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The advantages in ship-owner expected
A ship is an important asset to its owner. The application of NSafe-Hull can minimize the spread of damage and loss caused by an unexpected collision and thereby mitigates a ship owner’s burden attributable to a collision. Major advantages in ship-owners offered by the use of NSafe-Hull are:

1. Greater reduction of damages caused by accidents by high ductility of the steels
2. Shipbuilding operations identical to those of conventional steels due to chemical composition design for high weldability
3. Profitable resale of ship as a vessel of high added value
4. Corporate social responsibility contributes to environmental preservation

NSafe-Hull has already been applied in the world’s first shipbuilding application. It has been adopted by 12 vessels so far, and the shipment volume exceeds 20,000 tons. Collision simulations to confirm the applied effects of NSafe-Hull were carried out at the National Maritime Research Institute, Japan, which is the world-renowned centre for its analysis technologies.

Many ships have already adopted
High performance is confirmed by ship collision simulation.

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Application Records of NSafe-Hull

Ship name: Orange Phoenix
Completion: Oct. 2014
Length: 299.94 m
Breadth: 50 m
Dead weight: 206,600 DWT

Nearly tripling the capacity of a ship to absorb collision energy and nearly doubling the critical striking ship speed for penetration* over conventional steel plates. NSafe-Hull steel plates have been developed by novel concepts and advanced technologies unique to NIPPON STEEL.

NSafe-Hull is a highly ductile steel plates in which the ductility has been improved by the optimum use of NIPPON STEEL’s original chemical composition design and crystaline size-order microstructural control. When an impact force is applied to a ship, it is absorbed by denting of the plates themselves. In the NSafe-Hull, the capacity to absorb collision energy has been improved three times over that of conventional plates. The critical striking ship speed is twice that of conventional plates as well. Consequently the high ductility offered by NSafe-Hull can increase the period in which cracks and ruptures occur in.

For example, even if a crude oil tanker is in an accident, NSafe-Hull can prevent the oil spill into the sea. NSafe-Hull contributes toward safer and securer marine transport of tankers, cargo ships and other types of ships.

*Critical striking ship speed: The maximum speed at which penetration does not occur after collision
Highly ductile steel plates developed by original chemical composition design

**NSafe-Hull**

Study on ship collision has led to the development of NSafe-Hull, a new plate that is suitable for a wider range of applications, including cargo hold hull and fuel oil tanks. NSafe-Hull’s high ductility is achieved by the original chemical composition design and crystaline size-order microstructural control. Its workability (shearing, bending, welding and painting) is identical to those of conventional steels. The safety and security only NSafe-Hull provides is now available to users.

**NSGP™-1**

Pitting corrosion occurring in bottom plate sections of crude oil tanks can be reduced by using NSGP™ (NIPPON STEEL Green Protect)-1 steel. If this steel is applied in an unpainted state, shipbuilding and maintenance costs can be reduced.

**NSGP™-2**

Corrosion occurring on ceiling parts of crude oil tanks can be reduced by using NSPG (NIPPON STEEL Green Protect)-2 steel. If this steel is applied in an unpainted state, shipbuilding and maintenance costs can be reduced.

**NSGP™-3**

Coming soon on the market

**NSafef-Hull**

Enhancing Ship Collision Safety while Maintaining Conventional Hull Structural Design and Shipbuilding Productivity

NIPPON STEEL Values Applicability of NSafe-Hull to a Wide Variety of Ships.

In the field of medium and heavy steel plates for shipbuilding, NIPPON STEEL offers diverse kinds of high-performance steel plates in addition to conventional plates. NSafe-Hull, among others, is the most-advanced shipbuilding plate. You only need replacing conventional plates with NSafe-Hull to enhance ship collision safety – This is NIPPON STEEL’s way starting at the research and development stage.

Because there are no changes in ship design and manufacturing technologies, NSafe-Hull can be applied in a wider range of shipbuilding. High quality Made-in-Japan steel plates can be applied with no considerable cost increase. Their applications will differentiate lead your precious products from others built by conventional shipbuilders.

