JFE

STEEL PLATES FOR SHIPBUILDING

JFE Steel Corporation

JFE's Steel Plates for Shipbuilding

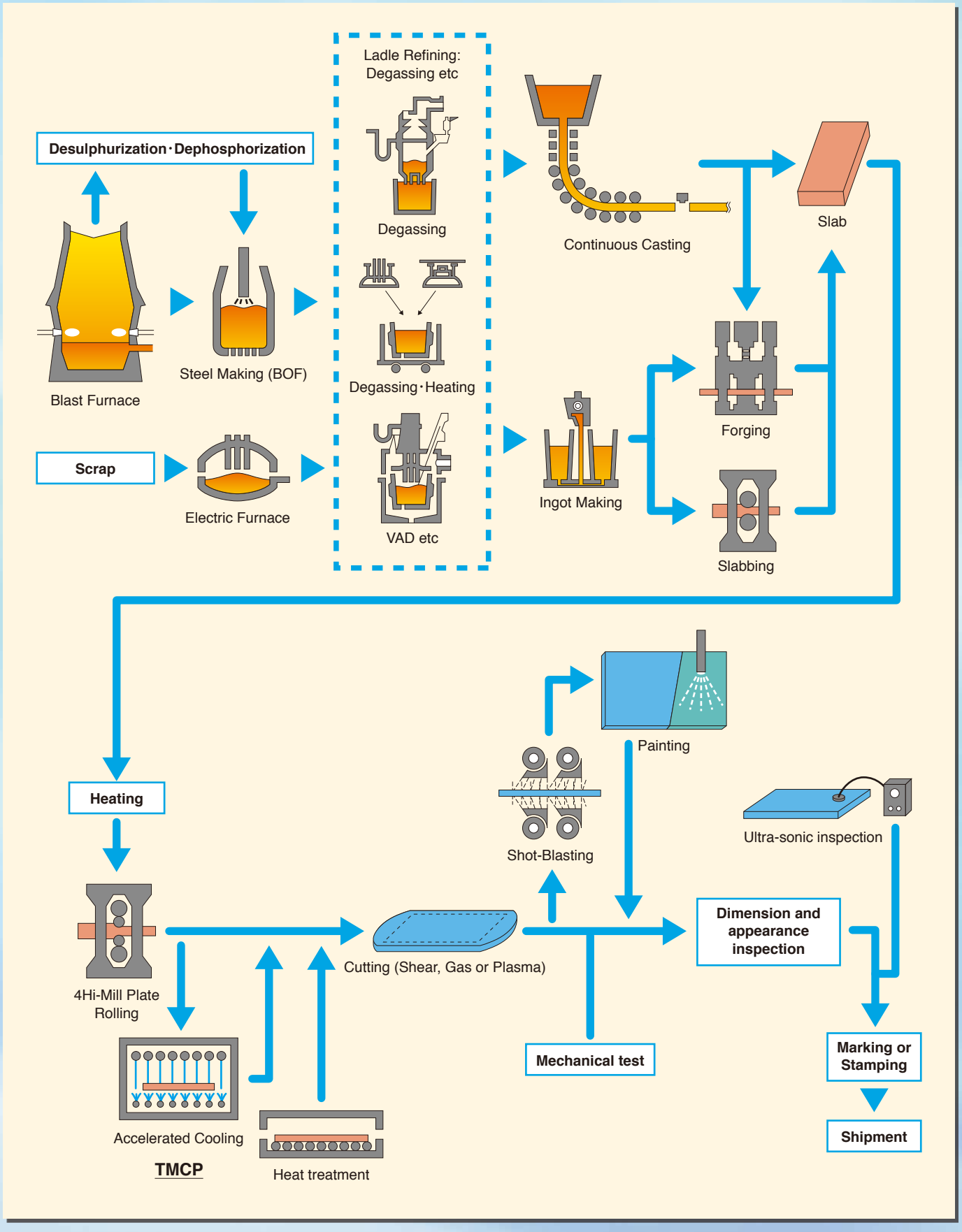
Contents

~ A Pioneer of TMCP Steel Plates ~

To improve the cruising range of ship and to reduce the building cost of ship, recently the use ratio of high tensile steel is becoming higher.
The weldability and workability of high tensile strength steel have been improved drastically by introducing the TMCP (Thermo-Mechanical Control Process) into the production of steel plates.
The TMCP plates have already been incorporated into standards of major classification societies.
JFE started the operation of the On-line Accelerated Cooling system (OLAC™) at Fukuyama Plate Mill in 1980, the first in the world. This device was replaced by the state-of-the-art Super-OLAC™ in 1998.
Thus JFE has been leading company of TMCP technology.

