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Nippon Steel Corporation

Integrated Mass Production of High-Strength X120-Grade Linepipe and Other High-Strength Grades with Combined Properties

Nippon Steel Corporation has now decided to make an investment for the integrated mass production setup for high-strength UO-pipe (large-diameter welded pipe) at the pipe mill of its Kimitsu Works. This investment will complete the integrated mass production setup for X120 ("X" is a strength symbol for line pipe of API 5L), a cutting-edge, high-value-added grade of linepipe, and other high-strength grades with combined properties. The first mass production setup of its kind worldwide will become operational, ahead of all other competitors, in March 2008.

1. Background to this investment decision

As world energy consumption continues to show an upward tendency, explorations for natural gas as a clean source of energy continue at a brisk pace, accompanied by a steady increase in demand for linepipe for gas transportation.

As the search for natural gas reserves is taken into ever more remote areas under increasingly exacting conditions (frigid regions, deep sea, etc.), linepipe is required to fulfill increasingly severe requirements and possess diverse combinations of properties. Correspondingly, in order to ease the rising burden of development costs, the need for drastic downsizing (the use of high-strength steel) has grown. Nippon Steel has already developed API 5L X100 and X120 grades (Note-1) (though the current mainstream of the market is X70 at most) and other high-strength grades with combined properties (low-temperature toughness (Note-2), high collapse resistance (Note-3), high ductility (Note-4), etc.), and, with the present capital investment, we are readying ourselves for full-scale commercial production.

2. Joint R&D project with ExxonMobil

Since 1996, Nippon Steel has carried out a joint R&D project with ExxonMobil for the development of X120-class high-strength linepipe, designed for substantial cost reduction in pipeline laying. In 2004, for a demonstration line (one-mile) in Canada, for the first time in the world, we made a delivery of this jointly developed X120 UO-pipe, which proved successful in laying and operation. After the clearing of various tests, and verification and confirmation of practicality, the joint X120 development project was completed in 2005. Relevant international standardization (API and ISO) has been undertaken jointly by Nippon Steel and ExxonMobil.

Many patent applications are filed under the development program both in Japan and overseas.

3. Outline of equipment measures

Making the most of our characteristic advantage of being an integrated steel producer and also of what we have long accumulated on the frontiers of steel technology in the world, we are going to complete our mass-production setup for UO-pipe with the world's highest strength level (X120) and featuring various combined properties. By process integration throughout, from the upstream processes of steel-making and plate-manufacture, which are investment programs now well under way, to the downstream processes of forming, welding, and quality assurance, into which our investment has now been decided.

(1) Upstream processes (the steel-making plant to the plate mill, Kimitsu Works)

Strategic capital investments already made in the upstream processes, namely, the No. 6 continuous caster to be started up at the steel-making plant in November this year, in combination with the next-generation type controlled-cooling process "CLC-μ" of the plate mill, which has been in operation since last year, and other improvements, are expected to ensure the manufacture of high-class plate representing the world's highest metallurgical level.

(2) Downstream processes (the 500,000t/y UO-pipe mill, Kimitsu Works) (the capital project now authorized)

- **Primary objectives of the investment:**
  - **① Introduction of a high-accuracy pipe-forming method, by establishing accurate forming techniques, using FEA (Note-5), to realize high quality and high dimensional accuracy in high-strength UO-pipe up to X120.**
  - **② Reinforcement of related equipment for the purpose of full-scale application of newly-developed welding material for high-strength steel with low-temperature toughness, and also for improving the quality of welds.**
  - **③ Introduction of an automatic size measurement device in response to the increasing use of automatic welding in pipeline construction and increasing numbers of deep-sea pipeline projects. This, in combination with the state-of-the-art ultrasonic flaw detector (UST) installed the year before last, will constitute the world's highest level quality-control and quality-assurance system for securing product safety.**
- **Investment amount: approx. ¥4 billion**
- **Schedule: Completion scheduled for January and start of mass-production in March 2008.**

4. Features and effects of our pipe products and a marketing outlook

- **X120 and other high-strength grades soon to be mass-produced are expected to contribute to a dramatic reduction in development costs, while satisfying the demanding safety standards set in consideration of the surrounding environment of sites of many large, long-haul pipelines being planned in various parts of the world in 2008 and subsequent years. (Many of them cover a distance of more than 1,000km, using more than 500,000 tons of steel; such as the West-East 2nd Phase Gas Pipeline in China, the Alaska Highway in North America, and several major projects in Russia.) Nippon Steel's endeavors from the early development stages to mass-production of high-strength pipe grades (up to X120) have been highly rated by the oil and gas majors and other energy-related industries worldwide.**
- **The present capital project, permitting mass-production of not only high-strength linepipe but also other pipe products with cutting-edge functions and combined properties (low-temperature toughness, high collapse resistance, etc.) for cold-region and deepwater offshore service. Our UO-pipe's promising applications include: offshore pipelines at depths of 2,000m and more in the Arctic region, Mediterranean Sea, etc., CNG carriers by new technology (Note-6), and other development projects in otherwise forbidding environments elsewhere in the world.**
- **Our UO-pipe thus embodying the leading-edge technology and being put on the market presently will provide solutions to varied requirements of customers in the energy field. Being a supplier of materials, we shall continue to aggressively propose and offer solutions to those associated with the development of sources of energy, for expansion of our high-end pipe business in this field.**

Note-1: X100, X120
The figures 100 and 120 express yield strength of steel pipe in units of ksi (kilo pound square inch) and respectively correspond to 760MPa and 915MPa and over, as converted into tensile strength. The higher figures are, the greater the guarantee a steel pipe provides against deformation under high internal pressure. This means that under the same internal pressure, wall thickness and weight of our UO-pipe can be reduced in the pipeline design, as compared with other commercially available linepipe. Or, with the same wall thickness, the use of our UO-pipe withstanding higher inner pressure assures greater efficiency in transportation (operational pressure).

Note-2: Low-temperature toughness
Toughness is an index of steel's quality of being strong but flexible and capable of withstanding impact. Whether any minuscule flaw in material should lead to breakage, or whether any breakage, once it occurs, should propagate over a long distance relates to the toughness of the steel. In particular, in cold regions (where steel is liable to brittleness), toughness is an indispensable property for natural-gas pipelines (high-pressure transportation).

Note-3: High collapse resistance
Collapse resistance is an index of strength to withstand external pressure. When the quest for oil and gas resources extends to deep areas of the oceans, linepipe is required to have high collapse resistance against enormous water pressures.

Note-4: High ductility
Ductility is the capability to withstand bending moment, and high ductility means that even in the event that pipe should become deformed, it is hard to break. When a pipeline is laid in an earthquake-prone or fault zone, or in a discontinuous permafrost zone, there is a possibility that the pipeline may shift due to movements of the earth's crust. For this reason, high ductility has become an important requirement of steel pipe intended for service in such regions.

Note-5: FEA (Finite Element Analysis)
One of the methods of numerical analysis by computer calculation of the state of deformation and stress and strain distribution when force is applied to a body. A body is divided into fine "elements", and a simultaneous equation is composed for each of the elements, and the equations are solved. This method is widely used in strength calculations for structures and machine parts.

Note-6: CNG carriers
Vessels for transportation of CNG (Compressed Natural Gas). Compressed natural gas is contained in pressure-type pipes carried aboard the vessel for

sea haulage.
Unlike LNG, CNG is transported without liquefaction, which means less initial investment in development and greater flexibility in planning the size and number of vessels according to the planned scale of production and demand. CNG vessels are attracting attention as a new chain of supply suited for the development of medium to small gas fields.

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