[redacted]

INDEX NO. S-43

SHIP AND RELATED TARGETS

JAPANESE NAVAL VESSELS
OWN SHIP'S NOISE

U.S. NAVAL TECHNICAL MISSION TO JAPAN

TMJ
SRT
S-43

U. S. NAVAL TECHNICAL MISSION TO JAPAN
CARE OF FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

NS/doh

12 January 1946

RESTRICTED

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

Subject: Target Report - Japanese Naval Vessels, Own Ship's Noise.

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

1. Subject report, covering Target S-43 of Fascicle S-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Comdr. V.R. Hayes, USN, assisted by Lt.(jg) W.M. Weil, USNR, as interpreter.

C. G. Grimes

C. G. GRIMES
Captain, USN

30677

RESTRICTED S-43

JAPANESE NAVAL VESSELS
OWN SHIP'S NOISE

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

FASCICLE S-1, TARGET S-43

JANUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

SHIP AND RELATED TARGETS

JAPANESE NAVAL VESSELS - OWN SHIP'S NOISE

The Japanese investigated and attempted to minimize own ship's noise for two reasons: (a) to reduce the background noise in the hydrophones and thus increase their range, and (b) to decrease the range at which the ship could be detected by means of enemy hydrophones. This noise reduction was accomplished by mounting machinery on rubber pads, thus reducing the transmission of vibrations to the hull.

Pipelines, other than high temperature, and, in the case of small ships, main shafts also were fitted with rubber to reduce the transmission of vibrations to the hull. Although not relevant to this report, it should be noted that an additional reason for this installation of rubber was to decrease damage to the machinery of submarines caused by depth charges. One of the most common sources of noise aboard our own ships - that of axial flow ventilation fans - was not a problem to the Japanese because of their use of centrifugal fans of lower velocity. Axial flow forced draft blowers were used, however, and required treatment for noise reduction.

TABLE OF CONTENTS

REFERENCES

Japanese Personnel Interrogated:

Capt. T. KUYAMA, IJN, Naval Technical Department in charge of measurement and methods of reduction of own ship's noise.

Capt. K. MATSUMOTO, IJN, in charge of hull design at Kure Navy Yard.

K. NAGAI, in charge of engineering general arrangement design at Naval Technical Department.

TAMEHIRO, Engineer in charge of paint research at Kure Navy Yard.

LIST OF ENCLOSURES

(A) List of Documents Forwarded to WDC via ATIS.

(B) Explanation Concerning "Vibration Preventing Rubber", prepared by the 2nd Naval Institute, Acoustic Department.

LIST OF ILLUSTRATIONS

INTRODUCTION

This investigation was conducted to determine what progress the Japanese had made in the reduction of own ship's noise. A preliminary survey of this subject was made by the Scientific Intelligence Survey headed by Dr. Karl T. COMPTON. Enclosure (B) was prepared at the request of that Survey. The reasons for research on this subject, and the methods of measuring and reducing own ship's noise were determined by questioning cognizant personnel.

THE REPORT

1. Technique for Measuring Own Ship's Noise

Since the Japanese were concerned with the measurement of own ship's noise primarily because of the sound vibrations transmitted through the hull and the water to their own hydrophones and those of enemy ships, it is quite natural that they should utilize hydrophones for the measurement of those vibrations. This was done in two ways. In one, the ship's own hydrophones were used, and in the other, the ship would steam over a hydrophone placed on the bottom of the sea. In both cases, the output of the hydrophones was sent through an amplifier to a recorder and an indicator. The recorder made a strip record of the vibrations, while the indicator gave a reading of the sound intensity on a dial. The method using the ship's own hydrophones was the one employed more extensively. There were no provisions for measuring sound intensity by frequencies so that an analysis could be made to determine which machines were producing excessive noise.

Early in 1945, some turbine-driven ships were treated for reduction of noise. Only part of the auxiliary machinery was treated and none of the main drives. In order to determine which equipment required treatment, tests were run with only one piece of auxiliary machinery in operation at a time. In this way, it was determined that the diesel generator, turbo-generator and forced draft blowers of the MATSU class destroyers should be rubber mounted. Captain KUYAMA stated that it is very difficult to make such tests with only one piece of machinery running, which is quite understandable.

