STEEL PLATES FOR SHIPBUILDING

JFE Steel Corporation
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<sup>TM</sup>) at Fukuyama Plate Mill in 1980, the first in the world. This device was replaced by the state-of-the-art Super-OLAC<sup>TM</sup> in 1998. Thus JFE has been leading company of TMCP technology.

“OLAC”, “Super-OLAC”, “ARRESTEX”, “SAFEED”, “SIP”, “EWEL” are registered trademarks of JFE Steel Corporation in Japan.
**JFE’s Advanced Technology**

**JFE’s leading TMCP technology**

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**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%.

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**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.
**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™

![Image of container ship and location](https://via.placeholder.com/150)

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

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

**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

**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

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

- 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.
**JFE-EWEL™**

Excellent HAZ toughness under high heat input welding.

**Super-OLAC™**

- Technology for controlling HAZ grain size
- Improvement of toughness of HAZ matrix
- Technology for controlling HAZ microstructure

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**

Various thickness profiles of LP plates

- Uni-directional LP plate (LP1)
- Uni-directional LP plate with isometric portion (LP2)
- Bi-directional LP plate (LP3)
- Bi-directional LP plate with isometric portion (LP4)
- Uni-directional 2-step LP plate (LP7)
- Uni-directional 2-step LP plate with isometric portion (LP8)

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.

- Designed thickness
- Weight increase
- Seam weld
  - Conventional
  - LP plate
    - Proper thickness
    - Weight reduction
    - Joint number reduction
  - Weight increase

Upperdeck
Transbulk-head
Cargo Hold
Bottom Plate
Tank Top

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8
Approval is obtained from major classification societies up to the thickness listed below.

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Class</th>
<th>NK</th>
<th>ABS</th>
<th>LR</th>
<th>DNVGL</th>
<th>BV</th>
<th>KR</th>
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*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

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<tr>
<th>Grade</th>
<th>Class</th>
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*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

<table>
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<th>Class</th>
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<tr>
<td>ABS</td>
<td>V039, V051, V060, VH039, VH051, VH060</td>
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<tr>
<td>DNVGL</td>
<td>VL2-2, 2-3, 2-4, 2-4L, VL4-2, 4-3, 4-4, 4-4L</td>
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</table>

*1: Please contact us about approved thickness range.
**Available sizes**

**Without Heat Treatment**

| Width (mm) | 1000 | 1401 | 1601 | 1801 | 2001 | 2201 | 2401 | 2601 | 2801 | 3001 | 3201 | 3401 | 3601 | 3801 | 4001 | 4201 | 4401 | 4601 | 4801 | 5001 | 5201 | 5301 | 5350 |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Thickness (mm) | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 | 11000 | 12000 | 13000 | 14000 | 15000 | 16000 | 17000 | 18000 | 19000 | 20000 | 21000 | 22000 | 23000 | 24000 |
| 6.0~6.9 | 22 | 22 | 22 | 19 | 16 | 13.5 | 13.5 | | | | | | | | | | | | | | | |
| 7.0~9.0 | 20 | 20 | 20 | 16 | 13.5 | 13.5 | | | | | | | | | | | | | | | | |
| 9.1~11.9 | 20 | 20 | 20 | 16 | 13.5 | 13.5 | | | | | | | | | | | | | | | | |
| 12.0~13.9 | 22 | 16 | | | | | | | | | | | | | | | | | | | |
| 14.0~25.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 25.1~28.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 28.1~32.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 32.1~38.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 38.1~45.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 45.1~50.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 50.1~55.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 55.1~60.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 60.1~65.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 65.1~70.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 70.1~75.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 75.1~80.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 80.1~90.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 90.1~100.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 100.1~110.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 110.1~120.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 120.1~130.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 130.1~140.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 140.1~150.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 150.1~160.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 160.1~170.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 170.1~180.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 180.1~190.0 | 16 | | | | | | | | | | | | | | | | | | | | |
| 190.1~200.0 | 16 | | | | | | | | | | | | | | | | | | | | |

1. In case of the diagonal-lined column, "A" shows the maximum product length. And the product length between "B" and 6.1m cannot 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.