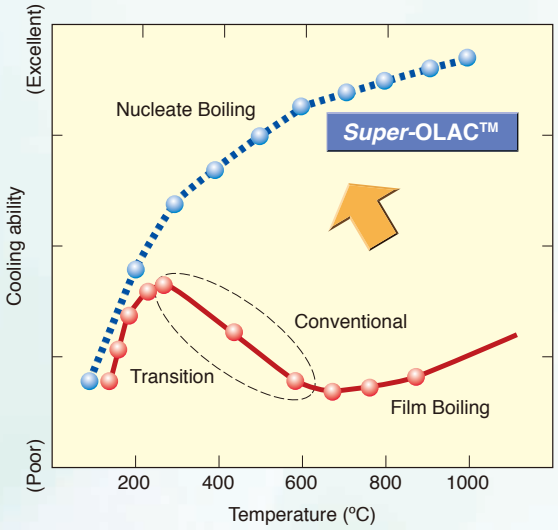
Production Facilities

Manufacturing Process



JFE's Advanced Technology

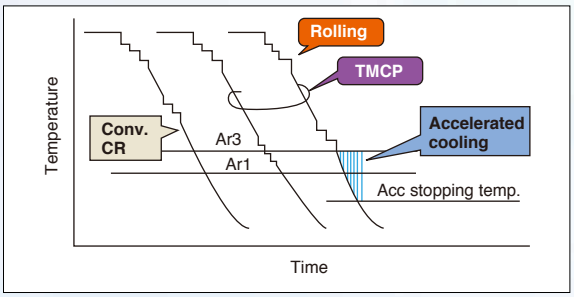
JFE's leading TMCP technology

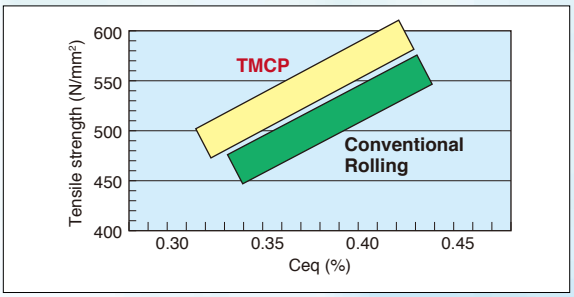


Super-OLAC™ is a leading-edge TMCP technology, and offers a higher cooling rate than conventional cooling systems.

- Good reduction of carbon equivalent offers high weldability and improves the reliability of structures.
- TMCP is also effective for thick plates.

Fabrication Benefits by TMCP Steel Plate





Remarkable relaxation or elimination of preheating

Improve the working environment for operators

Great saving fabrication cost

Elimination of preheating reduces the fabrication cost by 30% in the case of spherical tank.

Reliable welded joint

Almost no additional repair welding even without preheating

High heat input welding

Major reduction of welding pass

Far lower welding cost

Much shorter fabrication time

In case of VLCC ship construction, for example, using TMCP plates reduces the construction time by 10%.

ARRESTEX™

ARRESTEX™ prevent to propagation of brittle crack by its excellent crack arrest properties.

The structure of container ship and the location to apply ARRESTEX™

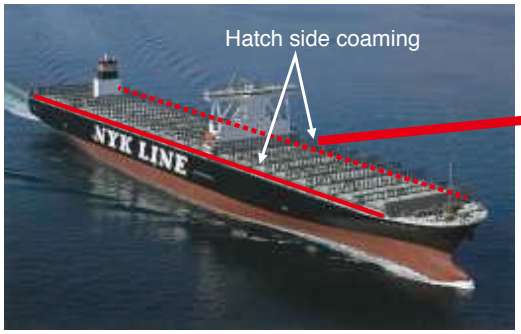
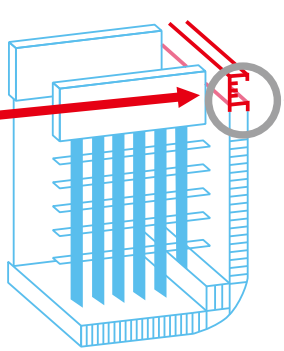
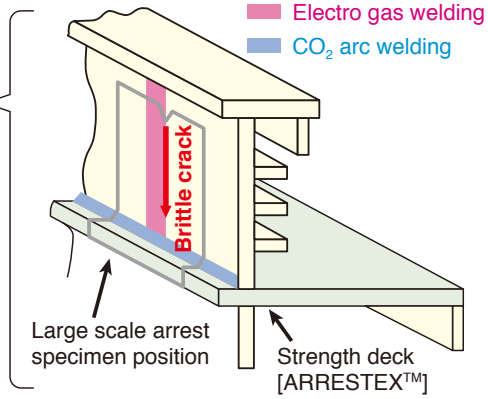


Photo. : KANRIN, Bulletin of the Japan Society of Naval Architects and Ocean Engineers, 73 (2017).

