In responding to environmental problems, particularly in the steel division, JFE is reducing environmental loads by developing advanced technologies and implementing voluntary programs for energy conservation, air and water protection, and chemical substance control.
Global warming requires a long-term solution involving every individual and business. JFE Steel already boasts the world’s highest energy efficiency, but it has also set a high target for global warming prevention measures under the Voluntary Action of the Japan Iron and Steel Federation.

Voluntary Action Plan by Nippon Keidanren (Japan Business Federation)

In anticipation of the Kyoto Protocol, Nippon Keidanren established a Voluntary Environmental Action Plan in July 1997, targeting voluntarily CO₂ reductions in the industrial and energy conversion sectors to 1990 levels by 2010. Under Japan’s Guidelines for Measures to Prevent Global Warming, results are reviewed annually in the Industrial Structure Council. In 2001, CO₂ emissions showed a 3.2% reduction from the 1990 baseline. Recognizing this achievement, a third party assessment report for 2002 praised participating businesses for “doing everything in their power, in the face of various difficult circumstances.”

Voluntary Action Program for Environmental Protection by Japanese Steelmakers

One distinctive feature of Japan’s steel industry, in comparison with the U.S. and Europe, is remarkably wide adoption of energy-saving equipment, giving Japanese mills the world’s highest energy efficiency. Reflecting Japan’s technical capabilities, in December 1996, the Japan Iron and Steel Federation established a Voluntary Action Plan, which targets a 10% reduction in energy consumption in 2010 against a 1990 baseline. As a supplementary goal, a 1.5% reduction by using waste plastic in blast furnaces (assuming creation of an adequate collection system) was later incorporated in the Plan. In 2001, energy consumption was 8.5% below the 1990 baseline, demonstrating the success of voluntary action.

Environmental Contribution of LCA-based Products

JFE is contributing to energy conservation by developing high-performance steel products which reduce both material consumption in the manufacturing process and final product weight. An LCA assessment of six high-performance steel products estimated that CO₂ emissions can be reduced by 3.1 million tons in manufacturing and 6.5 million tons in use, for a total of 9.6 million tons-CO₂, by adopting high-performance products (estimate for FY2000, entire Japanese steel industry).

Effect of reducing CO₂ emissions in view of LCA through using highly functional steel products

Product types surveyed are:
- High-performance steel plate for shipbuilding.
- Heat-resistant steel tubes for boilers.
- High-strength steel sheet for auto bodies.
- High-tensile steel plate for shipbuilding.
- Electrical steel sheet for transformers.
- Stainless steel sheet for railway carriages.

Terminology

Petajoule, joule (heat unit) x 10¹⁵ (1000 trillion), LCA (Life Cycle Assessment), CO₂ emissions originating from energy consumption.

Reducing Environmental Loads in Business Operations

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**Reducing Environmental Loads in Business Operations**

Terminology

- PJ: Petajoule, joule (heat unit) x 10¹⁵ (1000 trillion)
- LCA: Life Cycle Assessment, Method of assessing the total environmental load (resource depletion, energy consumption, waste, pollutants, etc.) over the entire product life cycle from raw material extraction through manufacture, use, recycling, and waste.
Slag Reduction and Recycling

Slag generated by blast furnaces, BOFs, and electric furnaces accounts for about 80% of steel manufacturing byproducts. JFE Steel has a long record of reducing steel slag by applying hot metal pretreatment and on-site reuse. Thanks to JFE’s efforts to develop product manufacturing and use technologies and encourage standardization under the Japan Industrial Standard (JIS), more than 99% of slag is now effectively used as roadbed material, aggregate for concrete, material for cement, etc. Cement using BF slag powder also contributes to energy saving and CO₂ reduction.

Development of Advanced New Applications for Slag (Example)

- **Use of slag to restore shoreline environments**
  1. Use of BF slag as sand capping material/shallows construction material for improvement of the marine environment
  2. Artificial reefs (Marine Block) for seaweed/fish farming using CO₂-absorbed slag solids
  3. Breakwater blocks and other marine structures using hydration hardening reaction (Ferro-Form)

- **Heat Island-Mitigating Paving Material**
  The heat-island effect can be mitigated by using a water-retaining solid composed mainly of fine BF slag in asphalt pavement. The pavement retains water in rainy weather and is cooled by evaporation in good weather, reducing the pavement temperature.

