JFE Engineering†

Abstract:

JFE Engineering has been established as a result of a merger between NKK and Kawasaki Steel, both are the major manufacturing companies in Japan, on April 1, 2003. Its former organization was the engineering divisions of the both companies and their subsidiaries. Our company started a new step forward to serve our customers with the best solution available based on the leading technology in the industry to assist them in the current business environment that has been in constant progress and change on a global scale.

1. Introduction

JFE Engineering inherited a tradition of manufacturing based on leading technologies from NKK and Kawasaki Steel. JFE Engineering sets constant improvement of its technologies as company priority and will focus research and development resource to the expansion of businesses and the promotion of new businesses.

JFE Engineering intends to take full advantage of the merits benefited from the merger of NKK and Kawasaki Steel in order to actively extend its engineering business across the world through technology exchanges and procurement.

JFE Engineering already has the world's best technology in a number of fields such as energy supply/distribution engineering based on pipeline systems, environmental engineering including waste incineration and water treatment systems, steel plant engineering, structural engineering as bridges and frames, and heavy industrial machinery. JFE Engineering will also provide services specifically suited for each client by combining these technologies.

2. Organization

Aiming at efficient management in response to various products and market fields, JFE Engineering is organized in business divisions and centers. Specifically, JFE Engineering consists of 5 divisions (Energy Industries Engineering Div., Environmental Industries Engineering Div., Water and Waste Water Engineering Div., Steel Engineering Div., Steel Structure Engineering Div.) and 2 centers (Solution Engineering Center, Machinery Center). JFE Engineering has also established the JFE Engineering Research Center for technology development, and the Business/Project Planning & Marketing Dept. for promotion of new businesses.

Each division and center performs as an "independent company" in conjunction with functionally dedicated subsidiaries in JFE Engineering Group. Divisions' and centers' directors are named as the "company head" to implement cross-company management strategies and maximize consolidated profits. The organization of JFE Engineering and the related JFE Engineering Group are shown in **Fig.1**.

3. Businesses by Division/Center

3.1 Energy Industries Engineering Division

Our life and all manufacturing activities cannot exist without energy. Consumption of natural gas is continuously rising because of stability in supply, environmentally friendliness and high conversion efficiency. Efforts are being made for its application expansion and technology development for higher efficiency in use. JFE Engineering supplies integrated engineering services for natural gas from upstream treatment, LNG production, receiving and storage to disbursement, transportation, and use field. JFE Engineering supplies integrated engineering services for natural gas treatment, LNG storage and transmission and distribution pipelines, and for the use in a variety of fields. JFE will continue to contribute to clean and efficient use of natural gas. Furthermore, we will supply energy systems of next generation such as fuel cells, for more efficient energy use, energy cost reduction, and environmental preservation.

The main products of Energy Industries Engineering Div. are as follows:

