

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

TMJ
OT
0-36-2

15 January 1946

RESTRICTED

From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.
Subject: Target Report - Light Armor by Nippon Special
Steel Co., OMORI, Tokyo.
Reference: (a) "Intelligence Targets Japan" (DNI) of 4 Sept.
1946.

1. Article 2 of the report, covering Target 0-36
of Fascicle 0-1 of reference (a) is submitted herewith.

2. The investigation of the target and the target
report were accomplished by Lt. Comdr. J.J. Glancy, USNR, as-
sisted by Lt.(jg) R.R. Boggess, USNR, as interpreter and
translator.



C. G. GRIMES
Captain, USN

30855

RESTRICTED

O-36-2

JAPANESE LIGHT ARMOR - ARTICLE 2

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

FASCICLE O-1, TARGET O-36-2

JANUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ORDNANCE TARGETS

JAPANESE LIGHT ARMOR - ARTICLE 2 MANUFACTURE OF LIGHT ARMOR BY NIPPON SPECIAL STEEL CO. OMORI, TOKYO, JAPAN

This report covers the manufacture by the Nippon Special Steel Co., OMORI, Tokyo, of 3mm to 16mm light armor (homogeneous and carburized). This armor was used as a protection against 7.7mm, 13mm and 20mm armor-piercing projectiles. Chemical composition, heat-treating methods, inspection, ballistic tests, etc., are described.

The contents of this report exemplify the manufacture of light armor by the Japanese.

TABLE OF CONTENTS

Summary Page 1

References Page 3

Introduction Page 5

The Report

- 1. General Page 7
- 2. Heat Treatment Page 7
- 3. Inspection Page 8
- 4. Ballistic Tests Page 8

REFERENCES

Location of Target:

Nippon Special Steel Company, OMORI, Tokyo, Japan.

Japanese Personnel Interviewed:

Masaichi SATO, Chief Engineer, Nippon Special Steel Co. (30 years experience in alloy and plain carbon steel manufacturing).

K. KAWAMURA, Technical Captain, IJN, Ph.D. in Engineering. Served in TOKYO for four years in the Japanese Naval Air Ordnance Department.

INTRODUCTION

This report describes the manufacture of light armor by the Nippon Special Steel Company at OMORI, Tokyo. Since 1941 this company regularly manufactured 3mm to 16mm aircraft armor for the Japanese Army and Navy. Prior to 1941, the company produced tank armor. Throughout World War II this company produced approximately 22,000 pounds of armor plate per month. However, the Nippon Special Steel Company was primarily a manufacturer of alloy steel parts for aircraft engines.

THE REPORT

1. General

The Nippon Special Steel Company manufactured two types of armor plate for the Japanese Army and Navy - a homogeneous type armor plate made to only one analysis and a carburized type to two different analyses, depending upon finished thickness. The following table lists the composition specifications for the three steels:

The steel was made in 8 and 15 ton Heroult-type tilting electric furnaces with basic linings. The electrodes were reported to be made of natural graphite mined in Korea, instead of amorphous carbon such as used in the United States. However, approximately 66 pounds of electrode per ton of steel were required. This is approximately three times the amount that would be used in the United States. A typical furnace charge was 30% armor plate scrap and croppings, 10% steel turnings, and 60% miscellaneous scrap.

The ingots were square and weighed approximately 1100 pounds. Approximately 20% was cropped from the top of the ingot and 10% from the bottom. The yield from an 8 ton heat was 2.4 tons of finished plate. Following cropping, the ingots were forged into slabs and all surfaces ground. Rolling to the required thickness was accomplished by another company.

Classification	Chemical Composition (%)								Armor Thickness (mm)	Type of Armor
	C	Mn	Si	P	S	Ni	Cr	Mo		
1st Special Steel	.35-.40	.8-1.0	.35	.030	.030	2.5-3.5	1.5-2.0	.4-.5	3,4,5,6,7	Homogeneous
2nd Special Steel	.18-.25	.8-1.2	.6-1.0	.030	.030		1.0-1.5		8,12	Carburized
3rd Special Steel	.23-.30	.8-1.2	.6-1.0	.030	.030		1.0-		16	Carburized

2. Heat Treatment

After rolling, the plates were annealed from 700°C. The various types of armor plate were then heat treated as follows:

a. Homogeneous Armor

The 3mm, 4mm, 5mm, 6mm, and 7mm homogeneous plates were heated in a car-type furnace to 850°C, held for one hour, then cooled between heavy platens, the top platen being cooled by circulating water. The plates were then drawn for two hours in a rape seed oil bath at 180°C to produce a hardness of 500 to 560 BHN.

b. Carburized Armor

The 8mm, 12mm, and 16mm plates were carburized two at a time in a mild steel box. The plates were laid face-to-face, with the carburizing material between, and were then covered with dry sand. The mild steel box was then placed in a car-type furnace and held at 900°C for one of the following intervals, depending upon the thickness of plate:

8mm	18 hrs
16mm	24 hrs

The depth of the carburization was reported to be approximately 20% of the thickness of the plate. After carburizing, the plates were normalized at 850°C, held for one hour in a car-type furnace at 850°C, quenched by hand in whale oil, and drawn for two hours in rape seed oil at 180°C. The desired hardness was greater than 550 BHN for the face and greater than 400 BHN for the reverse side. The carburizing compound used was of powdered charcoal, 70%, and barium carbonate (BaCO₃), 30%.

3. Inspection

The following inspection was conducted by the manufacturer:

a. Chemical Composition

The chemical composition of the heat was checked by ladle analysis.

b. Hardness

For homogeneous armor a plate was returned for retreatment, if the hardness was less than 500 BHN or greater than 560 BHN. If, after a treatment, a carburized plate showed a face hardness of less than 550 BHN, or a reverse side hardness of less than 400 BHN, it was re-treated.

c. Dimensions

All plates were inspected as to dimensions after completion.

In the case of Navy armor, no inspection was required by a Naval representative. However, one plate from each heat was submitted by the manufacturer for ballistic tests to the First Naval Air Technical Arsenal at YOKOSUKA. The armor plate for the Army was inspected for dimensions and hardness by an Army representative, and a plate selected from each heat for ballistic tests. If the plate selected by either the Army or Navy failed to satisfy the ballistic tests, all plates from that particular heat were rejected and scrapped.

4. Ballistic Tests

The ballistic tests conducted by the Navy are listed below:

a. The projectiles and conditions of tests required are shown in the following table:

Steel	Plate Thickness (mm)	Projectile	Armor Obliquity	Striking Velocity
1st Special Steel	5 (.197")	7.7mm AP	0°	2362 F/S
		13mm AP	0°	1574 F/S
2nd Special Steel	8 (.315") 12 (.472")	13mm AP	0°	1640 F/S
		13mm AP	0°	2132 F/S
		20mm AP	0°	1476 F/S
3rd Special Steel	16 (.632")	13mm AP	0°	2378 F/S
		20mm AP	0°	1886 F/S

Projectiles were fired as single rounds with measured velocities, and where two projectiles are listed in the above table, both were fired. Apparently very few rounds were fired to test a plate.

b. If, under the conditions of test described above in paragraph (a), a projectile struck the plate with a velocity less than specified, and either (1) the plate cracked so that light filtered through, or (2) an impression was made in the plate greater than 5mm in depth, the plate was considered as not having passed the test.

The ballistic tests conducted by the Japanese Army were almost identical to those conducted by the Navy.