- **Slow-release Potassium Silicate Fertilizer**
  Slag fertilizer is released slowly into soil over long periods of time. It enriches soil with potassium and silica for slow-release nutrition of plants.

JFE has implemented a program of “Zero-Waste” activities for steelworks byproducts, which include slag, dust, sludge, waste oil, etc., and has already achieved 99.5% recycling. Landfill disposal has decreased to about 1.6% of 1990 levels, meeting the Japan Iron and Steel Federation target of 1/5 the 1990 level by 2010. (This result includes a 10,000 ton increase in surplus dust in 2002 due to a downturn in cement production.) Future measures will include on-site recycling equipment. The synergy of outstanding environmental and energy technologies, plant operation know-how, and steelworks infrastructure is contributing to effective recycling of waste from local community and other industries, beginning with waste plastic.

**Water Recirculation**

Because steel manufacturing requires huge quantities of water, JFE has created a comprehensive water recycling system. Purification technologies include advanced biological and physicochemical processes. Off-site release is minimized by recirculation and cascade techniques, achieving a water circulation ratio of approximately 95%. Circulation ratio (%) = (Total consumption – makeup water) / Total consumption.

**JFE’s Environmental Report 2003**
Building a Recycling-oriented Society

The transformation from a mass-production, mass-consumption, mass-waste society to a recycling-oriented society is causing a revolution in the basic paradigm of manufacturing. JFE is actively responding to the challenge of effective resource use, including the creation of new business to meet new social needs.

Zero Waste Activities in the Steelworks

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Waste Plastic Recycling

JFE entered the waste plastic recycling business in October 1996 and now has a treatment capacity of 190,000 tons/year.

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### Air Quality

**SOx**

To reduce emissions of sulfur oxides (SOx), JFE has adopted low-S fuels and introduced the world’s first high-efficiency ammonia-sulfate flue gas desulfurization system. After addition of another de-S system in 2002, JFE reduced SOx emissions to 1/7 the 1973 level.

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JFE has implemented thoroughgoing water recycling measures, achieving a recirculation rate of approximately 95%. Before discharge, wastewater containing organic matter is given biological treatment, and is then purified as required by coagulating sedimentation, filtration, adsorption with activated carbon (ammonia liquor), etc. to remove pollutants.

### Soil Quality

JFE has adopted measures to prevent releases of hazardous substances into the soil and checks soil and groundwater to prevent pollution. To protect the soil and groundwater environment, the company fully complies with the Soil Contamination Control Law enacted in February 2003.

### Terminology

**COD**

Chemical Oxygen Demand. Index of water pollution, expressing the amount of oxygen necessary to chemically oxidize and stabilize pollutants in water.

### Control of Chemical Substances

**PRTR**

Japan’s PRTR (Pollutant Release and Transfer Register) Law was enacted in March 2000. At the time, JFE was already participating in voluntary surveys by the steel industry as part of its commitment to controlling and reducing releases of chemical substances.

### Substances reported under PRTR (FY2002, JFE steel division)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Releases</th>
<th>Air</th>
<th>Public waters</th>
<th>Soil on-site</th>
<th>Landfill ash</th>
<th>Off-site</th>
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</table>

### Benzene and Other Volatile Organic Compounds

Beginning in 2001, the steel industry adopted a second stage voluntary control plan for atmospheric releases of benzene and other volatile organic compounds, continuing from its first stage plan (FY1997-99), with the aim of achieving further reductions. JFE set a target of reducing benzene releases by 80% from the 1999 baseline by 2003 through company-wide improvement activities, and had achieved a 70% reduction by 2002. JFE is also reducing releases of tetrachloroethylene and dichloromethane. In addition to voluntary controls by industry unit, it is also participating in a new voluntary control plan for benzene by regional unit, which began in 2001, and is working to reduce benzene releases in cooperation with neighboring businesses in other industries.

### Dioxins

The Law concerning Special Measures against Dioxins implemented in January 2000 set standard values for steelworks facilities (sintering furnaces, electric furnaces, and incinerators) effective December 2002. JFE satisfied the standard values for all regulated steelworks facilities in 2000, well in advance of the effective date, but is implementing additional voluntary measures to further reduce dioxin releases.