(1) Pipeline Systems (Oil pipelines, Gas transmis-

†Originally published in *JFE GIHO* No.1 (Jun. 2003), p.24–31

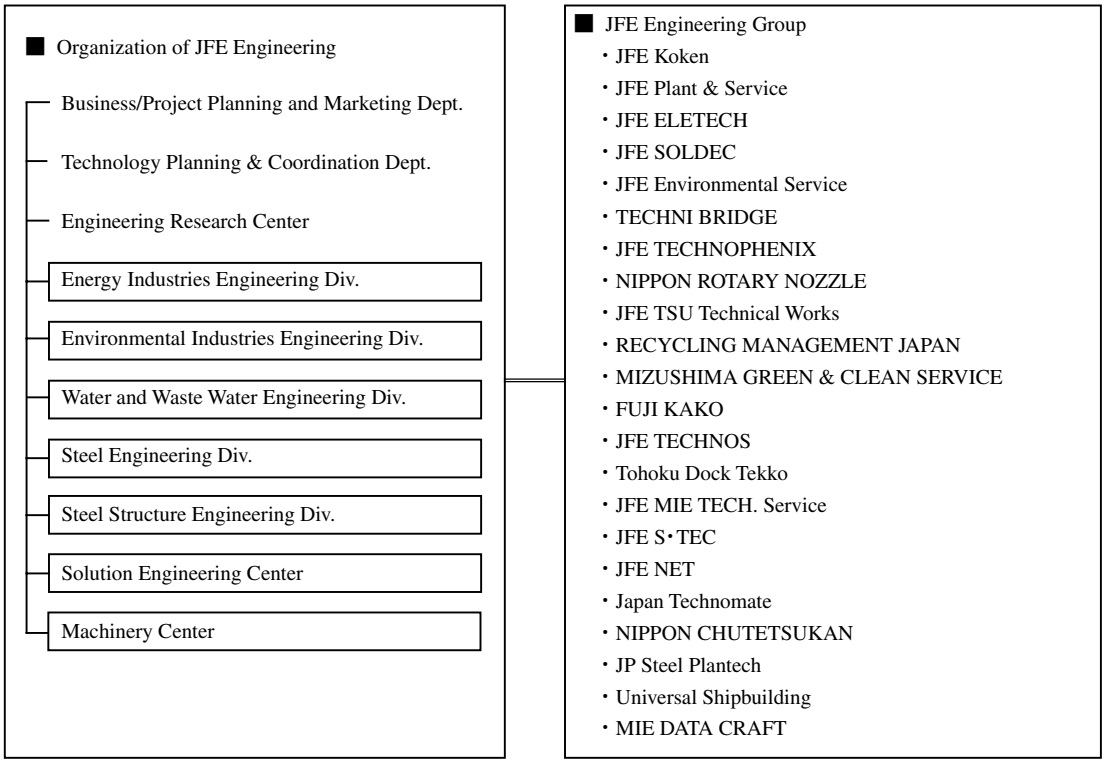


Fig. 1 Organization of JFE Engineering

sion and distribution pipelines, Submarine pipelines, SCADA (supervisory control and data acquisition) systems, Airport fuel supply facilities, shown in **Photo 1**)

(2) Storage Terminals (LNG storage facilities, LPG storage facilities, Oil and gas storage facilities, Nuclear plant related facilities, shown in **Photo 2**)

(3) Process Plants (Oil and gas production facilities, Chemical plants, Gas treatment facilities, shown in **Photo 3**)

(4) Energy Solution System (On-site energy supply systems, Regional heating and cooling systems, Co-generation systems)

(5) Offshore Facilities (Offshore structures, Platforms)

(6) Geothermal Energy System (Steam generation systems for geothermal power generation)

Photo 2 LNG receiving terminal

Photo 1 Natural gas pipeline

Photo 3 Natural gas production and treatment facilities

(7) Inspection and Maintenance Services (Pipeline inspection services, IT maintenance services, Steel structure inspection and maintenance services, Rotating equipment maintenance services)

3.2 Environmental Industries Engineering Division

To create a recycling and zero-emission society is a worldwide target not only for Japan. JFE Engineering develops businesses whose most important goal is to realize a well-balanced combination of safe treatment, recycling of materials and energy and reduced costs, and has a long record of successful environmental projects in diverse fields including waste incinerators, gasification and melting furnace technology, ash melting furnaces and recycling plants. Based on its achievements to date, it is JFE Engineering's policy for the future to develop more advanced versions of existing technologies and new Only 1 and No. 1 technologies which incorporate recycling, and to actively propose new products and new systems.

The main products of Environmental Industries Div. are as follows:

(1) Waste Incinerator (**Photo 4**)
- Stoker type incinerator (Hyper 21 Stoker System)
- Fluidized bed incinerator
- Kiln type incinerator

(2) Ash Melting Furnace
- Electric resistance type ash melting furnace
- Plasma type ash melting furnace

(3) Ash Treatment System (Hi-Clean DX System)
(4) High Temperature Gasification & Direct Melting Furnace
(5) Thermoselect Process (Gasification & Melting Furnace)
(6) Carbonizer
(7) High Efficiency Waste to Energy system/Heat Utilization System
(8) Refuse Derived Fuel (RDF) System
(9) Bulky Waste Treatment System
(10) Home Electronics Appliance Recycling System
(11) Composting System
(12) Waste Sorting and Recovery System
- Bag breaker system
- Air-classifier/ballistic-separator
- Glass bottle color sorting system