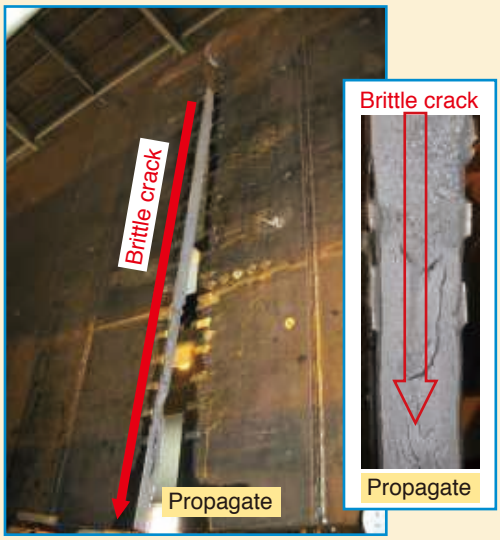




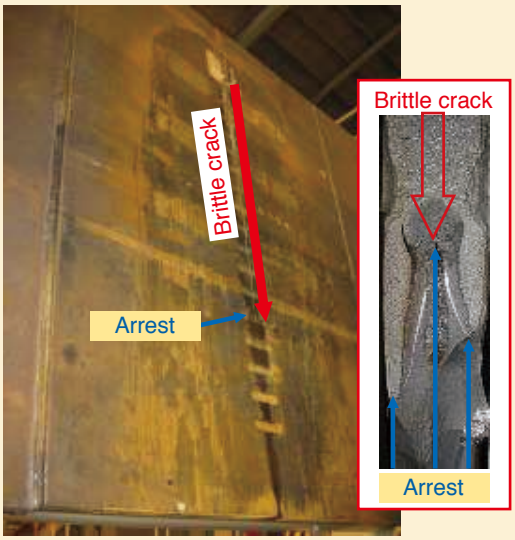
Feature of ARRESTEX™

- The brittle crack arrest toughness “Kca” at -10°C is equal to 6000N/mm$^{3/2}$ or more.
- Strength, Properties of weld joint and Weldability are equivalent to conventional steel.
- ARRESTEX™ is strong enough to prevent the propagation of brittle crack.
- Classification societies have given JFE Steel material approvals in accordance with IACS rule.

Large scale arrest test results



Conventional steel plate〔Kca＜6000N/mm$^{3/2}$〕



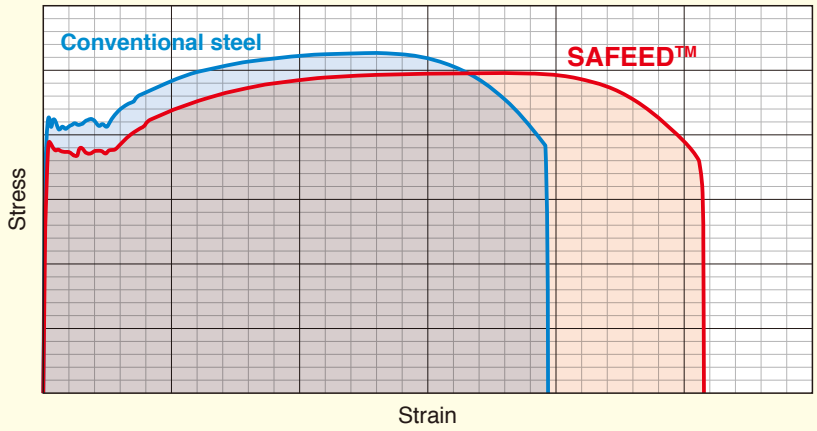
ARRESTEX™〔Kca≧6000N/mm$^{3/2}$〕

SAFEED™

SAFEED™ is able to reduce the damage risk from collision without changing hull structure.

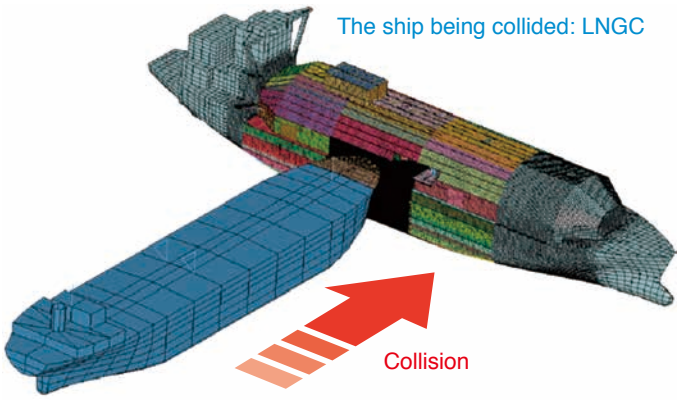
SAFEED™ has a highly excellent elongation by optimum condition of TMCP process. i.e. Controlled rolling , accelerated cooling.