**TMCP Steels**

With TMCP (thermomechanical control process) technology, steel with a lower carbon equivalent and higher strength can be produced compared to conventional steels. TMCP steels offer high strength, toughness and high weldability. They can be fabricated with large heat-input welding. They can therefore contribute to improved shipbuilding efficiency. Applications: Steel plates for extra ship hull structures

**High arrest tool (YP47 km steel)**

YP47 km steel is a steel material compatible with arrestability (toughness) and strength, in response to the enlargement of container ships. Even when brittle cracks occur in the hull, it is possible to stop the cracks and to realize the safety of the ship at a higher level.

**FCA™ Steels**

FCA (fatigue crack arrester) steels have improved fatigue strength in weld joints. If by any chance a fatigue crack occurs, the steel can reduce the propagation rate. Applications: Longitudinal sections (frames for double-wall bottom), hutch corner sections

**S-TEN™**

Sulfuric Acid and Hydrochloric Acid Dew-point

Corrosion-resistant Steel

S-TEN exhibits the best resistance to sulfuric acid and hydrochloric acid dew-point corrosion found in the flue-gas treatment equipment used with coal-fired boilers, waste incineration plants, etc.

**Marilloy™**

Oil Sludge-Water resistant and Seawater Corrosion-resistant Steel Pipe

Marilloy steel pipe exhibits high corrosion resistance in offshore applications, and is used for the cargo oil pipe through which oil runs into the inboard tanks of a tanker and for the water ballast pipe through which seawater runs.

**Safety Bow**

This plate has a large deformation capacity upon collision and can reduce damage to a struck ship through high collision safety. Application: Bulbous bows

**NSGP™-2**

Corrosion occurring on ceiling parts of crude oil tanks can be reduced by using NSPG (NIPPON STEEL Green Protect)-2 steel. If this steel is applied in an unpainted state, shipbuilding and maintenance costs can be reduced.
The performances of NSafe-Hull have been proved at the National Maritime Research Institute, Japan, which is known as the world-renowned centre for its ship collision analysis technologies.

NSafe-Hull is the Made-in-Japan product that was developed in an integrated process extending from R&D to production and is based on the sublime concept that hull ruptures should not occur even in a collision. The application of NSafe-Hull will prove the high structural reliability and safety of ships and will certainly improve the overall reputation of ships.

We are confident to say that ship design with NSafe-Hull will become the worldwide de facto standard in shipbuilding.

### Penetrating rupture-free performance even in a 12-knot collision

**NSafe-Hull**

The stated performance of NSafe-Hull has been proved by collision simulations at the National Maritime Research Institute, Japan. The simulation results demonstrate that the penetration does not occur in the inner hull of double-hull structure of a crude oil tanker employing NSafe-Hull in the case of the maximum strike speed of 12 knots. In the case of the bulk carrier with NSafe-Hull, simulation results confirmed that the penetration does not occur in the single hull structure at the maximum speed of 5 knots. NSafe-Hull is assessed to be a shipbuilding steel plate that can prevent oil spill that might otherwise cause huge environmental damages, as well as massive cargo discharge and even human injury. NSafe-Hull leads another evolutionary step in the enhancement of maritime safety.

### Expected Advantages of Highly Ductile Steel Plate (NSafe-Hull) as Structural Members

<table>
<thead>
<tr>
<th>Application section</th>
<th>Members</th>
<th>Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo hold single hull sections</td>
<td>Side shell plating, Hold frames, Side longitudinal frames</td>
<td>Prevention of flooded cargo holds, Protection of cargo, Prevention of penetration by loading machine grab impacts!</td>
</tr>
<tr>
<td>Fuel oil tanks (top-side tank sections)</td>
<td>Side shell plating, Top-side tank bottom platings, Fuel oil tank longitudinal bulkheads, Longitudinal stiffeners</td>
<td>Prevention of oil spill, Prevention of penetration by loading machine grab impacts!</td>
</tr>
<tr>
<td>Fuel oil tanks (engine room)</td>
<td>Side shell plating, Fuel tank longitudinal bulkheads</td>
<td>Prevention of oil spill</td>
</tr>
</tbody>
</table>

### Absorbed Energy by Struck Ship, Normalised

Approximately 3 times

### Critical Striking Ship Speed for Penetration, Normalised

Approximately 2 times

*Figures: Schematic images of simulation results.*