(13) Waste Plastic Recycling System (Waste plastic injection system for blast furnace)
(14) Remediation for Land Fill Site
(15) Biomass Power Generation System
(16) Methane Fermentation System

3.3 Water and Waste Water Engineering Division

With the continuing growth of civilization, pollution of rivers, lakes, marshes and oceans has become an increasingly serious problem on a global scale, and clean streams and beautiful marine environments are constantly being lost. To recover this natural heritage, comprehensive technologies and measures which are capable of reliably purifying and effectively circulating used water are needed. Because JFE Engineering is making efforts to solve environmental problems on a company-wide basis, it is the company's policy to provide advanced systems in a wide range of fields including systems for supplying safe, good-tasting drinking water, sewerage treatment and sludge treatment systems, raw sewage/seepage (leaching) treatment, river, lake, and marsh purification, and others using its accumulated technical development results and know-hows in connection with water.

The main products of Water and Waste Water Engineering Div. are as follows:

(1) Water Pipeline (Water piping, Water pipeline bridges, Steel pipe driving technologies, Steel service reservoirs, Elevated water tanks, Emergency water storage tanks, Piping renewal work)
(2) Water Work Plants (Sedimentation ponds, Filtration ponds, Activated carbon adsorption system, Biological membrane treatment system, Formed hypo chlorite system, Membrane treatment system, shown in **Photo 5**)

Photo 4 Hirano Waste to Energy Plant, Osaka City

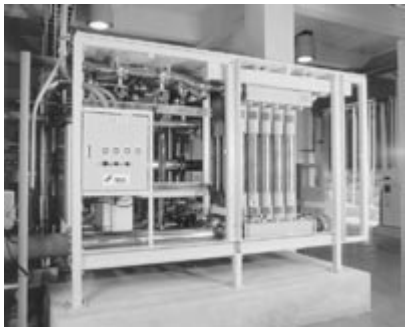


Photo 5 Drinking water supply system using membrance treatment

Photo 6 Egg-shaped digestion system for sewerage sludge

(3) Sewerage Treatment (Rain water/combined sewerage treatment system, System for sewerage treatment machines, Advanced treatment facilities, Submerged propeller OD (oxdation ditch) system)
(4) Sludge Treatment (Concentrators, Digesters, Digestion gas generation system, Incineration system, Sludge recycling system, shown in **Photo 6**)
(5) Night Soil/Seepage Treatment (Sludge regeneration treatment facilities, landfill waste water treatment system)
(6) River Purification/Pig Waste Treatment (River purification systems, Compost systems, Bigadan methane fermentation system)

3.4 Steel Engineering Division

This division was created by merging the Steel Engineering and Consulting Div. of NKK and Steel Plant Engineering Div. of Kawasaki Steel and serves as Steel Plant Engineering Div. for the JFE Group as a whole. Based on the world top-class steel plant technologies which the steel manufacturing divisions of NKK and Kawasaki Steel cultivated in diverse steel-related fields over many years, the organization has developed a wide range of businesses from the supply of technical know-how and licensing to the supply of complete steel manufacturing plants and operational guidance. In the future as well, it will be the policy of the Steel Engineering Div. to supply the optimum steel engineering services to clients both inside and outside of Japan, and to provide strong support for the development of clients' steel businesses by making comprehensive use of the resources of the JFE Group.