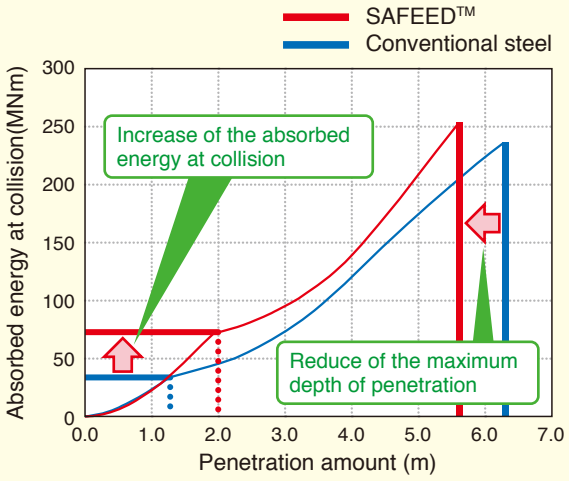
The tensile test property of SAFEED™



Advantage of application

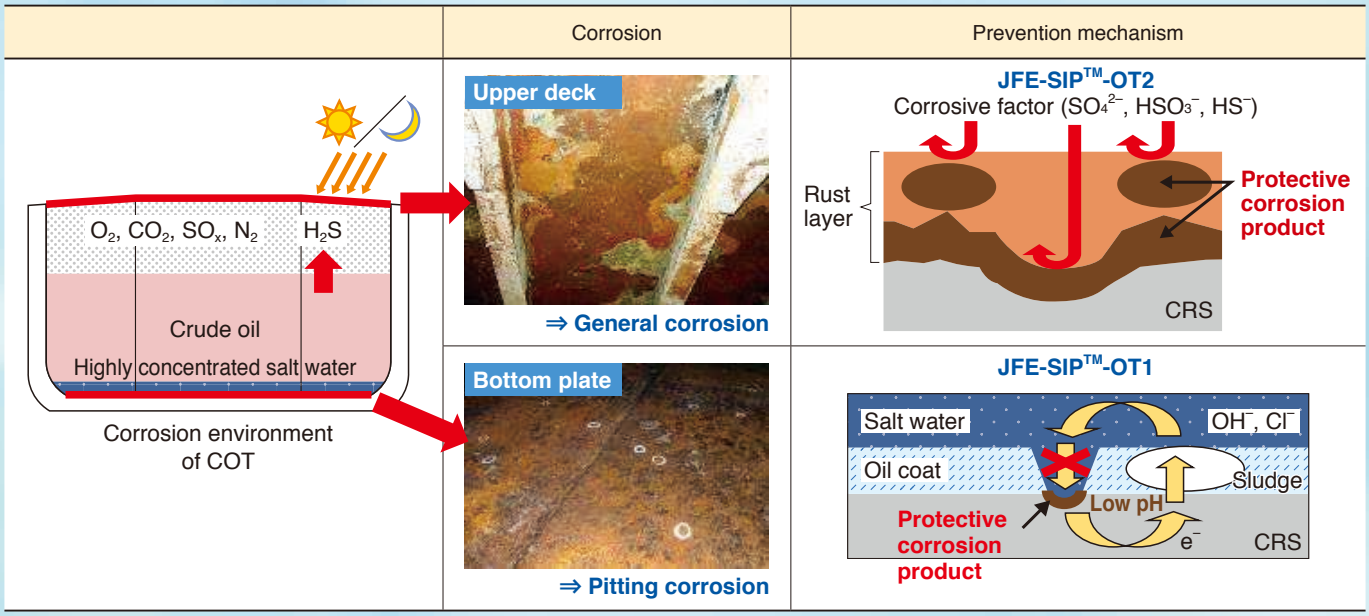
- The risk of brake of ship body can be reduced.
  The leak of ship and cargo can be prevented or mitigated.
- Weldability is equal to conventional steel.
- It is not necessary to change a design and structure of ship, except for application of SAFEED™
- SAFEED™ can make the value and price of ship higher.
- Class NK give a ship the notation for the increasing of the safety.





