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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Radio, Radar and Sonar Equipment.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering Targets E-17 and E-21 of Fascicle E-1 of reference (a), is submitted herewith.

2. The investigation of the target and the report were accomplished by Lieut. R.C. Brooks, USNR, with the assistance of Lt. Comdr. T.J. Glanville, RNVR.

C. G. GRIMES
Captain, USN

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E-17

JAPANESE RADIO, RADAR, AND SONAR EQUIPMENT

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE E-1, TARGETS E-17, AND E-21

FEBRUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ELECTRONICS TARGETS

JAPANESE RADIO, RADAR, AND SONAR EQUIPMENT

In considering Japanese radio, radar and sonar components, it must be remembered that Japan was a victim of her own sense of power and superiority. All military operations prior to December 1941 were conducted largely in China, where the success of their operations convinced them of the superiority of their equipment. The need did not exist for highly specialized electronics material. Consequently, because new design was expensive and because it was evident that what was available was more than adequate, manufacturing plants continued to produce resistors, condensers, inductances, etc., in accordance with existing standards.

After operations had been well underway in the drives deep into the subtropical and tropical regions to the south, reports gradually filtered back indicating the need for specialized component design, tropicalization, and smaller and more compact equipment with better performance characteristics. Thus, in the summer and fall of 1943, Japanese engineers began the study of component design to meet the conditions existing in the field. By the end of the war no equipment to meet the new requirements had yet been produced.

The components used in communications equipments, while well-made, closely resemble those available to amateur radio in the United States in the early and middle nineteen-thirties. Frequencies above 80 megacycles were rarely used for communications. In fact, such equipment was mostly in the laboratory stage. Weight and space requirements in aircraft were not too critical, largely because they did not carry the variety of instruments found in Allied aircraft. Most communications were carried on in the HF and MHF bands.

It is felt that an examination of the equipment collected by this Mission and shipped to the Naval Research Laboratory for further study will give the best picture of the more recent developments. A complete listing of all electronics material collected is contained in NavTechJap Report - "Japanese Electronics, General" - Index No. E-28.

As with other branches of scientific endeavor in Japan, the design engineers were, in general, quite competent from a theoretical standpoint. However, their model shop work was rather mediocre, and without something definite to copy, the manufacturers were lost. The mechanical ability to produce new components from mere ideas was totally lacking. Interrogations brought forth the statement, "We could make it in the laboratory, but the manufacturers could not reproduce it." Of course, one reason was the use of young, inexperienced, unskilled labor in the plants. It was necessary for items to be extremely simple before they could even be attempted.

Also included in the NavTechJap report mentioned above is a listing of Japanese documents and technical reports on various research problems in component design, insulation products, standardization, etc. It is suggested that this list be checked and the documents procured from the Washington Document Center, should further information be desired.

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REFERENCES

Location of Target:

1. Second Naval Technical Institute, Tokyo Branch, MEGURO.
2. Tokyo Shibaura Denki, K.K., TOKYO.
3. Nippon Denki, TOKYO.
4. Nippon Musen, TOKYO.

Japanese Personnel Interviewed:

1. Admiral S. NAWA, and Staff, 2nd Naval Technical Institute.
2. Mr. S. HAMADA, and Staff, Laboratory Director, Tokyo Shibaura Denki.
3. Dr. Y. NIWA, and Staff, Director of Engineering, Nippon Denki.

Associated Investigating Organizations:

Information was freely exchanged with other technical intelligence units operating in this theatre. Reports of the following organizations should be available from the War Department, G-2:

ATIG, FEAF, C of E, SIS, TLID, and USSBS.

LIST OF ENCLOSURES

(A) Pertinent Related Documents Forwarded to WDC (Untranslated).

INTRODUCTION

Prior to the end of the war, very little Japanese equipment coming into the United States for investigation possessed unusual features of design. Most components were standard, full-sized units which would operate satisfactorily under conditions existing in Japan and North Central China. It was desirable to investigate all design trends that might be of value to the United States Navy for future application. Consequently, a systematic investigation, beginning with Japanese naval electronic engineers and progressing through laboratories and manufacturing plants, was planned. Only those components reflecting new trends were studied.

THE REPORT

An attempt was made to find new or original designs on all components in use. For the most part, the components found were standard items such as would have been available in any supply house in the United States in 1935. A few typical examples, which follow, will give an insight into the nature of most of the material. However, it is suggested that an investigation and inspection be made of the equipment shipped to the Naval Research Laboratory.

