

**MARILOY S-400 Pipes,  
1%Cr Steel for  
Cargo Oil and Water  
Ballast Pipes**



**Nippon Steel Corporation**

# **Overview**

**1.Features of Mariloy**

**2.Why Mariloy is good**

**3.Investigation result of Mariloy**

# **Overview**

**1.Features of Mariloy**

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# Features of MARILOY S-400 Pipes

1. Chemical composition : **1% Cr**

2. Manufacturing processes : **SML, ERW, UO**

3. Available length: **up to 15 m**

(SML: 5.5 or 6.0m, ERW : 9-12m, UO:9-15m)

4. Corrosion Resistance :

**Better pitting corrosion and erosion resistance than 1% Cr cast steel** in cargo oil and water ballast pipes environment

5. **Workability** : enough for expanding, bending. Plates for fittings (elbows, reducers) can be supplied.

6. **Weldability** :

Good weldability owing to chemical composition of low carbon

# Mechanical Properties of MARILOY S-400 Pipes

	UO (JIS G 3457 STPY400 basis)			ERW (JIS G 3454 STPG410 basis)			SML (JIS G 3454 STPG410 basis)		
		Specification	Example		Specification	Example		Specification	Example
Tensile Test	Tensile Strength	400MPa,min	459	Tensile Strength	400MPa,min	461	Tensile Strength	400MPa,min	437
	0.2% Proof Stress (16mm,max) (16mm,over)	245MPa,min 235MPa,min	352	0.2% Proof Stress	245MPa,min	362	0.2% Proof Stress	245MPa,min	300
	Elongation (16mm,max) (16mm,over)	19%,min 22%,min	29	Elongation (Type JIS No.12) (Type JIS No.5)	23%,min 18%,min	47	Elongation (Type JIS No.12) (Type JIS No.5)	23%,min 18%,min	55
	Tensile Strength of Weld Joint	400MPa,min	497						
Flattening Test				t/D: 8%,max t/D: 8%,over	2/3D, max 3/4D, max	Good Good	$H = \frac{(1+e)t}{e+t/D}$ $e=0.07$		Good

# Standard Size of MARILOY S-400 Pipes

Outside Diameter(mm)	Wall Thickness (mm)											
	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	
60.5												
76.3				● 7.0								
89.1				● 7.6								
101.6												
114.3			● 6.0	● 8.6								
139.8			● 6.6		● 9.5							
165.2				● 7.1		● 11.0	● 12.7	● 14.0				
216.3						● 12.7						
267.4						● 12.7						
318.5						● 12.7						
355.6						● 12.7		● 16.0				
406.4						● 12.7		● 16.0				
457.2						● 12.7		● 16.0				
508.0						● 12.7		● 16.0				
558.8						● 12.7		● 16.0				
609.6								● 16.0				
660.4						● 12.7		● 16.0				
711.2								● 16.0				
762.0						● 12.7		● 16.0				
to 1422.4								● 16.0				

SML : Minimum lot is 4 tons for standard size.

ERW : Minimum lot is 5 tons. Standard size only. Length is limited to be 9 to 12m.

UO : Minimum lot is 5 tons. Length can be 9 to 15 m.

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# Why Mariloy is good?



Flange

**Present:** Long carbon steel pipe coated with tar epoxy resin paint on the inner surface of the pipe.



Sleeve

**Proposal :** Long Mariloy S-400 pipe without a coating on the inner surface of the pipe.



# **Why Mariloy is good?**

## **Merit for ship-builders:**

**As no flange, no coating on the inner surface in fabrication and maintenance**

**1) Cost and time can be reduced**

**2) Ecological**

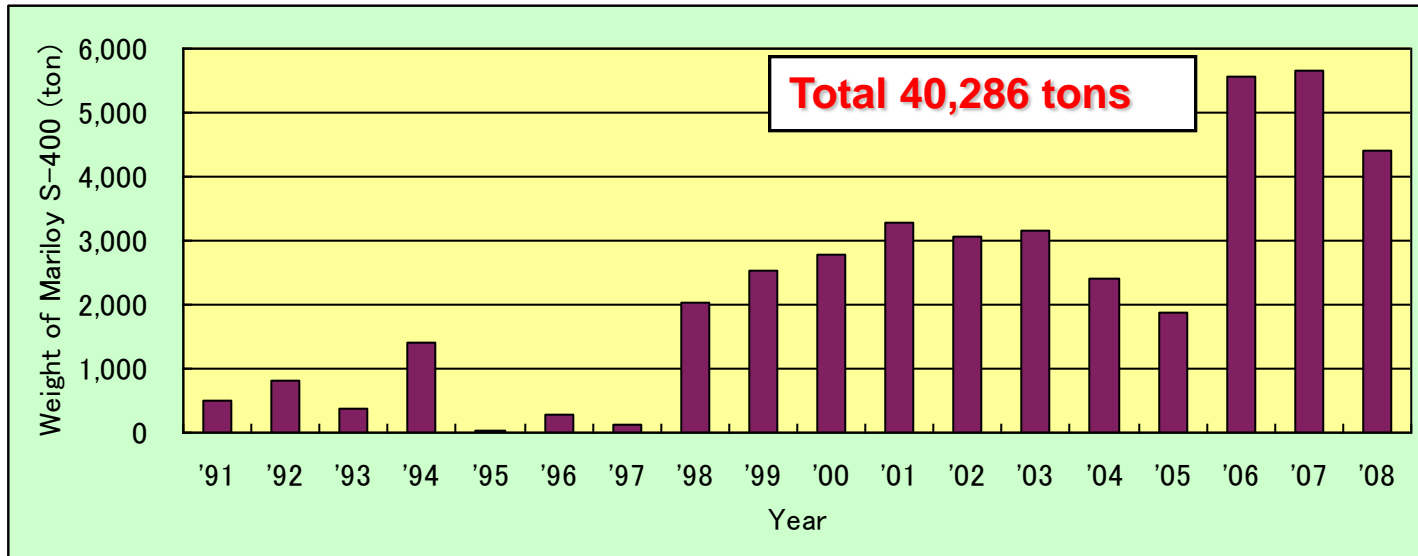
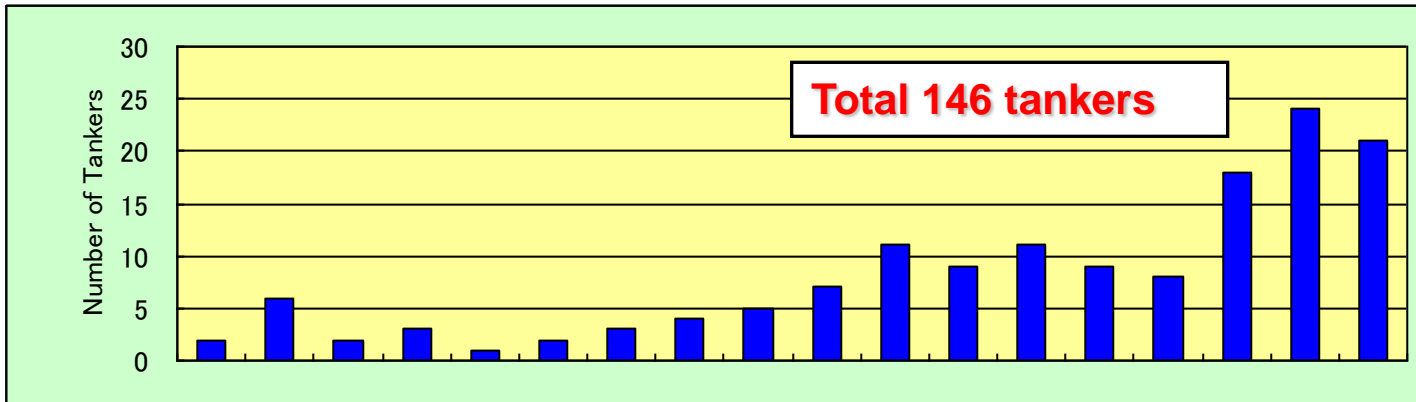
**3) Reliability**