The main products of Steel Engineering Div. are as follows:

(1) Ironmaking
- Blast furnace, Sintering plant, Coke oven
- Coke dry quenching (CDQ)
- Pulverized coal injection (PCI)
- Hybrid palletized sintering process (HPS/SSW)

(2) Steelmaking
- Hot metal pretreatment—Hot metal dephosphorization, Hot metal desulfurization technology
- BOF (Combined blowing technology/Refractories, etc.)
- Continuous casting technology
—Mold electromagnetic stirring technology, etc.
- Stainless steelmaking technology

(3) Rolling
- Hot rolling mill, Pickling line
- Cold rolling mill
- Long product (shape steel) rolling mills
- Continuous annealing line (CAL)
- Continuous galvanizing line (CGL)
- Electrolytic tinplating line (ETL)
- Billet continuous rolling technology (EBROS)

(4) Control Systems
- Steel plant-related control systems

(5) Environment/Energy Saving Technology
- Exhausted-gas treatment equipment (Desulfurization, Denitrification)
- Waste plastic injection technology into blast furnace
- Dust collecting/dust treatment technologies
- Blast furnace top gas pressure recovery turbine (TRT)
- Environment-friendly electric arc furnace (ECOARC)
- Regenerative burner

(6) General: Steel Works Construction Consulting
- Steel works project-making
- Operational and technical guidance
- Licensing

3.5 Steel Structure Engineering Division

Reduction of the construction cost and the life cycle cost (LCC) of public works are among the most significant issues for the creation of public infrastructure in Japan. In response to these needs, JFE Engineering proposes new construction methods and new types of steel structures not limited by conventional thinking, making comprehensive use of a deep understanding of steel materials cultivated over many years, and the development of element technologies for long and large bridges such as earthquake- and wind-resisting technologies, and advanced technical capabilities in design, manufacturing and installation. For example, in the field of steel and concrete composite structures, the company has developed numerous products which have earned a high evaluation, such as U-rib composite deck and hybrid bridges for joining a steel girder to RC piers (for bridges), hybrid caissons and pontoons (for port and harbor structures), and hybrid piers (for hydraulic gates).

As the company's policy for the future, JFE Engineering will contribute to the creation of social infrastructure by supplying new construction methods and new types of structures with outstanding economy,

Photo 7 Bridge over Suez Canal (Inclined drawbridge)

Photo 8 Wind power generating equipments (2 types; 750 kW, 2 000 kW)

taking advantage of the excellent properties of steel, based on a strong program of technical development.

The main products of Steel Structure Engineering Div. are as follows:

(1) Bridges and Bridge-Related Products (**Photo 7**)
- Highway bridges, Railway bridges, Pedestrian bridges, Pedestrian decks
- U-rib composite deck, Pre-beam bridge, Waveform steel plate web bridges, Others (Shield tunnel steel shell segments, Underground structures)

(2) Port and Harbor-related Products
- Quays, Wharves, Breakwaters (Hybrid caissons, Steel caissons, Jackets)
- Pontoons/connecting bridges (Hybrid pontoons, Steel pontoons)
- Bridge foundations (Steel shell caissons)
- Tunnels (Submerged tube tunnel, Shafts, Hybrid segments)
- Others (High rise steel fish shoals, Approach lights, Airport decks)

(3) Hydraulic Gates, Penstocks, and Related Products
- Flood control gates and sluice gates (Gates for rivers and dams, Hybrid piers)
- Penstocks (For general hydro power plants, pumping-up power plants)
- Movable bridges (Balanced drawbridges, gangway)
- Others (Hybrid piers flood prevention machinery, With drawal facilities treatment plants, Dam sand removal equipment)

(4) Architectural Steel Structure-Related Products
- Steel frames (inside/outside Japan), Steel towers, Steel stacks
- Steel *torii* gates, silos, beer tanks

3.6 Solution Engineering Center

JFE Engineering possesses diverse technologies in the engineering fields of energy, environment, water, steel plants, and steel structures. Based on these technologies, in 2001, the company began developing a solution business which supplies clients with solutions, particularly to market-inherent problems, amid the major transition as the age of cross business field, advanced information society, or IT age. The Center' s policy is to contribute to society by aiming consistently to "provide the optimum solution."

The main products of Solution Engineering Center are as follows:

(1) Eco-Power Generating Systems
JFE Engineering has delivered more than 120 environment-friendly wind power generators as the leading company in this field in Japan. (**Photo 8**)

(2) Material Handling and Logistics Systems
Based on a partnership relationship with customers, JFE Engineering provides total solutions from business planning to facility construction and operational support, and is also developing a customer support business.

