Chita Works, JFE Steel†

Abstract:

Chita Works is a special steel pipe factory without a parallel in the world for the reason that manufacturing facilities for various pipes except UO pipes exist in one site. This article introduces the history, present state, organization, major equipment, a feature of manufacturing technologies, a quality assurance system and major products of Chita Works.

1. Introduction

Chita Works is a unique special steel pipe manufacturing plant, featuring production facilities for all types of tubular product except UOE pipes at a single site, and produces the world's largest repertoire of tubular products. Construction of Chita Works as a special steel plant owned by Kawasaki Heavy Industries, Ltd. began in 1943. Following the Second World War, Chita Works became part of the newly organized Kawasaki Steel. In 1961, Chita Works began manufacturing spiral tubes, and in the years that followed, gradually expanded its product line to include electric resistance welded (ERW) pipes and seamless pipes. Facilities were expanded to meet growing demand for oil country tubular goods (OCTG) following the Oil Crises of the 1970s, and the works achieved monthly shipments of 110 000 t in 1982. After reaching this peak, however, the demand contracted rapidly. Although Chita Works had mainly produced general-purpose products up to that time, it responded to this difficult business environment by changing its management policy to center on high value-added products, and has become a leader in the field of high grade pipes and tubes.

In 2003, Chita Works became part of JFE Steel, following the merger of Kawasaki Steel and NKK. In particular, Chita Works is known as a supplier of high grade pipes and tubes to the energy industry, specializing in 13%Cr OCTG, high grade ERW line pipe, boiler tubes for elevated temperature service, and similar high-end products, and has established a firm position in this field. The works celebrates its 60th anniversary in 2003, and is carrying out activities aiming at achieving substantial new growth as a global pipe maker with deep roots in its local region. This paper describes the origins and history, current conditions, main equipment and products of Chita Works.

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2. History and Current Conditions

2.1 Origins and Development

The main events in the history of Chita Works are as follows:

1943 Start of construction as Chita Works as a special steel mill owned by Kawasaki Heavy Industries, Ltd.
1945 Startup of steelmaking shop.
1950 Establishment of Kawasaki Steel.
1957 Start of production of rolls for hot rolling.
1961 Startup of spiral tube mill.
1964 Startup of 20" medium diameter ERW pipe mill.
1970 Startup of small diameter seamless pipe mill.
1971 Startup of OCTG production equipment.
1972 Startup of small diameter ERW pipe mill.
1978 Startup of medium diameter seamless pipe mill.
Startup of 26" ERW pipe mill.
1979 Startup of V-process casting equipment.
1990 Startup of stainless flexible tubing mill.
1991 Expansion of special pipe mill equipment.
1993 Awarded Okochi Memorial Special Production Prize for establishment of a high productivity production technology for stainless seamless pipe.
2000 Start of production of HISTORY tube.
2003 Establishment of JFE Steel.
60th anniversary of start of construction of Chita Works.

2.2 Profile

Chita Works is located near the center of Kinuura Coastal Industrial Zone on Handa Peninsula in Aichi Pref., and occupies a site of approximately 1 810 000 m^2, fronting on Kinuura Bay. The layout of the main mills is shown in **Fig. 1**. All mills have been laid out considering an efficient material flow, which is per-

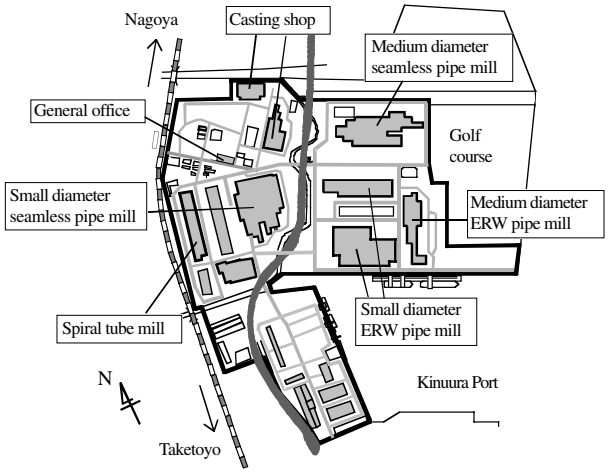

Fig. 1 Plan of Chita Works

formed on-site by the pallet method. By main product divisions, annual production is approximately 300 000 t of seamless pipe and 500 000 t of welded pipe, for a total of 800 000 t. Taking advantage of its excellent location, Chita Works has expanded its business globally and maintains a high ratio of exports. As materials for pipemaking, the works receives high quality semi-finished products from JFE Steel's East Japan Works and West Japan Works. The production system features advanced pipemaking and inspection technologies, enabling integrated quality assurance from the material through the finished product.