## **Merit for ship-owners**

**1) Maintenance free**

**you will be able to use pipes for over 30 years  
(our estimation)**

# Supply Records of MARILOY S-400 Pipes of course “NO LEAK”



# Users of MARILOY S-400 Pipes

## 1. Ship-building Companies

- IHI MARINE UNITED,
- SUMITOMO HEAVY INDUSTRIES,
- UNIVERSAL SHIPBUILDING CO.,
- NAMURA SHIPBUILDING CO.,
- MITSUBISHI HEAVY INDUSTRIES (JPN)
  
- HYUNDAI HEAVY INDUSTRIES,
- DAEWOO SHIPBUILDING(KOR),
  
- NACKS, OTHERS(CHINA),
  
- KEPPEL, JYURONG,(SINGAPORE)

# Users of MARILOY S-400 Pipes

## 2. Ship-owners

### *Japan:*

NIPPON YUSEN K.K., KYOEI TANKER CO.,  
TOKYO KISEN CO., IINO KAIUN KAISYA,  
NISSHO KISEN CO., MITSUI O.S.K. LINES,  
SHINWA KAIUN KAISYA, TAIHEIYO KAIUN CO., IDEMITSUI

### *Oversea Countries:*

PULTAMINA, NAVIX, GROVAL TRANSPORT ENTERPRISE,  
WORLD WIDE, ONASSIS, GLAFKI MARITIME COMPANY,  
FORMOSA, FRONTLINE, SINYCALIERO, SUN ENNTH,  
SOPONATA, DYNACOM TANKERS, DSD SHIPPING,  
PREDEUS SHIPPIG, NANFUNK, PETRONAS

# **Overview**

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**Investigation of  
Mariloy Pipes used  
in a tanker for a Long Time**

# Investigated Tanker and Operating Conditions

## 1. Tanker

Tanker Name: TOHZAN (ex-COSMO ASTREA) /Kyoei Tanker

Building Date: November 1992

DWT: 230,000

Mariloy Pipe: UO/341 tons, BR/43 tons, ERW/15 tons)

## 2. Operating Conditions

9 times a year, between Middle East and Japan

[Middle East to Japan] Cargo oil pipe and tank=filled with crude oil

Water Ballast Pipe=empty, however, wet

[Japan to Middle East] Cargo oil pipe and tank=empty, however, wet

Water Ballast Pipe=filled with sea water

## 3. Investigation Time

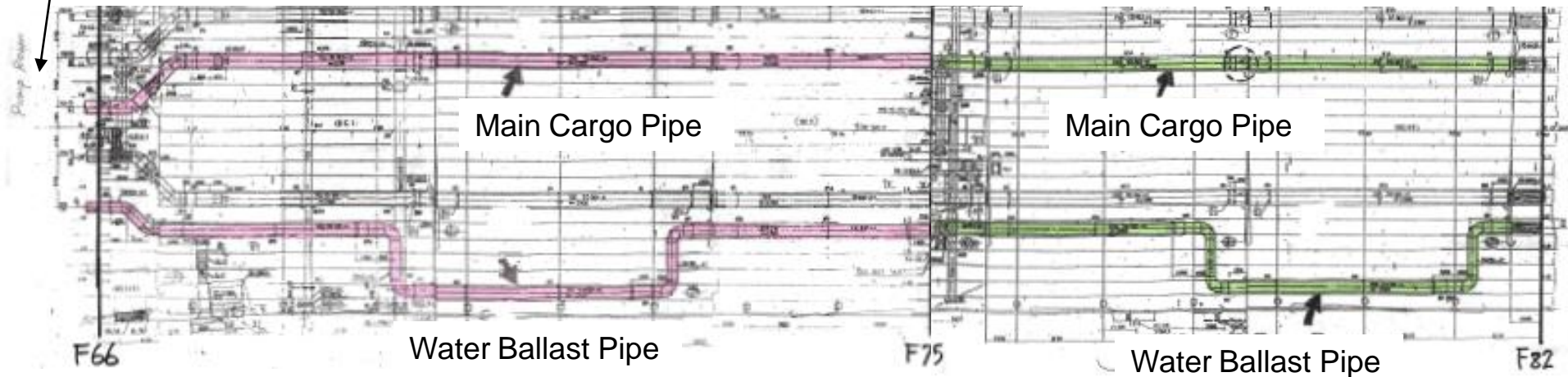
After 2.5, 7.5, 12.5 and 15 years

# Inspection After 2.5, 7.5, 12.5 and 15-Years Services

Pump Room

No.5 Cargo Oil Tank

No.4 Cargo Oil Tank



## Inspected Portion

- Main cargo oil pipe: pump room to No.4 oil tank  
about 100 m in length of 750Ax19mmt UO pipes
- Water ballast pipe: pump room to No.4 oil tank  
about 100 m in length of 650Ax17mmt UO pipes