(3) Parking Systems
JFE Engineering proposes all types of parking system from building self-drive type to mechanical type. In particular, high-performance, speed systems include the fork type Puzzle Tower and pallet-simultaneous-exchange underground parking garage, Super Dash.

(4) Soil Environmental Engineering
As engineering solutions for maintaining and creating sound soil and groundwater, JFE Engineering is promoting a wide-ranging support business from investigation and consulting to implementation of remediation and counter measures.

(5) Boilers and Turbines
JFE Engineering is promoting biomass power generation for utilization of this new energy resource, using the circulating fluidized bed (CFB) boiler, thus providing solutions which anticipate the needs of a recycling-based society.

(6) Special Structures
JFE Engineering provides steel structure engineering, taking advantage of the total potential of manufacturing fabrication and installation of steel structures.

(7) Regional Development

JFE Engineering contributes to environment-friendly urban development through planning, design, and execution of redevelopment projects for the sites of factories which have been closed as a result of corporate restructuring, etc.

(8) Marine Engineering

JFE Engineering supplies optimum solutions to a wide variety of engineering needs associated with human relationship with the sea, with key resources that include floating structures and technologies for offshore deep water areas, marine purification, etc.

3.7 Machinery Center

The Machinery Center, located in Tsurumi District, is a production base for machinery/machine structural products. Using core machine design technology and production technology developed over many years, the center produces heavy equipment products for a wide range of applications from the environmental engineering and water treatment fields to transportation machinery, construction machinery and power plants (engines) for ships. In particular, because transportation equipment, shield machines and ship power plants are among its core products, the center is actively developing new products which apply advanced technologies in each of these areas in anticipation of the needs of the times.

For example, in transportation equipment, the center supplies a seismic-isolation type container crane, incorporating an earthquake-resistant system developed independently by JFE Engineering, and a high efficiency automatic crane which meets the needs of automation. In the field of earth/sand transportation equipment, the company has developed environment-friendly, low dust, low noise conveyor equipment and is marketing this product for application in large-scale earth/sand transportation operations.

In shield machine, JFE Engineering has developed high reliability machines as required for various applications ranging from a 2 m diameter class to large scale machines with diameters exceeding 10 m. In new machine development, the company is developing machines which meet the needs of the times, such as long distance drilling, high speed execution, etc, and has a proven record of actual construction projects.

For marine engines, JFE Engineering developed a high reliability, high efficiency, high output medium speed diesel engine, and has supplied for numerous main engines, particularly for large-scale domestic ferries. In this field, the company is actively developing technologies which respond to environmental needs such as exhaust emission reduction technology and next-generation clean energy (DME: dimethylether).

Photo 9 Container cranes for Fukuoka Island City

In addition to development of existing products, Machinery Center is actively developing new, next-generation products based on a fusion of the design and production technologies owned by the center and leading-edge technologies such as IT.

For the future, the policy of Machinery Center is to contribute to building a more affluent, more pleasant society through manufacturing as the machinery production base of JFE Engineering.

The main products of Machinery Center are as follows:

(1) Engines (Marine diesel engines)

(2) Transportation Equipment (Container cranes, Earth/sand transportation equipment, shown in **Photo 9**)

(3) Shield Drilling Machines

(4) Other Heavy Industrial Equipment (Boiler, Water pipes, Turbines, etc.)

4. Engineering Research Center

The goal of JFE Engineering's Engineering Research Center is to develop comprehensive systems which respond to the needs of a recycling-based society in a wide range of fields, such as energy, environment, waterworks for city water and sewerage, steel-manufacturing related areas and steel structures, from the viewpoint of prevention of global warming, resource and energy saving and environmental preservation. The organization comprises a 4 laboratory system, consisting of Keihin District Energy Plant Systems Research Dept., Environmental Plant System Research Dept., Aqua Technology Research Dept. and Production Engineering Research Dept. in Tsu District.