The organization of Chita Works is shown in **Fig. 2**. The total number of employees is approximately 1 700. By adopting a flat, simple organization, Chita Works has created a management system which supports fast, efficient development of manufacturing technologies and new products in full cooperation with upstream material manufacturing departments and allows the works to make proposals to meet customer requirements across product lines.

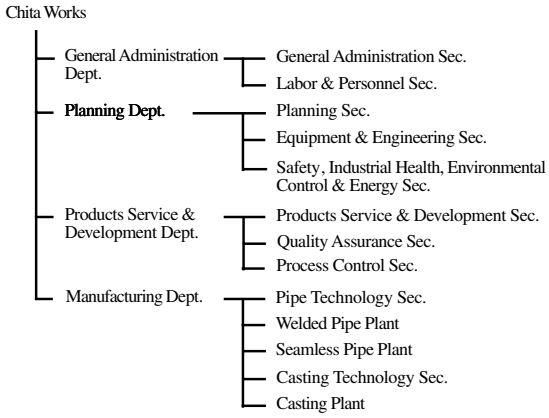

Fig. 2 Organization of Chita Works

3. Management Policy

The fundamental management policy of Chita Works is to be "a global business with its roots in the local community." Because the basis of any business is people, the policies of Chita Works emphasize not only safety countermeasures and preservation of the environment, but also active efforts to coexist with its host region, from the consistent viewpoint that the various people of the region and Chita Works' employees should live and work together in a mutually beneficial relationship.

The profitability of the pipe business significantly depends on conditions in energy markets and exchange rates. This means that there are two essential requirements for stabilizing the management of Chita Works. First, it is necessary to improve the profitability of energy-related products by supplying energy customers with high value-added products, such as high Cr stainless steel. At the same time, it is important to secure new sources of income in non-energy fields. For this reason, management policies include the development of Only 1 and No. 1 products in the automotive, construction material, and other fields with the aim of securing stable profits from these products.

4. Main Equipment and Technology

4.1 Pipe Manufacturing Equipment

4.1.1 Seamless pipe manufacturing equipment

Seamless pipes are manufactured by heating round billets to 1 200-1 300°C, following the material by piercing the center with a piercer, and performing elongation rolling and other processes. The outline of Chita Works' seamless pipe mill equipment is shown in **Table 1**. The small diameter seamless pipe mill **(Photo 1)** is distinguished by its high productivity for high Cr stainless steel, with defect-free rolling technology as a key element. In manufacturing premium joints for OCTG, Chita Works has introduced the world's first, practical tool rotation type NC threading machine, and manufactures various proprietary products including FOX and KSBEAR premium joints.

The main features of the medium diameter seam-

Table 1 Seamless pipe manufacturing equipment

Mill	Process	Outer diameter (mm)	Length (m)	Thickness (mm)
Small diameter seamless pipe mill	Mandrel mill process	25.4-177.8	4.0-22.3	2.3-40.0
Medium diameter seamless pipe mill	Plug mill process	177.8-426.0	5.5-13.5	5.0-55.0

Photo 1 Mandrel mill

Photo 2 HISTORY process CBR (cage bulge roll) forming mill

less pipe mill exist in the production of small lots by taking advantage of the plug mill process, technology of manufacturing with ultra thin or ultra heavy wall pipes, and production of hot-rolled square columns.

4.1.2 Welded pipe manufacturing equipment

The outline of welded pipe manufacturing equipment is shown in **Table 2**. Chita Works has four ERW pipe mills, one spiral tube mill, and one stainless steel flexible tubing mill.

