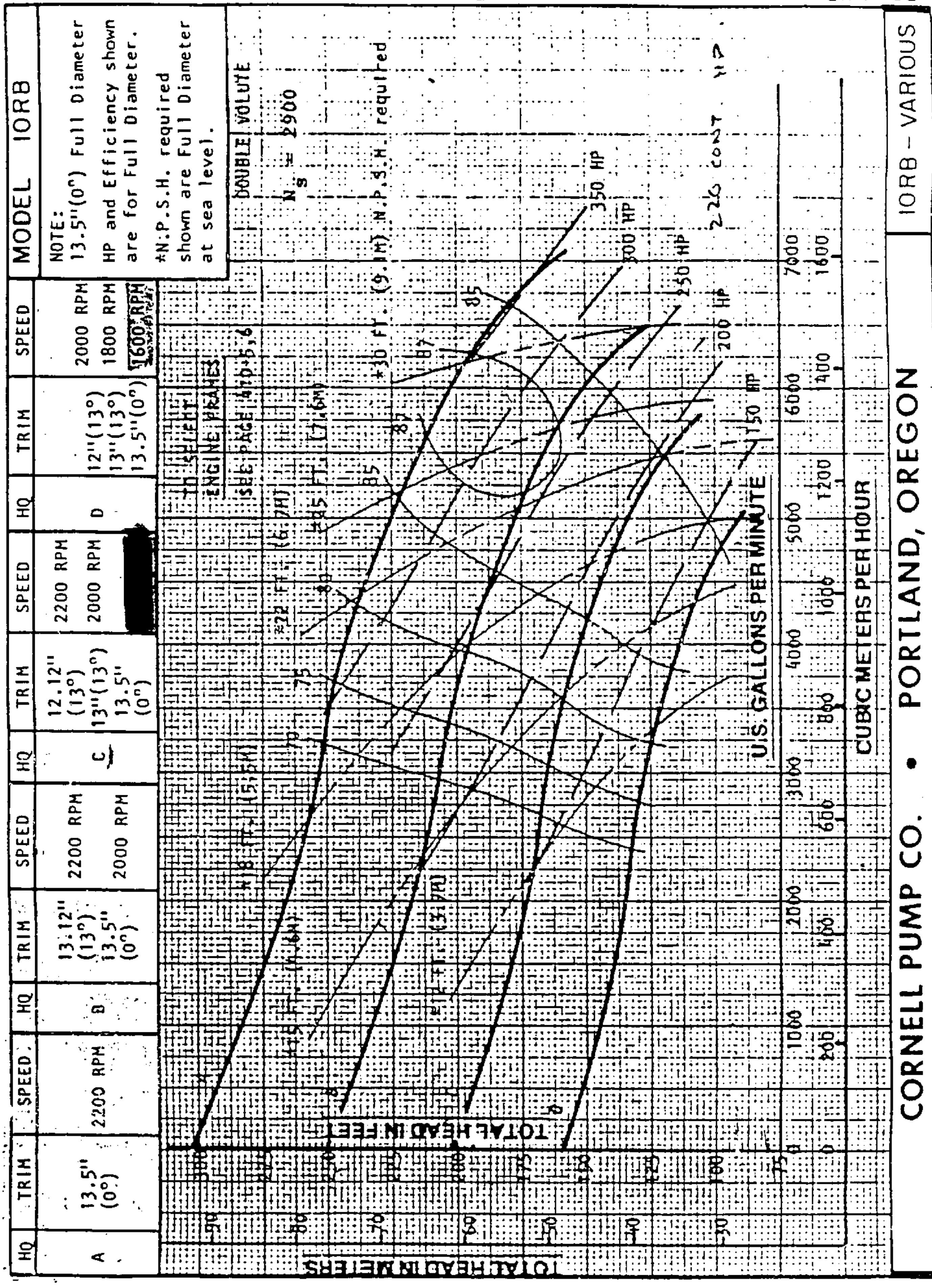
REF: 1158 TO 1164; NPSH TEST 78

CHART I

436-95

OCTOBER 1984

NEW PAGE



IMPELLER DIA. 13.5" / MAX SPEED 2000 rpm / IDLE 750 rpm / MAX SPEED 5000 U.S. gpm at 150 FT.

PERFORMANCE CURVE OF AIRGOLD WATER PUMP