The fundamental mission of Engineering Research Center is to improve business profitability through

Table 1 Examples of new product commercialized from in-house R&D

(1)	High temperature gasification and direct melting furnace for waste treatment
(2)	Bio-tube, advanced sewerage treatment system
(3)	Circulating fluidized bed (CFB) incinerator for sewerage sludge
(4)	Line pipe with high resistance to earthquake, "NK–HIPER"
(5)	Fully unmanned, high efficiency semi-shield tunneling system for very long tunnels "NTS1500"
(6)	High efficiency electric scrap melting furnace "ECOARC"
(7)	Continuous billet rolling equipment "EBORS"
(8)	Ship bow shape for low resistance to waves "Ax-Bow"
(9)	High efficiency ship hull manufacturing system "SBM"

research and development on new technologies. For core products which support the company's existing business, JFE Engineering seeks to maintain a position as "No. 1" technology by ceaseless technical innovation in close cooperation with business departments. At the same time, in order to create new growth businesses, the company carries out R&D under the keyword of "Only 1." It is important to note that Only 1 technologies are simply not those which are relatively superior to those of other companies; they must be preeminent and genuinely unique technologies. Researchers seek out profitable future markets with a global vision and, on this basis, positively develop innovative, original Only 1 technologies. **Table 1** shows examples of research and development result which have contributed to the improvement of profitability by R&D with a clarified market orientation.

In addition to hardware with these advanced technologies as its core, software technologies which supply solutions to the client will be indispensable for engineering business in the future. Therefore, JFE Engineering is putting great effort into the development of comprehensive solution-supply products for infrastructure such as urban energy supply, waste disposal and waterworks for city water and sewerage among other areas.

Energy Plant Systems Research Dept. is developing products built around innovative energy saving technologies. In particular, they include several products developed with funding from the national government: the hydrate slurry air conditioning system (**Photo 10**), which was developed independently by JFE Engineering, efficient cooling and heating technologies which utilize waste heat, and high efficiency production equipment for natural gas hydrate (HGH, **Photo 11**). The company is also developing software technologies which will become the core of solution technologies, and based on its successful results in the energy field, aims at growth into the field of urban infrastructure development as a whole.

Photo 10 Clathrate hydrate slurry

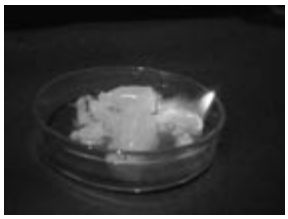


Photo 11 Natural gas hydrate

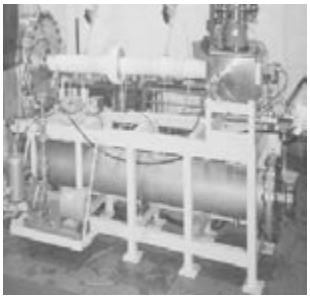


Photo 12 Test device for low cost hydrogen production system

Environmental Plant Systems Research Dept. carries out research and development with an aim of creating new business areas. In existing areas, the aim is to maximize the strength of current core businesses, centering on the environment, and to expand JFE Engineering's presence in these fields by taking advantage of the potential of global top technologies in a wide range of fields, centering on combustion and melting, thermal-liquid systems, chemical engineering and reactions, resources recovery and recycling, and mechanical systems. New areas include the development of a technology for low cost production of hydrogen using waste steam as an energy source (**Photo 12**) and a technology for reforming waste into gas fuel. As one field where the company plans to expand its presence, development of new energy recovery technology utilizing biomass is currently underway. Existing

Photo 13 Overview of facility

Photo 14 Gasification and melting furnace

Photo 15 Melted waste

businesses which the company intends to strengthen include in-house development of a next-generation stoker type waste treatment process, which incorporates high temperature air combustion control, a shaft type waste gasification and melting process (**Photos 13-15**) which is a fusion of blast furnace technology and fluidized bed technology, and an energy saving scrap melting process. At present, they are being actively used as commercial plants of environmental load reduction type.