Antennas, both for radio and radar, except microwaves, were extremely simple prefabricated systems. Antenna elements for early warning radar were copper tubing cut to length with the pinch left at both ends; masts were of wood-lattice construction; feeders, simple open wire lines; and disconnect-connectors were simple clips. These components were made by school children and had to be simple. In anticipation of short life in many combat units and in order to effect a saving in critical metals, wooden masts and supports were used wherever possible. One interesting aspect of antenna installation was the great number of insulators used to break up effects of guy wires as compared with our practice.

Large quantities of storage B-batteries have been found in various warehouses, similar to the storage B-batteries produced by "Willard" many years ago. Dry batteries were apparently not sufficiently reliable by the time they reached service.

Generally, capacitors were impregnated (wax) paper, moulded mica, or metal encased types for fixed capacity. Variables were patterned after the Cardwell and Hammarlund types. No temperature-compensated or compressed gas units were seen. For high-power operation, the variables were increased in all dimensions, and glass or ceramic insulation was used for supporting the stator plates. Several reports on electrolytics, mica, and paper condensers are included among the Japanese documents forwarded to the Washington Document Center.

Inductors, for transmitting, were of good form factor, made of plated or polished copper and were either "plug-in" or held down with lugs and machine screws. Low frequency IF coils were standard and of air coil construction. For high gain, high Q, "sendust" cores were used (see NavTechJap Report - "Japanese Electronic Equipment Construction Materials" - Index No. E-19) in the most recent designs. Most MF and MHF receivers employed from three to seven or eight plug-in coils to replace when changing frequency bands. Some RDF units and the Type 97 Receiver employed band switch operation.

Replacement windings for transformers were provided in quantity, since they were one great source of trouble in the field. They were packed in neat wooden boxes and supplied as spares. The spare parts boxes were perhaps the best item the Japanese made - very neat, well constructed, with a place made specially for each spare part.

Dials were usually of the planetary type equipped with vernier scales. Some had small dots of radium paint at every tenth division for night operation. Dial lights, when used, were accessible from the front of the panel and shielded for concentration. On transmitters, knobs used to change inductance taps were large and easily gripped, with the indexing in the center of the knob. Chart frames with calibration curves were provided in most cases.

Headphones were light-weight magnetics, with felt pads for noise reduction. Microphones, for the most part, were carbon types, like the transmitter unit in a powered-type telephone hand-set, and the elements were easily replaced. There was a trend toward dynamic microphones to improve articulation. Sound power equipment is covered in NavTechJap Report - "Characteristics of Japanese Naval Vessels, Article 5 - Shipboard Electrical Equipment" - Index No. S-01-5. Loud speakers were usually small, compact, metal diaphragm-driving units coupled to horns. Most of the cone-type speakers were magnetics similar to the old RCA 100-A units.

Soldering irons, pliers, diagonals and similar hand tools were of poor construction. A little pressure would snap the screw driver blade or break the jaws of the pliers. One soldering iron was of particular interest - by rotating the handle through approximately 120 degrees the unit was adapted to either 100 or 220 volt operation.

Panel meters were standard, except for the small, 1½ inch dial face meters used in aircraft equipment. Volt-ohmmeters were copies of Triplett and similar products, although not too reliable because of poor resistor elements and switches. The YEW precision meters were excellent in construction and in many cases had hand-calibrated mirror scales. They were accompanied by charts giving instrument errors at various deflections. These errors, it might be mentioned were usually so small that they could not be read without calibrated optical equipment.

For example, on a 0-3 volt instrument with a 5 inch scale a correction of +.015 volts was given at the 2 volt reading. Samples of this type have been sent to the Naval Research Laboratory for analysis.

Insulators of ceramic, glass, and phenolic composition were used. Some of the porcelain was glazed. Feed-thru insulators of all sizes were seen, but moisture rarely accompanied them. A report on all interesting insulation products will be found in NavTechJap Report - "Japanese Insulation Materials" - Index No. E-23.

Jacks and plugs, cable connectors, etc. followed standard practice, although the only water-proofing was usually an application of lacquer. Phone plugs were usually of the two-prong, banana-type, rather than the more common switchboard variety.

For a detailed report on electric wire and cable, see NavTechJap Report - "Quality of Japanese Electric Wires and Cables" - Index No. X-14.

Resistors were the subject of several research projects, and pertinent documents have been forwarded to the Washington Document Center (see list in NavTechJap Report - Index No. E-28). However, not much attention was paid to power dissipation. The same resistor in a radar set would blow time and again leaving charred terminal strips and carbonized insulation. The resistor was usually replaced with one of the same value, and if the set operated, no attempt was made to ascertain the initial difficulty. The Japanese had never progressed to the small, compact variables used in the United States and rarely used less than the one-watt size in their manufacturing process. In general, the variables had the appearance of "bargain catalogue" offerings of the early nineteen forties.