# Inspection Method



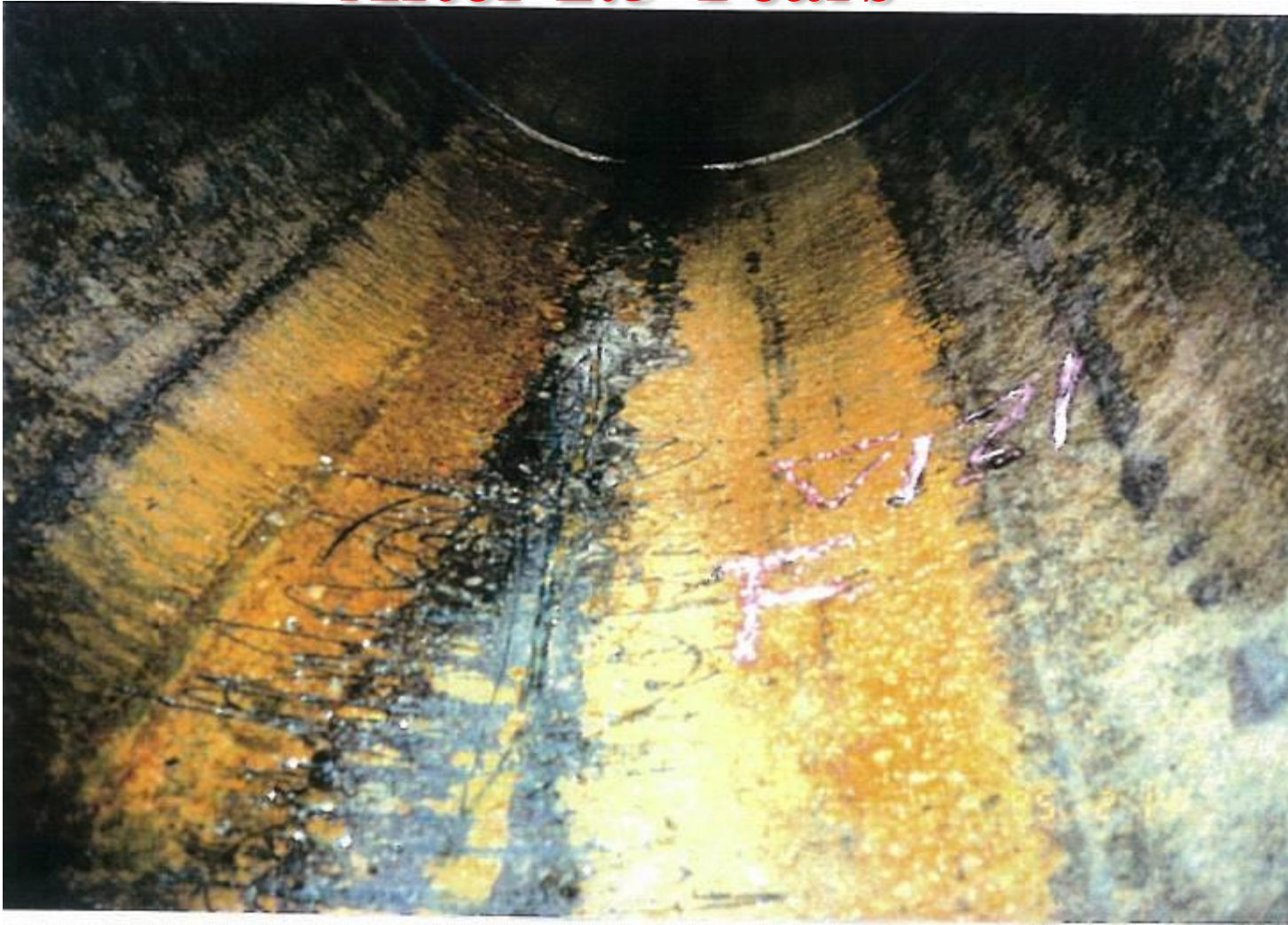
Wall thickness of pipes were continuously measured by using ultrasonic testers.



Inside of pipes were visually inspected and the depth of pitting was measured using depth gauge.