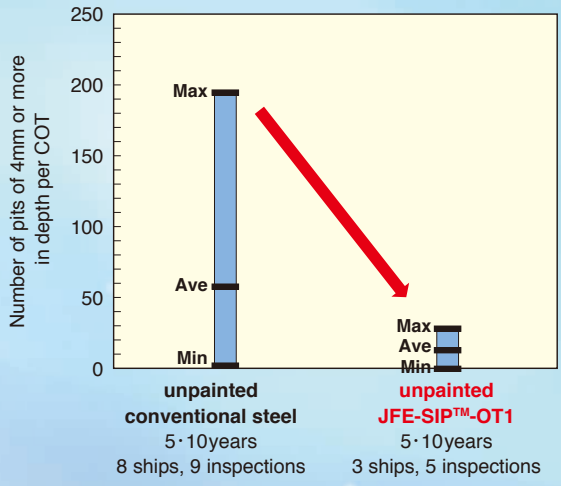
JFE-SIP™-OT1, OT2

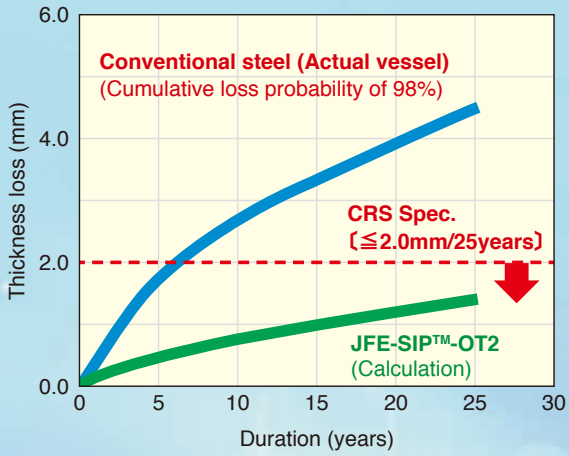
JFE-SIP™-OT1, OT2 have excellent Corrosion Resistance for severe Cargo Oil Tank environment of Crude Oil Tanker. OT1 is for bottom plate, OT2 is for upper deck.



Feature of JFE-SIP™-OT1, OT2

- The number of pits of 4mm or more in depth is extremely small (OT1).
- General corrosion loss is significantly suppressed (OT2).
- JFE-SIP™-OT1, OT2 are satisfied with IMO regulation.





Benefit of JFE-SIP™-OT1, OT2

On stocks:

- **Not need coating management**

On service:

- **Reduce recoating cost**
- **Reduce repair work period**
- **Suppress penetration of pit from cargo oil tank to ballast tank (OT1)**
- **Improve human safety by no recoating work at deck back (OT2)**
- **Not need backside burning care of coating due to fire construction on deck (OT2)**

JFE-SIP™-BT

Corrosion of WBT

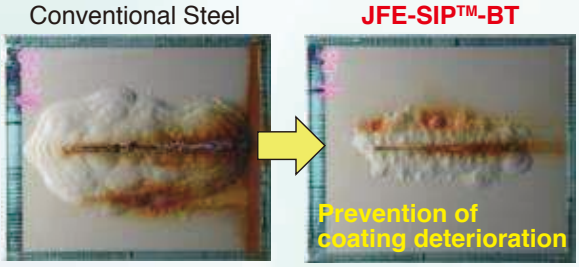
WBT: Water Ballast Tank

- Severe corrosive environment of seawater
- Deterioration of coating
- Need of repair (recoating, exchange of steel)
- Require a great cost

Corrosion of WBT

New Technology

- Develop the corrosion resistant steel (JFE-SIP™-BT) which enhance coating durability
- Protective rust layer formed by the alloying element in JFE-SIP™-BT steel
- Suppress corrosion and coating deterioration

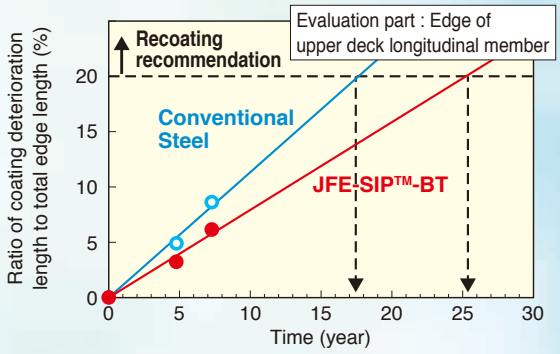


Coating deterioration from coating scribe

Laboratory corrosion test

Effects of SIP™ in actual WBT

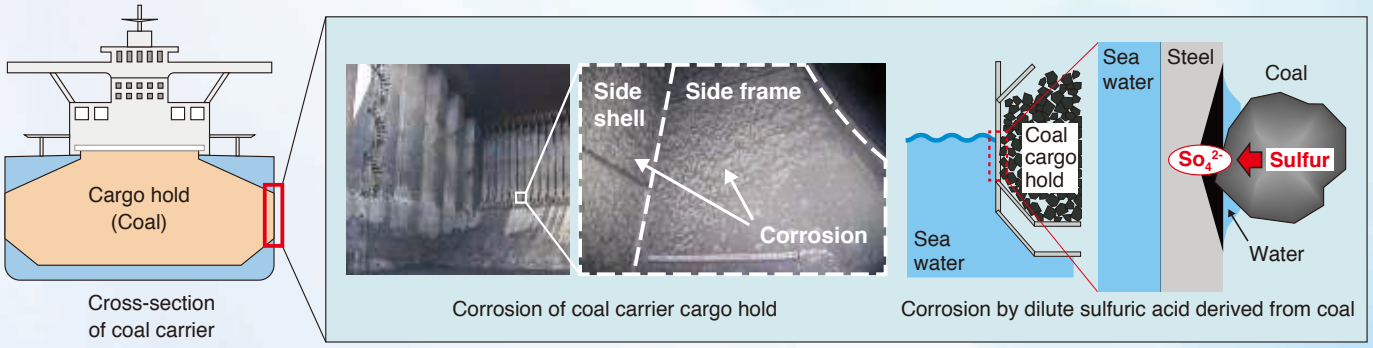
- Deterioration length of JFE-SIP™-BT was reduced to 70% of conventional steel
- Average recoating time of JFE-SIP™-BT is expected to be 25yrs or more



