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Subject: Kawasaki Engine Design and Development.

Reference: Hdqtrs AAF, "Air Staff Intelligence Requirements in the Far East" dated 25 July 1945. Sect.III A(b).

Persons Interviewed:
Mr. I. YOTSUMOTO, General Manager of Takatsuki Plant.
Mr. Y. YOSHIDA, Chief Designer of Kawasaki Company.
Mr. T. KADOTA, Chief Inspector
Mr. U. NAKANO, Chief of Assembly of Takatsuki Plant.
Mr. I. OGAWA, Inspection Engineer.
Mr. T. TOMINAGO, Chief Production Engineer.

Interviewing Officers:
Commander J. H. WORSE, Jr., U.S.N.
Major A. E. PETAJA, AC RES
Major R. L. JACKSON, AC RES
Captain T. W. HOWARD, Jr., AC RES

Brief of Material Discussed: General design and development of Kawasaki engines.

1. This interview was held at the Takatsuki plant of the Kawasaki Engine Company. Takatsuki is a small town midway between Osaka and Kyoto. When the main plants of the company at Akashi were bombed in January, 1945, the company was dispersed and the liquid cooled production moved to Takatsuki and vicinity. The engineers concerned with liquid cooled production, those personnel listed above, were removed to Takatsuki at the same time. The air cooled production of the company comprised only the Ha 35-32 under license from Nakajima and required no design or development engineering. The personnel interviewed are considered those most qualified to discuss the Kawasaki liquid cooled engine. There was no sign of reticence or reluctance to furnish any information requested and the information so furnished is believed reliable.

2. The liquid cooled engine production of this company was confined entirely to variations of the basic German DB designs. The company had been licensees of the DB company for several years before the war and contined with this basic design up to the end of the war. Production was for the Army only.

3. While the company manufactured experimentally a number of variations of the basic model, their main production was confined

to two models, the Ha 40 and the Ha 140. Data on these engines is contained in Appendix (A). Two experimental engines of the Ha-240 designation had been built, but had failed the type test. These engines were destroyed in the bombing of Akashi. At the end of the war the primary experimental effort of the company was devoted to supercharging the Ha 140 engine to obtain 1250 HP at 6500 meters altitude (21,000 feet). This altitude rating was never actually attained.

The relations of the company with the Army were relatively good, although there was some resentment of interference in design matters. The company was permitted to design its own remedies for service difficulties, although occasionally the Army enforced its own designs. The company considered the quality of Army engineers very poor, although the Navy engineers were considered very capable.

The Mitsubishi high pressure injection equipment was used exclusively. The entire equipment was brought directly from Mitsubishi. Injection at 120 atmospheres was directly into the cylinder head. Difficulties were encountered with fuel leakage and fuel line rupture due to the very high pressures.

Water injection was utilized at powers above 80% rated power. A fifty percent water-alcohol mixture was injected into the supercharger impellor inlet. Great difficulty from corrosion was experienced and no really effective remedy had been found.

Ignition equipment gave much trouble. These difficulties affected almost all parts of the system. The spark plugs which were furnished by the Army were always bad, being either too hot with resulting preignition, or too cold with consequent fouling at low powers. No detachable leads or pressurizing systems had been used or designed, and no plans were being made for low tension ignition development.

The Ishikawajima Shibaura company had built one turbo supercharger for the Ha 140 model engine which was mounted in a company experimental airplane. One month of flight tests gave no data on turbine performance because difficulty with the turbo regulator had existed on every flight. The end of the war prevented further experimentation on this installation.

A design for a three speed gear driven supercharger had been developed, but none had been built. A two stage double entry type had been tested on an electric motor, but had not been incorporated on the Ha 140 for which it was designed. The standard supercharger was a variable speed design using the Vulcan fluid coupling. This required a larger oil cooler than would have been necessary without this type of drive.

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Cooling difficulties consisted of overheating exhaust valves because of poor coolant passages through the castings. This difficulty was overcome by the use of an internal pipe running through the casting and directing coolant through appropriately located holes toward the hot parts of the valve system. The packing of the centrifugal coolant pump caused trouble when the quality of asbestos packing deteriorated because of war shortages. Castings gave much trouble with leaks at various places throughout the coolant system. 50% glycol was used only in cold weather as an anti-freeze with plain water being used ordinarily. It was claimed that little trouble resulted from cooling system corrosion, even though the glycol mixture was used continuously without discarding. No detailed information on radiator corrosion was available.

Bearings were the cause of many failures. The Kelmet type was used in general with a 23% lead content. Experiments had been made with cadmium silver bearings but without success. Ball bearings were used only where space limitations required and had given considerable difficulty in the high speed supercharger installations. These troubles were blamed on the quality of bearing production. The same reason was given for the failures of big end master rod roller bearing cages which had been quite prevalent. There was a particularly bad epidemic of Kelmet bearing failures in 1943 when the quality of copper was allowed to deteriorate but this trouble was largely eliminated when the quality of copper was again carefully controlled.

When the power was appreciably increased as when passing from the Ha 40 to the Ha 140 ratings, crankshaft failures occured. Six failures in one hundred forty engines were reported, and no fix had been developed at the end of the war.

Valve overlaps were quite large, 75 degrees for the Ha 140 and 50 degrees for the Ha 40. Experimental overlaps of 120 degrees had been used but not adopted because of poor starting.

For engine testing only simple dynamometer equipment was available. One dynamometer was equipped for tests of engines up to 1000 HP with refrigerated air down to -15 degrees C. There were no provisions for altitude exhaust. No design had been started for engine torquemeters. Calibration procedure consisted of running a series of curves of constant boost with coordinates of horsepower and speed. Type test was in accordance with the standard A-N type test specification.

No jet or rocket work was being done by the company. The government had asked the company to undertake some of this work in 1943 but the company refused.

Before the air raids of January 1945 the main experimental effort had been concentrated on supercharger development for the

Ha 140. After the January air raids little experimental work had been done and the intensive effort was applied to dispersion and consequent production problems.

SUMMARY: The Kawasaki company produced liquid cooled engines based on the German DB design and air cooled engines on license from Nakajima. The design efforts of the company were directed primarily toward minor modifications of the basic German design and to improvements in supercharging. The design ability appeared definitely second rate and far below that of both Mitsubishi and Nakajima engineers. The company is considered of secondary importance in both production and design of aircraft engines. No features were noted that would be of interest to American designers.

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APPENDIX (A) - KAWASAKI LIQUID COOLED ENGINE RATINGS

DESIG.	NO.CYL.	BORE	STROKE	CU.IN.	RATED POWER	RATED R.P.M.	RATED POWER	RATED R.P.M.
Ha 40	12	150	160	2075	1020	2400	1175	2500
Ha 140	12	150	160	2075	1350	2650	1500	2700
*Ha 240	12	154	160	2200	1500	2700	1700	2800
**Ha 440	12	165	170	2700	1800	2700	2000	2800

* 2 engines built, type test never passed, both engines destroyed in bombing of AKASHI.

** Never built. Only crank case and cylinder block cast. Army showed no interest and design was dropped.