### Reference

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Protecting the Environment

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Air Quality

SOx

To reduce emissions of sulfur oxides (SOx), JFE has adopted low-S fuels and introduced the world’s first high-efficiency ammonium-sulfate flue gas desulfurization system. After addition of another de-S system in 2002, JFE reduced SOx emissions to 1/7 the 1973 level.

NOx

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Dust

Sprinkling in ore and coal yards, sealed conveyor connections, and other measures prevent dust generation. At coke ovens, sintering furnaces, blast furnaces, BOFs, and other dust-generated facilities, high-performance dust collectors minimize airborne dust.

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Soil Quality

JFE has adopted measures to prevent releases of hazardous substances into the soil and checks soil and groundwater to prevent pollution. To protect the soil and groundwater environment, the company fully complies with the Soil Contamination Control Law enacted in February 2003.

Control of Chemical Substances

PRTR

Japan’s PRTR (Pollutant Release and Transfer Register) Law was enacted in March 2000. At the time, JFE was already participating in voluntary surveys by the steel industry as part of its commitment to controlling and reducing releases of chemical substances.

Substances reported under PRTR (FY2002, JFE steel division)

<table>
<thead>
<tr>
<th>Substance</th>
<th>Releases (106Nm3/year)</th>
<th>JFE (1999 = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOx</td>
<td>Air</td>
<td>Public waters</td>
</tr>
<tr>
<td>NOx</td>
<td>Air</td>
<td>Public waters</td>
</tr>
<tr>
<td>COD</td>
<td>Index</td>
<td></td>
</tr>
</tbody>
</table>

Benzene and Other Volatile Organic Compounds

Beginning in 2001, the steel industry adopted a second stage voluntary control plan for atmospheric releases of benzene and other volatile organic compounds, continuing from its first stage plan (FY1997-99), with the aim of achieving further reductions. JFE set a target of reducing benzene releases by 80% from the 1999 baseline by 2003 through company-wide improvement activities, and had achieved a 70% reduction by 2002. JFE is also reducing releases of tetrachloroethene and dichloromethane. In addition to voluntary controls by industry unit, it is also participating in a new voluntary control plan for benzene by regional unit, which began in 2001, and is working to reduce benzene releases in cooperation with neighboring businesses in other industries.

Dioxins

The Law concerning Special Measures against Dioxins implemented in January 2000 set standard values for steelworks facilities (sintering furnaces, electric furnaces, and incinerators) effective December 2002. JFE satisfied the standard values for all regulated steelworks facilities in 2000, well in advance of the effective date, but is implementing additional voluntary measures to further reduce dioxin releases.

Terminology

PRTR

Pollutant Release and Transfer Register. A system of reporting to the government the amounts of designated chemical substances released into the environment and transfers as wastes. Annual reporting of quantified amounts in the previous fiscal year is required, beginning in FY2002.
Improving Transportation

Distribution-related environmental impacts include CO₂, NOx, and SPM generated by fuel combustion during product transportation. Because these are all factors in global warming and/or air pollution, distribution is an important environmental issue at JFE Steel. JFE endeavors to reduce environmental load through well-considered selection of transportation modes, reduction in distance, improvements in load efficiency, and introduction of information technology ahead of the steel industry. JFE is responding to stricter regulations on SPM in metropolitan areas beginning in October 2003 with a modal shift.

Efficient On-site Transportation

Large on-site transportation vehicles such as the 100X U-frame vehicle, and 160x carrier can carry larger single-trip loads than conventional trucks, helping to reduce CO₂ emissions.

Innovative Marine Transportation

RORO Ship

RORO ships enable direct loading/unloading of pallet carriers and are used in scheduled service between JFE’s steelworks and major cities.

FERO Ship

Similar to ferries, FERO ships are designed to carry loaded trucks. Regular service across Tokyo Bay between JFE’s Chiba District and Negishi FERO base reduces truck traffic in the heavily-congested Tokyo area.

IT Applications and the Effect of the JFE Merger

Optimized Land Transportation Network (Cargo, Vehicle Request System)

This is a specialized, IT-based dispatching system for heavy overland cargos, making maximum use of JFE’s transportation and dispatching know-how for steel products and other heavy cargos. Optimum matching of cargo and vehicle information improves the vehicle operating rate and reduces the environmental impact of fuel consumption. JFE takes justified pride in this industry-leading open system.