Coating deterioration behavior of ship using JFE-SIP™-BT

JFE-SIP™-CC

In cargo hold, dilute sulfuric acid derived from sulfur in coal corrodes steel severely

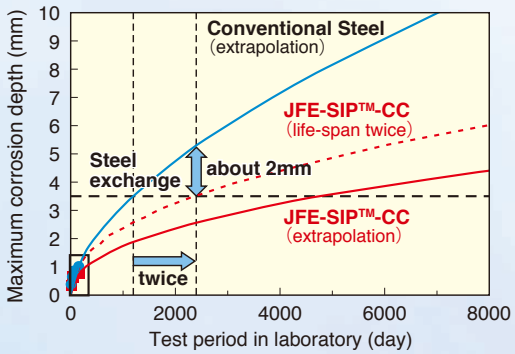


Cross-section of coal carrier

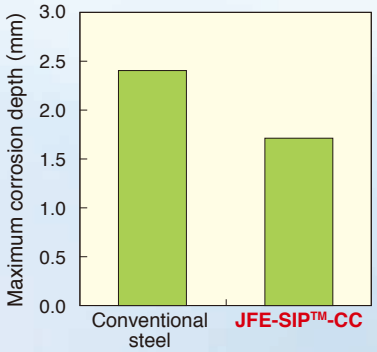
Corrosion of coal carrier cargo hold

Corrosion by dilute sulfuric acid derived from coal

- **Extension of life-span of steel (more than twice) Reduction of maintenance cost of coal carriers.**
- **In the actual environment of cargo hold, good corrosion resistance of JFE-SIP™-CC was confirmed.**



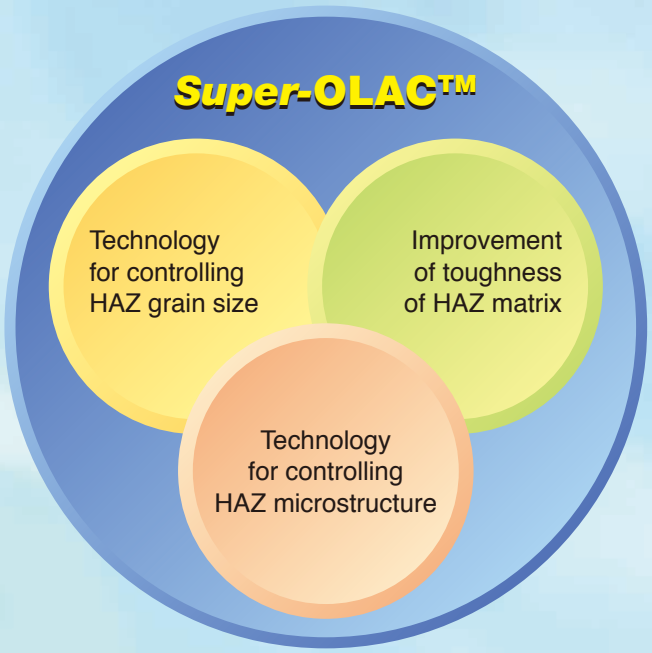
Life-span extension effect based on laboratory corrosion test



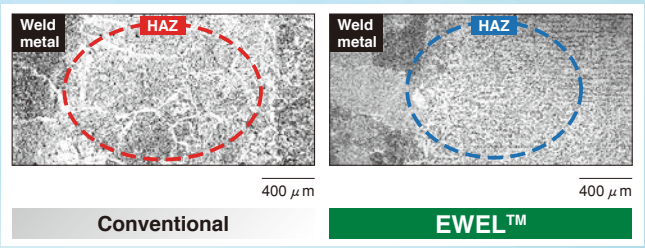
Exposure test result in actual coal cargo hold (for 2.5years, test pieces)

JFE-EWEL™

Excellent HAZ toughness under high heat input welding.