The 3” small diameter ERW mill has adopted a stand quick-change technology, so that an optimum forming method can be selected for the pipes varying from stainless steel pipe as thin as 0.6 mm to a steel pipe as thick as 10 mm.

The 4” mill manufactures a revolutionary product called HISTORY pipe (HISTORY: high speed tube welding and optimum reducing technology), which is the first controlled rolling process for steel pipes and tubes in the world. **Photo 2** shows a view of the CBR (cage bulge roll) forming method used in the HISTORY process.

The 26” ERW mill is the world’s strongest mill in its size range, and is used in combination with advanced nondestructive inspection technologies. Main products are high grade line pipe and square columns for building construction.

4.2 Manufacturing Equipment for Casting

Manufacturing equipment for casting includes 6 t, 25 t, and 40 t low frequency induction furnaces, centrifugal casting equipment, heat treatment furnaces, and large scale lathes. Chita Works developed the world’s first centrifugal casting technology for manufacturing high speed steel rolls, and now manufactures all types of high speed steel rolls for hot rolling.

Equipment for manufacturing small scale cast steel and cast iron includes V-process casting equipment, high frequency induction furnaces, and an atmosphere-controlled heat treatment furnace, and is used for manufacturing plugs for seamless pipes rolling and base plates. In plug manufacturing, on-site production and related development activities enable a quick response to the operational needs of the seamless pipe mills at the works.

Table 2 Welded pipe manufacturing equipment

Mill		Outer diameter (mm)	Length (m)	Thickness (mm)	Product (example)
Small diameter ERW pipe mill	3”mill	25.4- 76.3	4-18	0.6 - 2.5	Water line pipe, Automotive tubes, Machine structural use
	4”mill	21.7-114.3	4-12	1.8 - 7.5	
	6”mill	60.5-165.2	4-18	2.0-12.0	
Medium diameter ERW pipe mill	26”mill	318.5-660.4	5-20	4.0-25.4	Line pipe
		250□-550□	6-18	6.0-25.0	Square column
Spiral tube mill		400-1 600	6-18	4.0-26.0	Steel pipe pile
Stainless flexible tubing mill		10A, 15A, 20A, 25A			Stainless flexible tubing

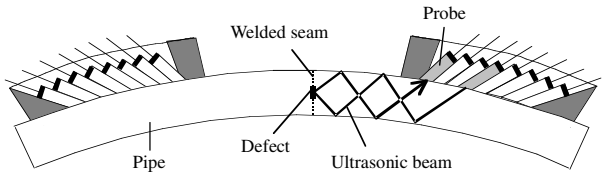

Fig. 3 Multi-tandem ultrasonic testing method

5. Quality Assurance System

In 1993, Chita Works was certified under the international standard for quality assurance, ISO 9001. The works is carrying out activities to implement a quality system which ensures even higher levels of customer satisfaction.

At present, Chita Works has approximately 40 units of automatic nondestructive inspection equipment for steel pipes, and is continuing to introduce new equipments to meet the strict quality requirements of customers, aiming at "performance guarantee for entire length, surface and cross section area" and "performance assurance." The multi-tandem ultrasonic testing (UT) method shown in **Fig. 3** was developed by JFE Steel. It enables 100% quality assurance of the entire welded portion, which also includes mid wall area, in high grade ERW line pipe for the first time in the world and has won high marks from major oil companies.

6. Production Control System

Chita Works has been using a production control system which enables a real time control from placement of order to delivery of product. Information on actual products is incorporated in a database and applications have been developed using object-oriented technology to realize a quick and accurate production control.

The information which is controlled in this system is widely available to customers by way of the internet under the name "Steel Pipe Customer Support System". It is making an important contribution to the improvement of the efficiency of customer jobs such as confirmation of process progress, instruction for shipment and search for mill sheet information, etc. The top page of the system is shown in **Fig. 4**.