# **Inspection result for cargo oil pipes**

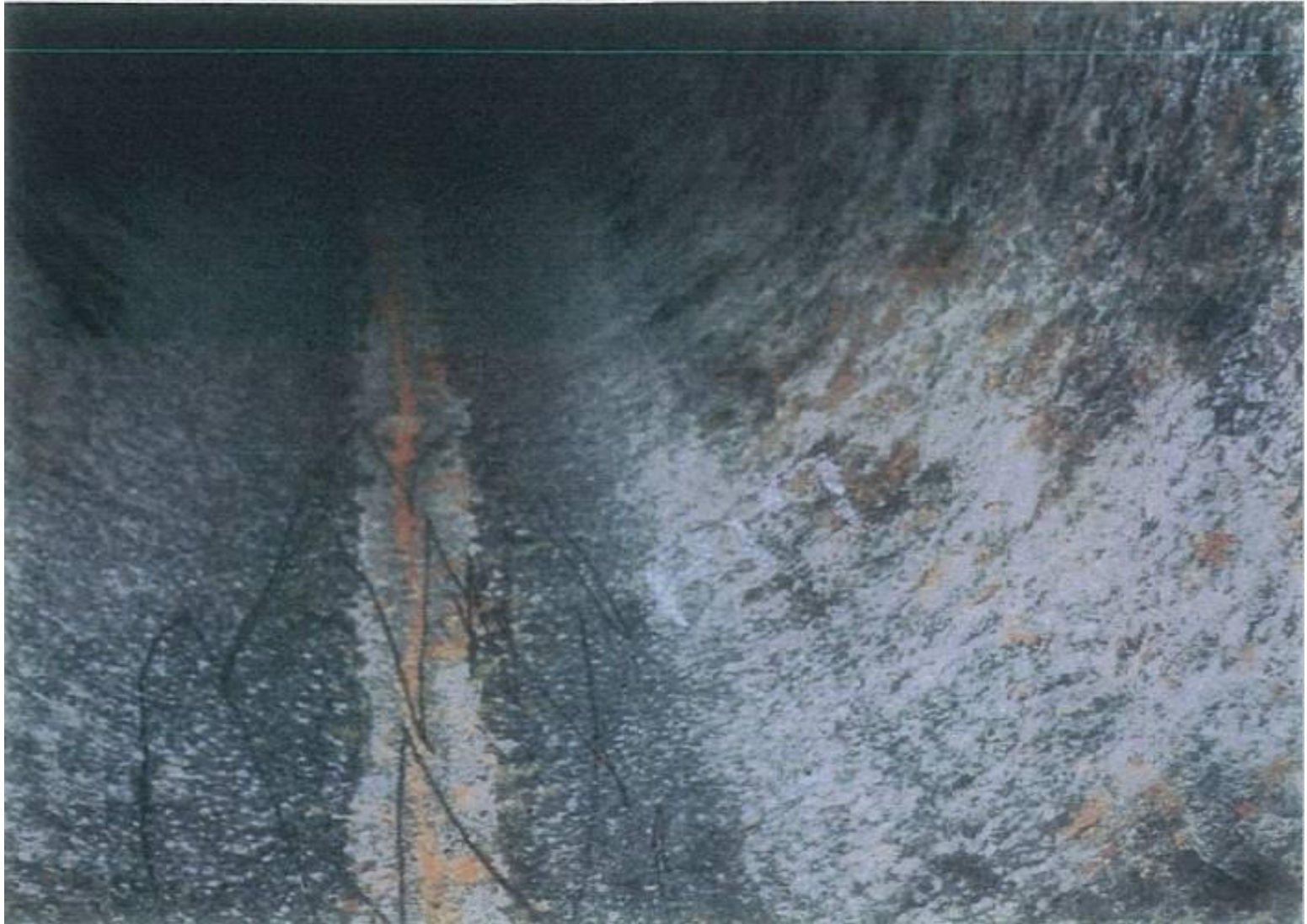
# Inside of Cargo Oil Pipe After 2.5 Years



# Inside of Cargo Oil Pipe After 7.5 Years



# Inside of Cargo Oil Pipe After 12.5 Years



# Inside of Cargo Oil Pipe After 15 Years



# **Pit with Maximum Depth(5mm) After 15 years-Service**



# Pit with Maximum Depth(5mm) After 15 Years-Service





# Analysis of Corrosion Product

## After 12.5-Years Service

(b) Chemical composition of sludge/ corrosion product on the bottom of cargo oil pipe

(relative intensity %)												
Na	Mg	Al	Si	P	S	Cl	K	Ca	Cr	Mn	Fe	Zn
0.34	0.14	0.06	2.42	0.02	26.3	0.57	0.04	0.18	0.55	0.42	68.9	0.09

from the Mariloy pipe

(c) Result of XRD analysis

+++	++	+	+/-
Fe <sub>3</sub> S <sub>4</sub>	Fe <sub>3</sub> O <sub>4</sub> CaSO <sub>4</sub>	alpha-FeOOH	beta-FeOOH

+++; I/I<sub>0</sub>=80-100%, ++; I/I<sub>0</sub>=20-80% ++; I/I<sub>0</sub><20%  
+/-; I/I<sub>0</sub><5% and some of peaks overlapped with others