Relays also followed standard practice, and were manufactured in large quantities before the war. A few midget relays were seen, but nothing unusual. Telephone-type relays were in extensive use. In certain airborne communication units they were used for band charging. Nippon Denki and Oki Denki, being the largest telephone manufacturers in Japan, were the main source of supply for relays of all types.

Low-voltage dynamotors and gas-engine driven generators were in no way unusual and little effort was spent to make them waterproof or fungus-resistant. Many were stored in caves as early as six to eight months before the end of the war. They were painted, but no rust or corrosion-proofing was applied. How the Japanese expected to use this equipment when needed can only be surmised; when inspected, the equipment was definitely not operable.

NavTechJap Report - Index No. E-18, referred to below, covers to a large extent the measures taken to prevent the effects of fungus, humidity, and high altitudes. The manufacturers, as well as the design engineers in the Navy, rarely received reports on failures from the Fleet. Therefore, no steps were taken to improve the quality of the product.

Voltage regulators (inductive type) as well as vibrator regulators were used. For shipborne radio and radar, direct current from the ships main generators drove an alternator, and the output, thru a voltage regulating transformer, supplied the radar set. The best airborne voltage regulator was a copy of a 1933 Eclipse vibrating-reed type.

Power transformers and audio-transformers were great sources of trouble due to poor insulation and lack of moisture seal. Reportedly, this difficulty corrected toward the end of the war (see NavTechJap Report - "Japanese Radio Apparatus Construction Methods" Index No. E-18), but no reports were received from the fleet as to the success or failure of the treatment. Very few of the audiotransformers were designed for flat response, and most of the radio equipment suffered from "poor articulation." Pulse transformers were under investigation and design at some of the technical colleges. Using an 8-to-1 turn ratio on a "Sendust" core, they pulsed the M-312, 2kw magnetron. The wave form from the secondary of this transformer was not suitable for efficient operation.

If pressure-temperature-humidity chambers were employed, their use must have been limited to technical colleges. None were seen either in Navy laboratories or in manufacturing plants.

Tubes, of course, were the greatest source of trouble. On one occasion a special request for a supply of transmitting tubes was received from an island base in a forward area. These were flown out, and only one was usable. An issue was made of this case, and a control system of better quality was set up in the manufacturing plant. "By that time the war was nearly over, so it did not do much good," was the comment.

Lack of standardization for tube bases and sockets caused unnecessary duplication. On some 75mm cathode ray tubes, for example, three different types of bases were used. Admittedly, this prevented the placing of the wrong type of tube in socket. Interrogation revealed that the possibility of placing designating numbers on corresponding tubes and sockets had not been considered.

In "walkie-talkies" and "radio sonde" equipment, standard components were used. The only concession to space or weight evidenced was in the removal of the base of the tube and the soldering of the tube into the circuit. Tube base cement was very poor. When stored in damp caves, as was the practice late in the war, the tube bases generally loosened.

Quartz crystals were normal, thin, square crystals in a rather large holder. They were calibrated against a secondary frequency standard similar to General Radio products, and the frequency standard was checked against government standards. Because of the scarcity of quartz, most crystals were X-cut, and in the majority of the equipments, no temperature control was used to maintain their accuracy. In some airborne equipment, both receiver and transmitter were crystal-controlled, although provision was made for M.O. operation, if necessary.

The Japanese readily admitted that, with the facilities at their disposal in the closing years of the war, it would have been impossible to build on a production basis anything comparable to the American ARC-1, ASB, or Loran units. Shortage of heavy machinery, raw materials and tools and dies formed only a part of the problem. The greatest drawback was lack of mechanical skill and trained employees.

It is realized that this report is, for the most part, a negative one. The Japanese, for all their love of precise gadgetry, simply have not created any new or outstanding components worthy of mention.

ENCLOSURE (A)

PERTINENT RELATED DOCUMENTS FORWARDED TO WDC
(Untranslated)

NavTechJap No.	Title	Atis No.
ND21-6008	Comparative test results: Electrolytic capacitors.	3480
ND21-6018	Report of the standards committee on small paper and mica capacitors.	[illegible]31
ND21-6023	Comparative test results: Enamel coated fixed resistors.	3482
ND21-6061	Standard radio parts.	3483
ND21-6069	Comparative tests results: Variable high resistors.	3485
ND21-6149	Research on sound-proof and shock-proof material.	
ND21-6199	Research on deterioration of steatite cable insulators due to sea water.	3456
ND21-6201	Comparative test results of Japanese manufactured steatite.	3458
ND21-6204	Experiments on rubber insulated wire for Navy use.	3460
ND21-6220	Test results: Oil-filed capacitors used in communication manufacturing by the SUMITOMO Electric Company.	3486
ND21-6225	Test results: Small type electrolytic capacitors.	3487