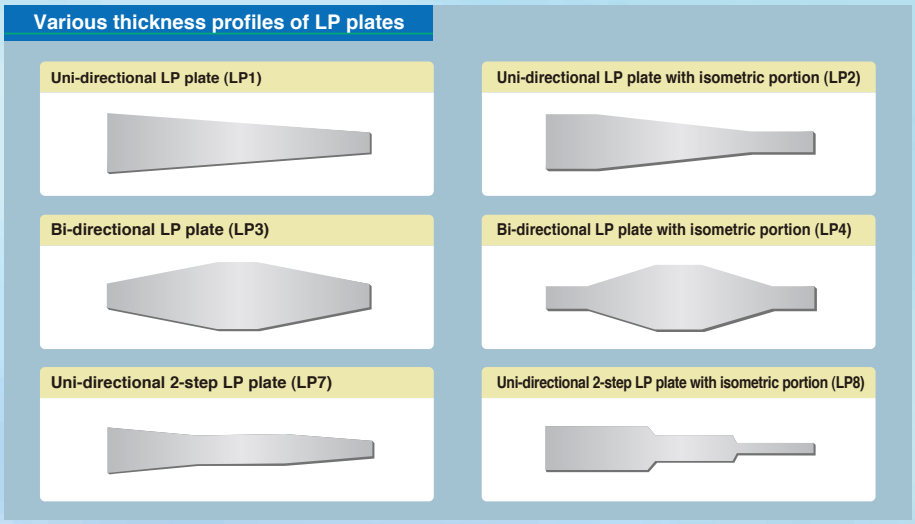


EWEL™ is composed of three independent technologies based on Super-OLAC™. One of them produces finer austenite grains at the peak temperature of welding, one changes the brittle coarse bainite structure to fine ferrite and bainite structure, and the third improves the toughness of the HAZ matrix by reducing free nitrogen through chemical reaction during the welding thermal cycle.



Each technology, or combination with other technologies, is used according to the customer's requirement.

LP (Longitudinal Profile) Plate



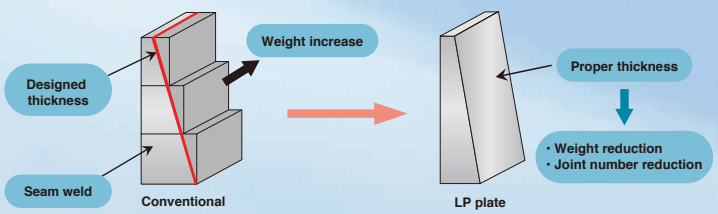
LP steel plates are plates in which the thickness is changed continuously in the longitudinal direction, and make it possible to reduce the production cost and steel weight in structures.

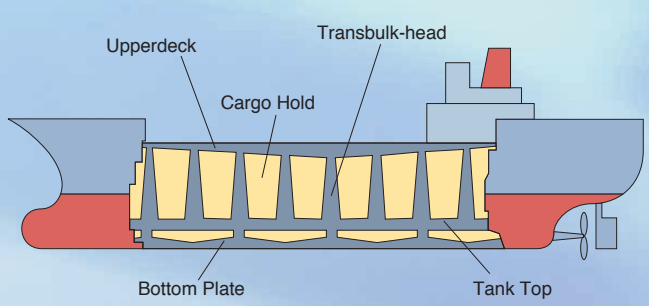
Features of LP plates

- Various thickness profiles
- Wide range of steel grade from mild steel to YP40
- Wide range of plate width up to 4600mm

Typical application of LP plate for shipbuilding

Use of LP plates enables further reductions in weight and in the number of joints.





Approval

Approval is obtained from major classification societies up to the thickness listed below.

- Normal & High Strength Steel
- Supply Condition:As Roll or TMCP

(Maximum Thickness mm)

Grade \ Class[*1]		NK	ABS	LR	DNVGL	BV	KR	CCS
Mild Steel	A,B,D	120	120	120	120	120	120	100
	E	120	120	120	120	120	120	100
YP32	A~EH32	100	100	100	100	100	100	100
	FH32	80	80	80	100	100	80	50
YP36	A~EH36	100	100	100	100	100	100	100
	FH36	80	80	80	100	100	80	50
YP40	A~EH40	80	80	80	80	80	80	80
	FH40	80	80	80	80	80	80	80
YP47	A~EH47[*2]	80	80	80	80	80	80	80

*1: Other Classes not shown here are subject to negotiation.
*2: Approved conditions of YP47 are different according to Classes. Please contact us before order placing.

- Normal & High Strength Steel
- Supply Condition:Normalized

(Maximum Thickness mm)

Grade \ Class[*1]		NK	ABS	LR	DNVGL	BV	KR	CCS
Mild Steel	A,B,D	200	200	200	200	200	200	—
	E	200	200	200	100	200	200	—
YP32	A~EH32	150	150	150	150	150	150	50[*2]
	FH32	—	—	32	—	—	—	—
YP36	A~EH36	150	150	150	150	150	150	50[*2]
	FH36	—	—	32	—	—	—	—
YP40	A~EH40	—	—	—	—	—	—	—
	FH40	—	—	—	—	—	—	—
YP47	A~EH47	—	—	—	—	—	—	—

*1: Other Classes not shown here are subject to negotiation.
*2: Approval of YP32, 36 of CCS Class is only for E grade.