7. Main Products

7.1 13%Cr OCTG

As a result of the significant progress achieved in drilling technology in recent years, the number of oil and gas wells characterized by high temperature/

Fig. 4 Top page of "Steel Pipe Customer Support System"

Photo 3 Premium joints for OCTG

high pressure service and corrosive environments associated with CO_2 and minute quantities of H_2S has also increased. JFE Steel's 13%Cr and Hyper 13%Cr OCTGs can be used even in such severe environments, and not only reduce the total life cost of the well, but also contribute to environmental protection by eliminating the usage of inhibitors. JFE Steel has also developed proprietary connections such as FOX and KSBEAR **(Photo 3)** as highly reliable premium joints for gas wells as deep as more than 4 500 m below the sea as well as on-shore service. JFE Steel has the capability to supply the 13%Cr OCTG series which can meet the required service environment and has been contributing to social needs. Now the 13%Cr OCTG has obtained 40-50% of the global market share and become one of the strategic products of Chita Works.

7.2 Line Pipe

Line pipes are used to transport energy resources such as oil and natural gas. An example of the line pipe laying operation is shown in **Photo 4**. In response to increasing global demand for natural gas, JFE Steel has developed high grade products such as high strength, high toughness pipes up to the API X80 class, which can be used even in difficult environments, line pipe for sour service, and others. In fiscal year 2002, Chita Works set an all-time record of approximately 250 000 t for high grade line pipe production.

7.3 Tubes for Automotive Applications

With increasing need for steel products which contribute to improved fuel consumption, as one measure

Photo 4 Scene of line pipe in operation

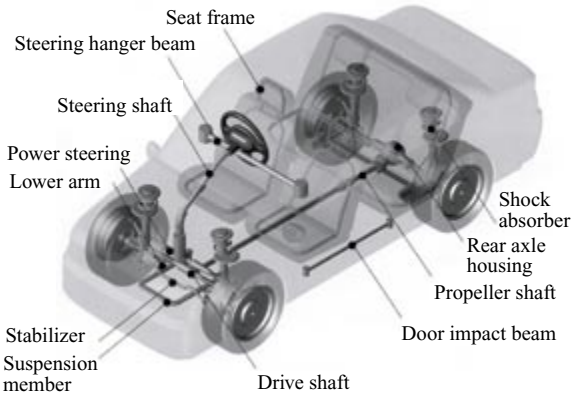

Fig. 5 Examples of application of steel tubes for automotive use

for preserving the global environment, high strength steel tubes are now applied in large quantities in auto parts where steel sheets or round bars had conventionally been used. Examples of automotive applications of steel tubes are shown in **Fig. 5**. In particular, tubes which possess high formability, while also providing high strength, are required in parts that are formed into complex shapes by new technologies such as hydroforming.

In response to these needs, Chita Works quickly developed small strain ERW forming steel tube manufacturing equipment, which is used to produce high ductility tubes. Chita Works also has developed a controlled rolling technology for steel tubes, which makes it possible to control the mechanical properties of the material in line. This technology is used in manufacturing high strength, high ductility ERW steel tubes (HISTORY pipes) based on new metallurgy. In recognition of its contribution to auto body weight reduction, Toyota Auto Body Co., Ltd. awarded Technical Excellence Prize to this new product.

Photo 5 Rolls for hot rolling

7.4 Rolls for Hot Rolling

Chita Works has developed high performance, high speed steel rolls which are now part of the integrated rolling technologies used at JFE Steel's East Japan Works and West Japan Works. In particular, Chita Works developed a manufacturing technology for high speed steel rolls for hot rolling which have demonstrated excellent performance in terms of wear resistance, surface deterioration resistance, and other properties while maintaining the cost superiority of the centrifugal casting process (awarded with Technical Development Prize of the Japan Institute of Metals in 1993 and 2000), and supplies all types of roll for hot rolling **(Photo 5)**.

8. Summary

With the creation of JFE Steel by the merger of Kawasaki Steel and NKK, the steel pipe and tube business will become substantially larger. Taking advantage of this business opportunity, Chita Works plans to actively enter various new fields, not limited to its existing businesses, and to supply technologies which take full advantage of the distinctive properties of steel pipes. Chita Works also intends to develop businesses which are capable of providing total solutions to its customers by developing Only 1 and No. 1 products utilizing leading-edge technologies. As a plant with a history of 60 years, Chita Works has played a leading role in its local community, and in the future, will continue to contribute to society as a works with deep roots in its home region.