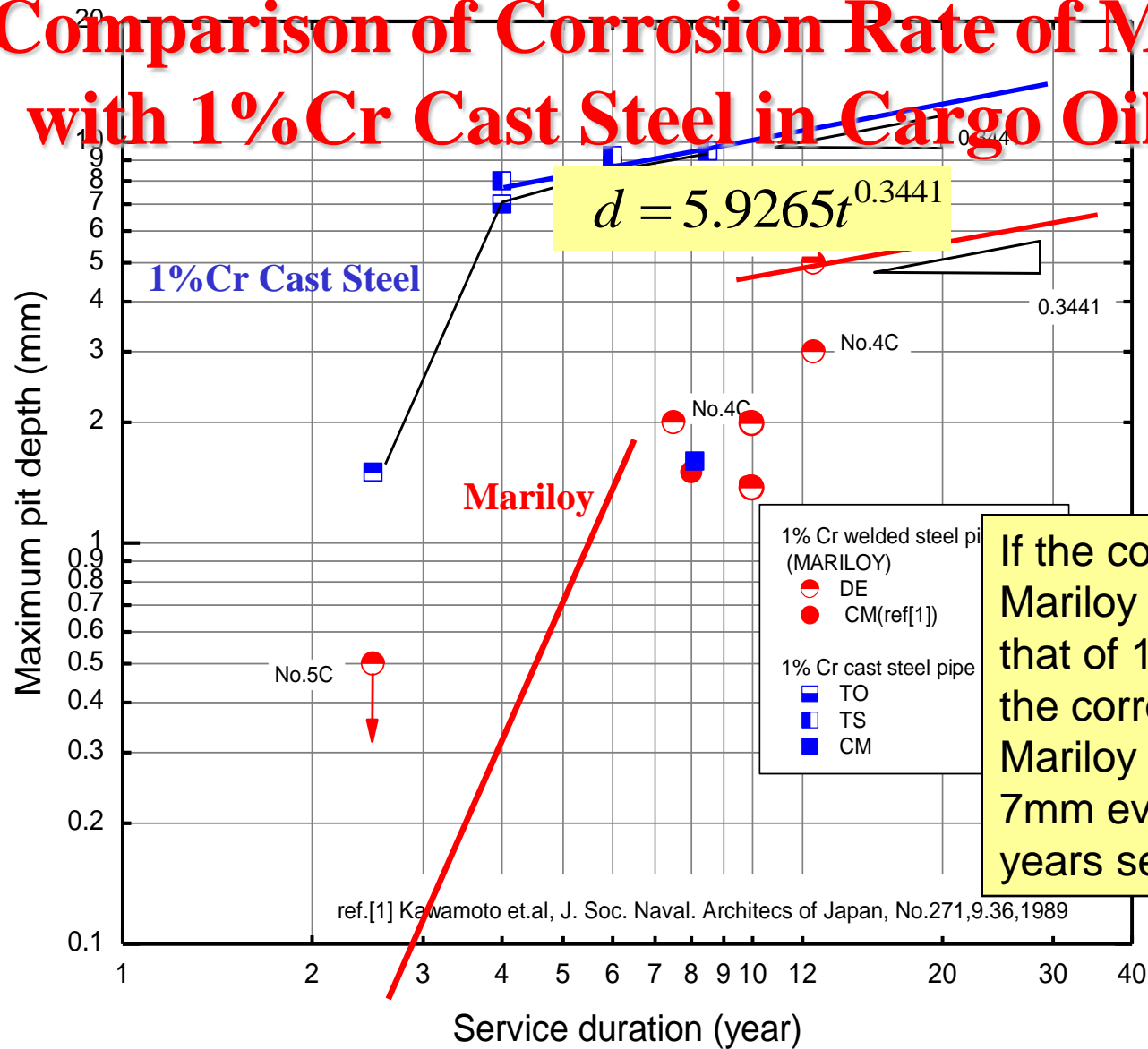
(d) Composition of water soluble ionic species in sludge/ corrosion product

(mass% v.s. specimen)

pH	S <sup>2-</sup>	S <sub>2</sub> O <sub>3</sub> <sup>2-</sup>	SO <sub>4</sub> <sup>2-</sup>	Cl <sup>-</sup>	total-Fe ion	Na <sup>+</sup>	Ca <sup>++</sup>	Mg <sup>++</sup>
5.14	0.1	1.91	1.56	0.29	0.16	0.12	0.1	0.03

The corrosion product is close to that usually observed in cargo oil carbon pipes and tanks, except the existence of Cr. The good corrosion resistance of Mariloy pipe may come from Cr-containing oil coat.

# Comparison of Corrosion Rate of Mariloy with 1%Cr Cast Steel in Cargo Oil Pipe

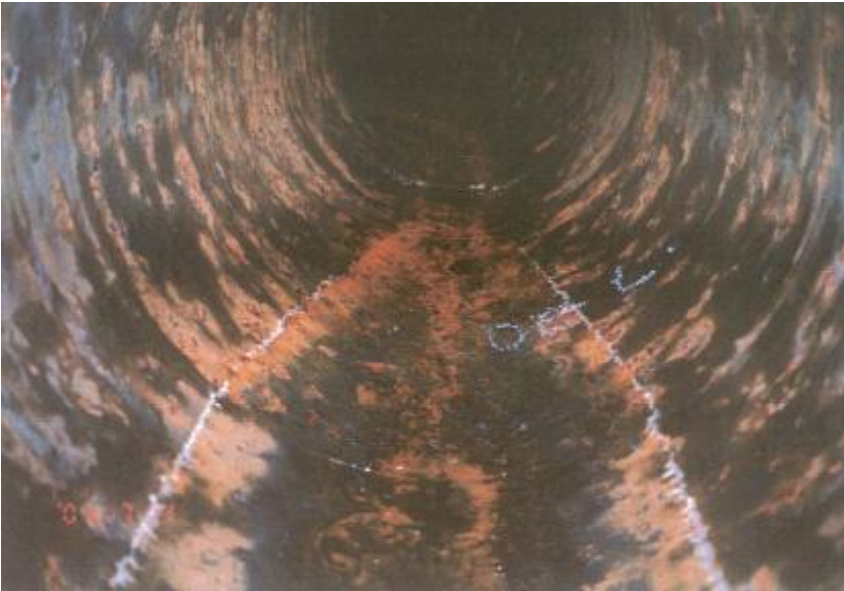


If the corrosion rate of Mariloy is the same as that of 1%Cr cast steel, the corrosion depth of Mariloy is less than 7mm even after 30-years service.

ref.[1] Kawamoto et.al, J. Soc. Naval. Architects of Japan, No.271,9.36,1989

# **Inspection result for water ballast pipes**

# Inside of Water Ballast Pipe After 7.5 and 12.5 Years



**After 7.5 years (Water ballast pipe in pump room)**

About a half of surface was covered with rust and the other half was covered with mill scale.



**After 12.5 years (Water ballast pipe in cargo oil tank)**

The surface was fully covered with rust. Dark spots were wet portion.