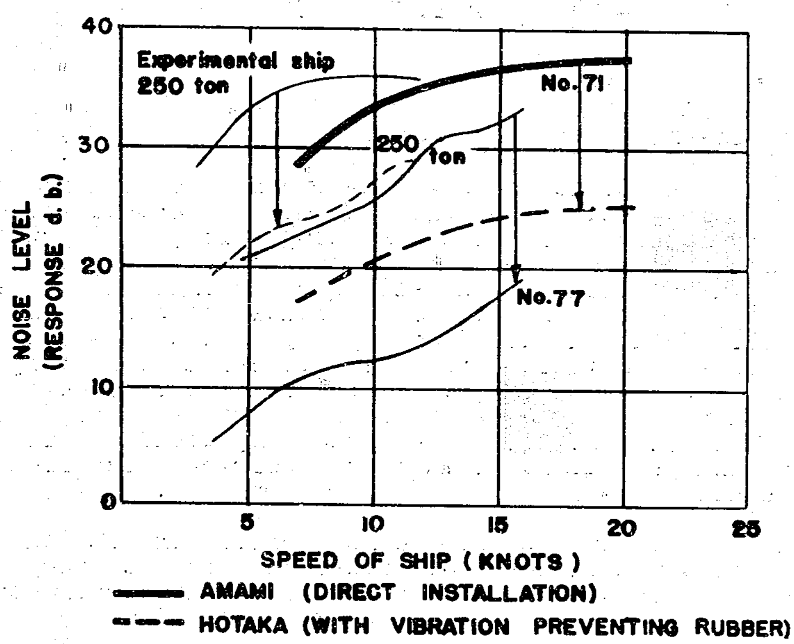
The desired maximum noise level was set at 10 decibels, with one micro bar being the datum plane.

2. Silencing of Machinery

The primary aim of the Japanese was not a reduction in the noise level as such, but rather a reduction of the vibrations transmitted to the hull and thence to the hydrophones. To accomplish this, machinery was mounted on rubber, and rubber was installed between the flanges or pipelines and main shafts. This was done first on a 250-ton diesel-driven experimental ship. This installation was made about August, 1943, and a noise reduction of 10 to 15 decibels was accomplished (see Figure 1). About November, 1944, a similar installation was made on a 1000-ton diesel-driven coast defense ship, resulting in a decrease of about 15 decibels. In the first half of 1945 progress was being made in the sound treatment of destroyers and cruisers.

In the mounting of machinery, the pressure on the rubber was normally about 1 Kg/cm^2. The natural frequency of the mounting, which was to be greater than the maximum rpm of the machine, was computed from the static deflection formula $N = \frac{1}{2\pi}\sqrt{\frac{Kg}{W}}$ where "K" is the spring constant of the mounting and "W" is the weight of the machinery. The Young's modulus, E, of the rubber was stated to be 40 to 60 Kg/mm^2.

Figure 2 illustrates the method used to silence the forced draft blowers on the MATSU class destroyer. The intakes are covered with sound-absorbent rock wool to the main deck and spacers are used to give about 2cm of air space between the rock wool and the duct. Below the main deck, a bell mouth is used with no connection between it and the deck. The fan and the portion of the duct connected to it are supported on rubber pads, while a U-shaped rubber gasket isolates this apart of the duct from the remainder. This was reported to be very effective.



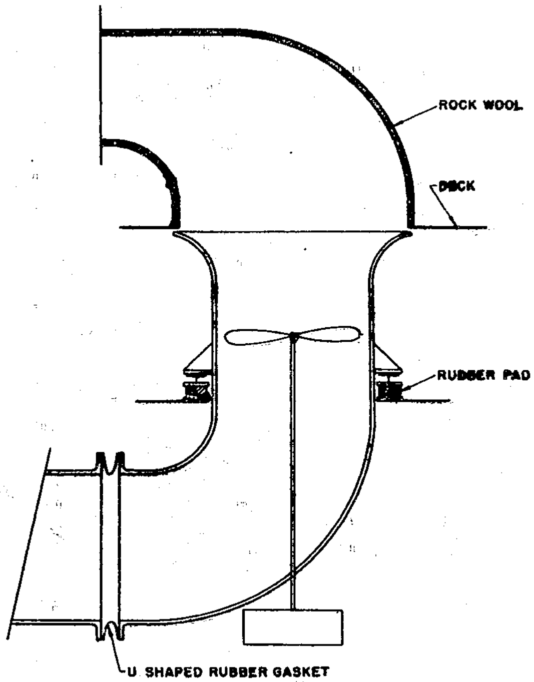
THE NOISE REDUCTION OF UNDER WATER LISTENING DEVICE BY INSERTING VIBRATION PREVENTING RUBBER BLOCK UNDER MAIN ENGINE.