Optimized Ship Operation Management (JFE Coastal Ship Control System)

An integrated system, for control of ship status and loading/unloading progress at JFE’s works, reduces deadheading and ensures more efficient coastal transportation by optimizing ship operation management.

Effect of the JFE Merger

To maximize transport lots and minimize distance, the selection of manufacturing plants and distribution relay bases was reviewed as part of the merger of NKK and Kawasaki Steel to create JFE.

Table: Viewpoint for improvement & Specific measures

<table>
<thead>
<tr>
<th>Viewpoint for improvement</th>
<th>Specific measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Selection of transportation mode</td>
<td>Selection of transportation mode</td>
</tr>
<tr>
<td>(2) Choice of larger vehicles, effective use of information, and joint use (more efficient transportation)</td>
<td>Use of larger transportation vehicles such as U-frame vehicles and carrier vehicles, direct transportation from mill-ends to berths for eliminating temporary storage (TPP), making land transportation more efficient by using IT and effective use of return trips</td>
</tr>
<tr>
<td>(3) Effective ship operation</td>
<td>Improvement of operating efficiencies of ships by using the coastal ship operation management system (JFE Coastal Ship Control System)</td>
</tr>
<tr>
<td>(4) Measures for coping with stricter exhaust gas regulations and lowering environmental impact</td>
<td>U-frame ships, use of vehicles with lower environmental impact, energy-saving operation of coastal ships in view of loading/unloading schedules, use of ship-bottom paints containing no hazardous substances, selection of routes at embarking sites</td>
</tr>
<tr>
<td>(5) Avoidance of truck transportation through urban central areas</td>
<td>Use of dedicated RORO ships in the Inland Sea, use of U-frame ships for coastal transportation in Tokyo Bay</td>
</tr>
<tr>
<td>(6) Reduction of materials</td>
<td>Use of long-life cushioning materials (conversion from rubber to felt), reduction of retaining timber (RORO ships, U-frame ships, FERO ships), reduction of wire and timber (promotion of hoop lashing), repeated use of retaining materials, simplification of packaging</td>
</tr>
</tbody>
</table>

Terminology

- **SPM**: Suspended Particulate Matter. Fine particles under 10 µm (1 µm = 1/1000mm) which remain suspended in the atmosphere for long periods and tend to accumulate in the lung and windpipe when inhaled.
- **Modal shift**: Shift in transportation modes from truck to rail or ship to improve transportation efficiency and reduce environmental loads.
Efficient On-site Transportation

Large on-site transportation vehicles such as the 100t U-frame vehicle and 160t carrier can carry larger single-trip loads than conventional trucks, helping to reduce CO₂ emissions.

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FERO Ship

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Reducing Environmental Loads in Business Operations

Optimized Land Transportation Network

(3) Effective ship operation

- Improvement of operating efficiencies of ships by using the coastal ship operation management system (JFE Coastal Ship Control System)
- Maximization of mixed loading of multiple products
- Joint transportation with other companies

(4) Measures for coping with stricter exhaust gas regulations and lowering environmental impact

- Utilization of dedicated RORO ships in the Inland Sea
- Use of FERO ships for coastal transportation in Tokyo Bay
- Energy-conserving operation of coastal ships in view of loading/unloading schedules
- Use of ship-bottom paints containing no hazardous substances
- Selective collection of waste at unloading sites

(5) Avoidance of truck transportation through urban central areas

- Use of dedicated RORO ships in the Inland Sea
- Use of FERO ships for coastal transportation in Tokyo Bay
- Avoidance of idling-stop operation
- Energy-conserving operation of coastal ships in view of loading/unloading schedules
- Use of ship-bottom paints containing no hazardous substances
- Selective collection of waste at unloading sites

(6) Reduction of materials

- Use of long-life cushioning materials (conversion from rubber to felt)
- Reduction of retaining timber (RORO ships, U-rack ships, FERO ships)
- Improved design and fitting (promotion of hoop lashing)
- Repeated use of retaining materials
- Simplification of packaging

IT Applications and the Effect of the JFE Merger

Optimized Ship Operation Management (JFE Coastal Ship Control System)

- An integrated system, control of ship status and loading/unloading progress at JFE’s works, reduces dead-heading and ensures more efficient coastal transportation by optimizing ship operation management.

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To maximize transport lots and minimize distance, the selection of manufacturing plants and distribution relay bases was reviewed as part of the merger of NKK and Kawasaki Steel to create JFE.

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