# Inside of Water Ballast Pipe After 15 Years



# Inside of Water Ballast Pipe After 15 Years



# Inside of Water Ballast Pipe After 15 Years



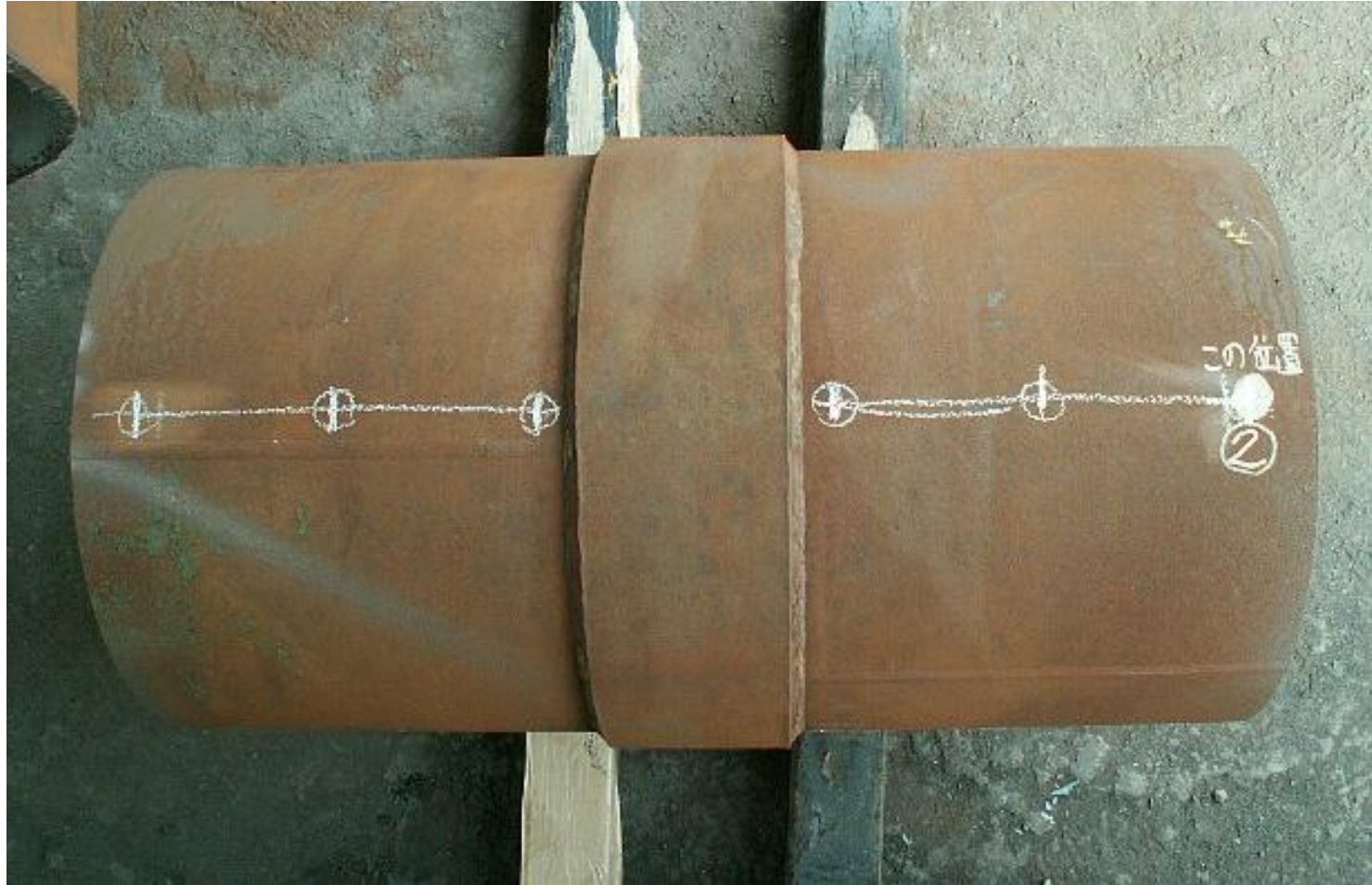
Before Hammering

After Hammering

There is no pit under the rust; General Corrosion

Ultrasonic measurement of wall thickness: max. 3.2mm loss

# Investigation of a water ballast pipe removed after 15 years service



Appearance



# Inside of water ballast pipe after shot blasting



# Conclusions of Investigation

1. Cr-containing oil coating may give Mariloy good corrosion resistance to cargo oil environment.

Inspection after 15 years service showed that Mariloy pipe could be used without painting over 30 years **in cargo oil pipe environment.**

# Conclusions of Investigation cont..

2.

There is no pit in the inside of water ballast pipe, though all surfaces rusted. That means that general corrosion occurred.

As the maximum loss in wall thickness is 3.2mm maximum after 15 years, Mariloy can be used without painting over 30 years also [in water ballast pipe environment](#).

# REVIEW

**1. Features of Mariloy**

**2. Why Mariloy is good**

**3. Investigation result of Mariloy**

# Conclusions

## 1. Good Corrosion Resistance

Inspection after 15-years service showed that Mariloy S-400 pipe could be used without painting over 30 years in cargo oil pipe and in water ballast pipe environments.

## 2. Merit of Using Mariloy S-400 Pipe

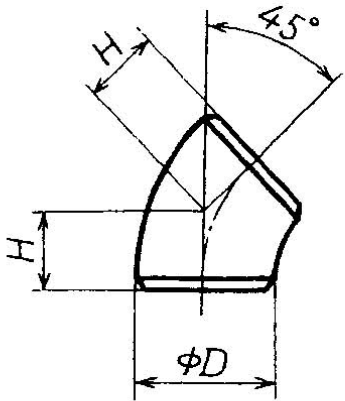
Using Mariloy S-400 gives you **an economical and ecological solution;**

**vs carbon steel pipe with painting:** reduction in the fabrication and maintenance cost and time, and solution to regulation of harmful paints.