FIG. I

Figure 3 illustrates the method used to silence piping. The various sections of piping were isolated from each other by a special rubber gasket between the flanges. An additional rubber gasket was placed over the bolt heads on each side and the complete assembly was protected by a metal cover. These gaskets were made in various sizes and for various pressures, the pressures ranging up to 120 Kg/cm^2. This method was not used on steam piping. A somewhat similar system was used on the main shaft of small vessels to isolate the lengths of shafting.

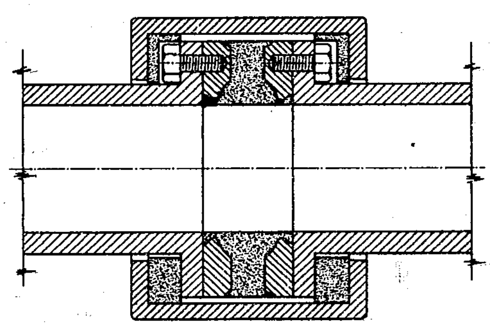
Near the end of the war, an experiment was started to float the sound room on rubber and thus further reduce the noise in the sound system. The plan was to rest the sound room on round rubber pads, the average pressure being 1 Kg/cm^2. Similar pads were to be placed between the bulkheads and the structural bulkheads, and the overhead and the deck above. There was to be a sufficient number of pads on each side so that the weight of the room and equipment, divided by the area of the pads on that side, would be 0.5 Kg/cm^2, and for the overhead, 0.25 Kg/cm^2. The room was to be built of plate 4mm thick, covered on the inside with wood. Rock wool was to cover the wood on the overhead and bulkheads, while linoleum was to be used on the deck. The experiment was not finished and none of the records have been saved.

The rubber shock absorbers were designed from some samples obtained from the Germans. Of the many German types, the Japanese standardized about ten, some of these being simplified copies of more elaborate German equipment. The inner part of the absorbers is made of vulcanized natural rubber covered by synthetic rubber. The composition of the synthetic rubber was given as follows:



METHOD OF SILENCING OF FORCED DRAFT BLOWER

FIG. 2



VIBRATION ABSORBENT TREATMENT FOR PIPING

FIG. 3

Chloroprene	100.00
Ferric Chloride	0.80 - 1.50
Stearic Acid	0.70 - 1.20
Magnesium Oxide	2.50 - 3.50
Iron Oxide	4.00 - 6.00
Tricresyl Phosphate	6.00 - 8.00
Zinc Oxide	5.00 - 7.00
Carbon Black	20.00 - 35.00
Sulphur	0.80 - 2.00
Mercapto Benzothiazol	0.80 - 1.20
Tetramothythiasam Disulphide	0.20 - 0.40

The rubber is reported to have been bonded to the steel by electroplating the steel with brass (60% cu, 40% zn) and then vulcanizing the rubber to the brass. A complete list of the standard types and sizes can be found in NavTechJap Document No. ND 21-6258, ATIS No. 3213.

3. Absorbent Coatings on Hull

The Japanese had developed a sound-absorbent composition for application to the hulls of submarines. While this composition was intended primarily to prevent reflection of sound waves to enemy sonar devices, it is also reported to have reduced the noise emitted by the submarine by about 15 decibels. The composition was developed in the belief that, if the entire surface of the submarine were covered by small air bubbles, sound waves would not be reflected.

The Japanese claim that the results of experiments made on a submarine showed that about 78% of the energy was absorbed.