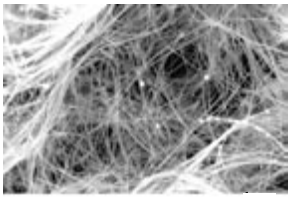
Aqua Technology Research Dept. promotes R&D and commercialization of technologies and systems in connection with pure water, sewerage and sludge treatment, water environment/hydrosphere purification, recycling of organic resources, water resource utilization and related fields in both the company's existing hydro engineering business and in new businesses based on water treatment technology (**Photo 16**), separation and bio technology (**Photo 17**), fluid technologies, and others. For example, to meet the needs of a recycling-based society, JFE Engineering is developing a biomass fermentation system for sewerage sludge, garbage and food wastes, and a phosphorus recovery system for sewerage and sludge. To provide a safe and pleasant water environment, the company is developing decomposition and separation technologies for toxic substances, heavy metals and environmental pollution components including both natural (environmental) water and waste water (effluents).

Photo 16 Tap water membrance filtration device

Photo 17 Carrier for microorganism solidification

Production Engineering Research Dept. carries out research and development aiming at maximizing the strength of core technologies and developing Only 1 products in cooperation with the respective business departments and centers over the wide range of basic technologies used in manufacturing in JFE Engineering, which include welding, nondestructive inspection and measurement, corrosion and corrosion resistance, and structures and strength. One successful effort in a new growth field, which was achieved on the basis of these fundamental technologies, is the development of a carbon nano tube (CNT) synthesis technology using arc discharge, measurement, and characterization techniques as the seed technologies. (**Photo 18**) The shape and high purity of the developed tape-shaped CNT make it a promising material for use as an electron discharge source in FPD (flat panel display), which has drawn a strong attention as a next-generation television. In addition to a mass-production synthesis technology for high purity CNT tape, JFE Engineering is also developing secondary processed products to meet customer needs. In another area, because the 21st century has already been called the "age of maintenance," JFE Engineering is developing optimum maintenance solution technologies for extending the life of ageing social infrastructure from

(a) Ultra-high purity CNT tape



(b) SEM micrograph of the surface

Photo 18 Carbon nano tube

the standpoint of life cycle cost.

JFE Engineering is mindful of the fact that timely information on these developments is also important. Recent press releases on key items include the following:

(1) Start of demonstration experiments for clathrate hydrate slurry production system[1)]
(2) Development of fine air bubble fluid types high efficiency NGH production technology[2)]
(3) Successful synthesis of tape-shaped substance from ultra-high purity CNT[3)]
(4) Development of new low cost hydrogen production technology using waste plastic and water vapor[4)]
(5) Development of methane fermentation technology utilizing co-generation waste heat[5)]

In all cases, the results of this new product- and new business-oriented research and development were crystallized in the form of an Only 1 technology. In order to smoothly develop Only 1 technologies into new products and businesses, JFE Engineering established New Business/Project Planning & Marketing Dept. This department promotes the entire process from the creation of new technologies for which future market needs are predicted to early commercialization, in a speedy manner through close cooperation among three divisions including Technical Administration Dept. which plans technical development for the company as a whole.

Only 1 technologies will provide the core for new growth fields. However, as the company cultivates new businesses built around these technologies, it is also essential to protect their technical superiority as intellectual property and to carry out strategic intellectual property activities to positively utilize this property. Pro-patent activities include strategic patent applications and the creation of an effective patent network as well as patent approval activities, which ensure that the rights of other companies are respected and are not infringed. These activities are carried out jointly with Intellectual Property Group in Technical Administration Dept. so that research and development results are effectively translated into profits.

In the future, JFE Engineering Research Center will continue to create attractive products and technologies in a timely and ongoing manner in order to develop new businesses for growth markets.

5. Summary

JFE Engineering will improve technologies through the concerted efforts of its Business Departments, Centers and Engineering Research Center, and will offer the best services suited for every client.

References (Examples of press release)

1) Nikkan Kogyo Shimbun. 2002-10-04.
2) Yomiuri Shimbun. Nihon Keizai Shimbun. 2002-12-13.
3) Nihon Keizi Shimbun. Nikkan Kogyo Shimbun. 2002-12-18.
4) Chemical Daily. 2002-12-27.
5) Nihon Keizai Shimbun. 2003-02-22.