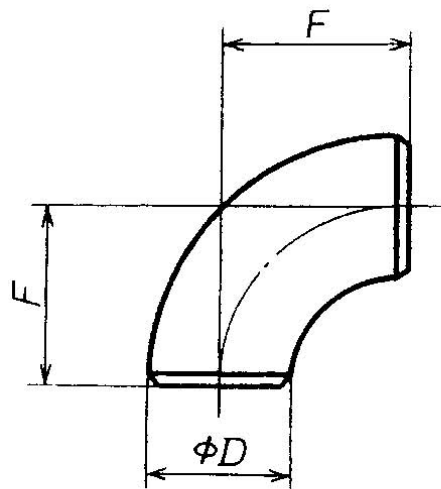
**Fabricating**

# Fittings of Mariloy Pipes

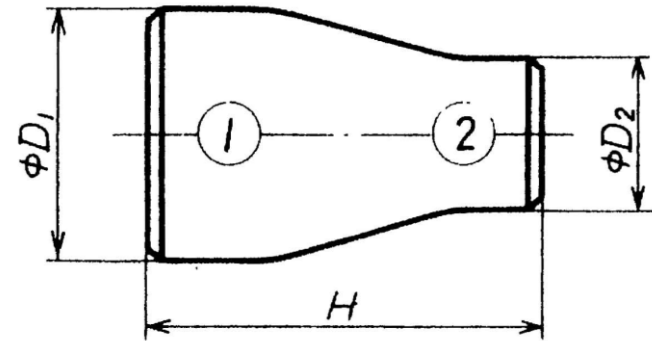
**45° Elbow**



**90° Elbow**



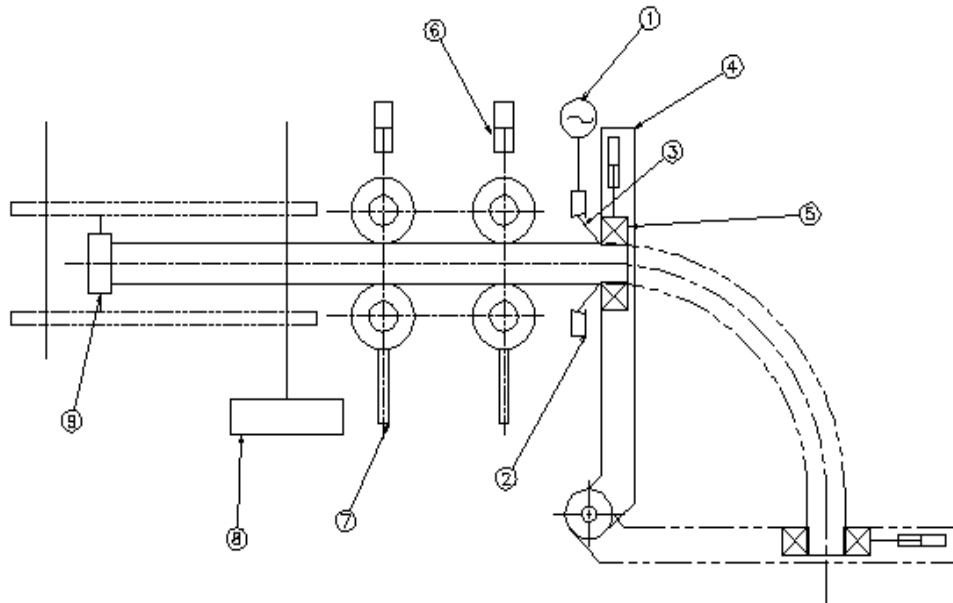
**Reducer**



Fittings of Mariloy are produced by BENKAN JPN .

# Induction Bends

Sketch of HF induction Bending Machine



**DAI-ICHI HIGH FREQUENCY CO.,LTD.**



# Welding Materials for MARILOY Pipes

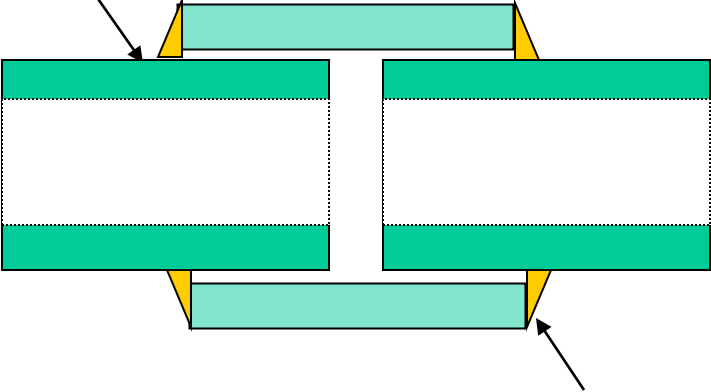
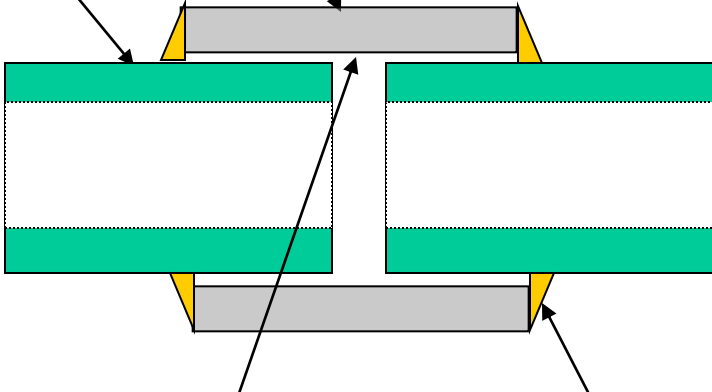
Type	Brand Name	Diameter mm	Shield Gas	Chemical Composition (%)					Mechanical Properties of Weld Joint			
				C	Si	Mn	Cu	Cr	YS(MPa)	TS(MPa)	EL(%)	Ea(J)
Shielded Metal Arc Welding Rod	RS-55	3.2		0.05	0.53	0.57	-	1.00	500	590	28	220 (at 0°C)
		4.0										
		5.0										
		6.0										
GTAW Rod	YT-55RS	2.4	Ar	0.04	0.31	1.05	0.11	1.16	480	540	27	-
Flux-cored Welding Rod	SF-55RS	1.2	CO <sub>2</sub>	0.04	0.41	1.01	0.23	1.00	520	600	26	100 (at 0°C)
		1.6										
Solid Wire	YM-55RSA	1.2	CO <sub>2</sub>	0.06	0.34	1.07	0.23	1.09	462	550	28	192 (at 0°C)

Weldability of Mariloy is almost the same as ordinary carbon steels.