- Low Temperature Steel
- Supply Condition:TMCP or Normalized

Class	Grade[*1]
NK	KL24A, KL24B KL33, KL37
ABS	V039, V051, V060 VH039, VH051, VH060
LR	LT-AH27S, DH27S, EH27S, FH27S LT-AH32, DH32, EH32, FH32 LT-AH36, DH36, EH36, FH36
DNVGL	VL2-2, 2-3, 2-4, 2-4L VL4-2, 4-3, 4-4, 4-4L

*1: Please contact us about approved thickness range.

Available sizes

Without Heat Treatment

(Product length : m)

Thickness (mm) \ Width (mm)	1000～1400	1401～1600	1601～1800	1801～2000	2001～2200	2201～2400	2401～2600	2601～2800	2801～3000	3001～3200	3201～3400	3401～3600	3601～3800	3801～4000	4001～4200	4201～4400	4401～4600	4601～4800	4801～5000	5001～5200	5201～5300	5301～5350
6.0～6.9																	22	22	19	16	13.5	13.5
7.0～9.0																		22	20	16	13.5	13.5
9.1～11.9																			20	20	20	16
12.0～13.9																					22	16
14.0～25.0																						16
25.1～28.0							25															16
28.1～32.0																			24	23	20	16
32.1～38.0															24	23	22	21	20	19	18	16
38.1～45.0												24	23	23	20	19	19	18	17	16	16	16
45.1～50.0										23	22	21	20	20	18	17	16	16	15	14	14	14
50.1～55.0							24	24	21	21	20	19	18	18	16	16	15	14	14	13	13	13
55.1～60.0							24	22	21	19	19	17	16	16	15	14	13	13	12	12	12	11
60.1～65.0					24	23	21	20	18	18	17	16	15	15	14	13	12	12	11	11	10	9.5
65.1～70.0				24	24	22	21	19	18	17	16	15	14	14	13	12	12	11	11	10	10	9.5
70.1～75.0	24	23	24	23	21	20	18	17	15	15	15	14	13	13	12	11	11	10	10	9.2	9	8.5
75.1～80.0	23	23	22	21	21	19	18	17	15	14	14	13	12	12	11	11	10	10	9.6	9.2	9	8.5
80.1～90.0	20	20	20	19	19	17	16	15	14	13	12	11	11	10	10	9.7	9.2	8.8	8.5	8.2	8	7.5
90.1～100.0	18	18	18	17	17	15	14	13	12	11	11	10	10	9.6	9.1	8.7	8.3	8	7.6	7.3		
100.1～110.0	16	16	16	16	15	14	13	12	11	10	10	9.7	9.1	9	8.3	8	7.6	7.2	7	6.7 / 5.8		
110.1～120.0	15	15	15	14	14	13	12	11	10	10	9.4	8.8	8.4	8	7.6	7.2	6.9 / 6.0	6.6 / 5.8	6	6		
120.1～130.0	14	14	14	13	13	12	11	10	9.8	9.2	8.6	8.2	7.7	7.3	7.0	6.7 / 5.8	6	6	5.1	5.3		
130.1～140.0	13	13	13	12	12	11	10	9.7	9	8.5	8	7.5	7.1	7	6	6	5.1	5.1	5.1	5.3		
140.1～150.0	12	12	12	11	11	10	9.7	9.1	8.4	7.9	7.4	7	6.7 / 5.8	6	6	5	5	5				
150.1～160.0	11	11	11	10	10	9.9	9.1	8.5	7.9	7.4	7.0 / 6.0	6.6 / 5.7	6	6	5	5						
160.1～170.0	10	10	10	10	10	9.3	8.6	8	7.4	6.7 / 6.0	6.6 / 5.7	6	5.1	5	5	4.4						
170.1～180.0	10	10	10	9	9.4	8.8	8.1	7.6	7.1	6.6 / 5.8	6.2	5.1	5	5	4.4				Not available			
180.1～190.0	9	9	9	9	8.9	8.3	7.7	7.1	6.7 / 5.8	5.4	5.1	4.8	4.5	4.3								
190.1～200.0	9	8.2	8.2	8	8.5	7.9	7.3	6.8 / 5.9	5.5	5.1	4.8	4.6	4.3	4.1								

1. In case of the diagonal-lined column (A/B), "A" shows the maximum product length.
   And the product length between "B" and 6.1m can not be provided.
2. The minimum product size is as follows: 1m wide and 3m long.
3. Please consult with JFE prior to ordering the product width between 5,201 and 5,350mm.
4. 30m length for limited thickness and width is available. Please consult with us.
5. For normalized steel, please consult with JFE Steel.

Cat.No.C1E-011-02

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