The composition by weight was given as follows:

Material	Below WL	Above WL
Vehicle		
Special Latex	21.0%	21.0%
Casein	6.0%	6.0%
Gum Arabic	3.0%	3.0%
Pigment		
Sulphur		0.7%
Vulcanizing Accelerator		0.3%
Anti-Weathering Material		0.3%
Portland Cement	16.0%	15.0%
Silicon Dioxide	30.0%	30.0%
Calcium Carbonate	10.0%	10.0%
Powdered FE304	2.3%	2.0%
Mica Powder	0.7%	0.7%
Asbestos Powder	11.0%	11.0%

Notes:

a. No bottom layer of base paint is used.
b. First day - apply first and second coats.
c. Drying time - two days.
d. When sulphur chloride bubbles have formed, apply a coat of Mark 2 ship's hull paint.
e. Apply one coat of vulcanizing fluid above the water line to the surface coating. For the surface vulcanizing fluid use 0.3% sulphur trichloride solution.

f. Instructions for mixing - Add a small quantity of pigment to the vehicle and stir. Pigment, which has been properly powdered, is then added.

The above information is derived from memory and notes and may not be completely reliable. Samples of the material called "anti-weathering material" and "vulcanizing accelerator" are being shipped to the United States, marked JE22-2011. A sample of the composition applied to a steel plate is marked JE22-2010.

See also NavTechJap Report "Japanese Sonar and Asdic", Index No. E-10.

ENCLOSURE (A)

LIST OF DOCUMENTS FORWARDED TO WDC VIA ATIS

NavTechJap No.	ATIS No.	Title
ND21-6260	3212	Annals of the Meeting on Methods of Installing Rubber Shock Absorbers on Ships Afloat
ND21-6258	3213	Standard Types and Sizes of Rubber Shock Absorbers

ENCLOSURE (B)

EXPLANATION CONCERNING "VIBRATION PREVENTING RUBBER"
Prepared by 2nd Naval Technical Institute, Acoustic Department

1. Aim of the research

The experiments were made on "vibration preventing rubber" to attain the three following effects:

a. To reduce the level of the disturbing noises of the main and auxiliary machines when in operation, which affect the effectiveness of the sound listening device, and thus to extend its audible distance.

b. To reduce the underwater noises which are radiated from the ship's hull due to the running of the machines, and thus to shorten the audible distance of the underwater sound listening device on other ships.

c. To prevent the destruction of machines in submarines by shocks from the depth charges.

2. Condition of the installation of "vibration preventing rubber" on ships

The following is an example of installation for the main engines on an A-class defense ship.

Displacement tonnage	about 1,000 tons
Horsepower	2,200
Number of main engines	2
Weight (each)	37 tons
Revolution (maximum)	610 R.P.M.
Size of vibration preventing rubber block	90x180x60 (mm)
Thickness of rubber parts	40 mm
Amount of depression of rubber block under loading	0.9 mm
Amplitude of vibration - maximum	0.8 mm
normal	0.4 mm
Composition of rubber - inside	natural rubber, vulcanized
outer-cover	chloroprene, artificial rubber
Hardness (Shore hardness meter)	60

Besides the above, suitable vibration preventing rubbers were installed on the propeller shafts, and water, oil and pneumatic pipes to completely separate the vibration and acoustic transmission paths to the ships loading.

ENCLOSURE (B), continued

3. Results

a. The level of the disturbing noises which affect the underwater sound listening devices was reduced by 15 to 20 decibels.

b. Consequently the audible distance was extended from 1,500 to 8,500 meters (to 100 ton launch).

c. The level of underwater noises which are radiated from the ship's hull was reduced by 10 to 15 decibels. (Consequently the audible distance of underwater sound listening device from other ships was reduced by a considerable amount.)

d. Generally, the decrease of vibrations and noises in all parts of the ship made life comfortable on-board.

e. On equipment other than the acoustic equipment, the decrease in vibration had good effects.

f. Technique of manufacturing vibration preventing rubber--regarding the technique of manufacture, that of other countries being unknown, we proceeded with our own method.

(1) Standard types: manufactured ten types with kinds limited to about 100.
(2) Adhesive strength to soft steel: 30-50 Kg/cm^2 (for tension).
(3) Load intensity: 1-2 Kg/cm^2.
(4) Hardness: 50-65 (Shore hardness meter.)