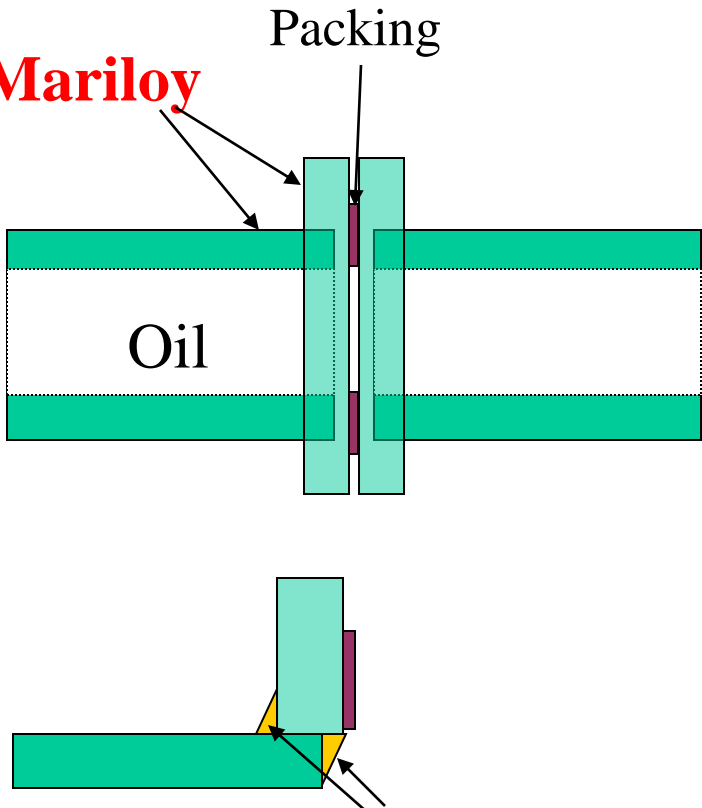
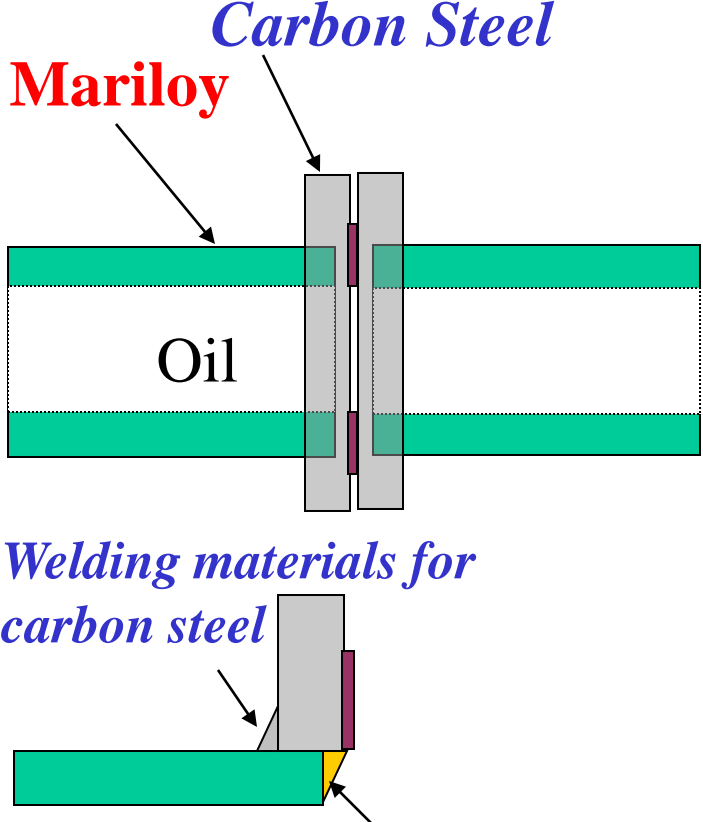
There is no need for pre-heating and post welding heat treatment.

The welding consumables for Mariloy are produced by Niipon Steel & Sumikin Welding Co.,Ltd.


↓  
**Joint-1**

	Recommendation	Acceptable Combination
Sleeve Joint	<p><b>Mariloy</b></p>  <p><b>Welding materials for Mariloy</b></p>	<p><b>Mariloy</b> <i>Carbon Steel</i></p>  <p><b>Welding materials for Mariloy</b></p> <p><i>Paint or Zn-Coat</i></p>

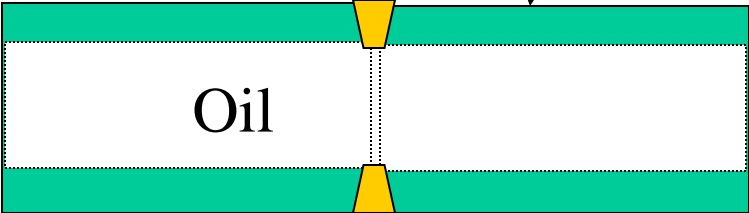
# ↓ Joint-2

	Recommendation	Practical Example
<p style="text-align: center;">Flange Joint</p>	<p style="text-align: center;">Packing</p> <p style="color: red; font-weight: bold;">Mariloy</p>  <p style="color: red; font-weight: bold; text-align: center;">Welding materials for Mariloy</p>	<p style="color: blue; font-style: italic;">Carbon Steel</p> <p style="color: red; font-weight: bold;">Mariloy</p>  <p style="color: blue; font-style: italic;">Welding materials for carbon steel</p> <p style="color: red; font-weight: bold; text-align: center;">Welding materials for Mariloy</p>

# Joint-3

	Recommendation
Dresser Joint	 <p>Paint</p>

# Joint-4

	Recommendation
Weld Joint	<p>Welding materials for Mariloy</p> <p>Mariloy</p>  <p>Oil</p>

# Conclusions

## 1. Good Corrosion Resistance

Inspection after 15-years service showed that Mariloy S-400 pipe could be used without painting over 30 years in cargo oil pipe and in water ballast pipe environments.

## 2. Merit of Using Mariloy S-400 Pipe

Using Mariloy S-400 gives you **an economical and ecological solution;**

**vs carbon steel pipe with painting:** reduction in the fabrication and maintenance cost and time, and solution to regulation of harmful paints.