UNIVERSIDAD NACIONAL DE INGENIERÍA

FACULTAD DE INGENIERÍA MECÁNICA

"IMPLEMENTACIÓN DE UNA INYECTORA AUTOMÁTICA DE CARBÓN DE 0.33 Kg/s A UN HORNO ELÉCTRICO DE FUNDICIÓN PARA AUMENTAR LA PRODUCCIÓN EN 1.5%"

INFORME DE SUFICIENCIA

PARA OPTAR EL TITULO PROFESIONAL DE:

INGENIERO MECÁNICO

RICARDO FELIX FALLA CRUZADO

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DEDICATORIA

A mis padres Tomas y Edith, que están cosechando lo que con amor, cariño y dedicación sembraron.

A mis queridos hermanos Laura y Tommy que me enseñaron el valor de la fraternidad y la responsabilidad.

ÍNDICE GENERAL

PRÓLOGO

El presente informe está dividido secuencialmente en 5 capítulos definidos en los que se presentan en forma lógica y ordenada los pasos para realizar la Implementación de una Inyectora Automática de Carbón en un Horno Eléctrico de 30 Toneladas de capacidad de Acero Líquido.

En el Capítulo I, hacemos mención de las necesidades que anteceden la Implementación, así como el objetivo general del informe considerando sus alcances y limitaciones, teniendo como fundamento la justificación cuantitativa y cualitativa del producto.

En el Capítulo II, presentamos el proceso general de fabricación del acero en la Planta así como también una descripción técnica detallada del equipo principal de dicha planta, el Horno Eléctrico, y finalmente el sistema de Inyección de Carbón, justificando teóricamente los conceptos que involucran los criterios de selección e implementación.

En el Capítulo III, nos abocamos a la selección del tipo de Inyectora considerando los requisitos técnicos y de seguridad que debe cumplir el equipo, así como también en el diseño de tuberías para la inyección de carbón y la modificación del panel refrigerado.

En el Capítulo IV, describimos la implementación del Sistema de Inyección Automático de Carbón, así como. los procedimientos utilizados para el montaje considerando la aplicación del tipo de materiales en todo el proceso y aprovechando las instalaciones existentes.

En el Capítulo V, presentamos los costos que demanda la Implementación así como el retorno de la inversión.

CAPÍTULO I

INTRODUCCIÓN

1.1 ANTECEDENTES

Desde 1956 SIDERPERU es una empresa dedicada a la fabricación de productos de Acero, utilizando dos vías de producción: Vía Alto Horno y Vía Horno Eléctrico. Debido a la crisis del año 2009 se cerró la línea de Producción vía Alto Horno, dejando solamente la producción vía Horno Eléctrico.

Hasta el año 2010 se utilizaban 02 Hornos Eléctricos de 30 Tn de capacidad con inyección manual de Carbón y Oxígeno, siendo éste sistema causante de frecuentes accidentes y baja eficiencia de inyección, que en consecuencia se traducía en pérdidas de Producción.

En el año 2010, en la Planta de Acería se implementó un nuevo Horno Eléctrico en reemplazo de los dos Hornos instalados desde 1956, éste cambio trajo consigo un considerable aumento en nuestro volumen de producción así como nuevas y modernas tecnologías en la inyección automática de Carbón y Oxígeno.

1.2 OBJETIVO

Implementar una Inyectora Automática de Carbón de 20 kg/min en el Horno Eléctrico de 30 Tn de capacidad de acero líquido para aumentar la producción en 1.5%.

1.3 ALCANCE

Presentar los criterios lógicos y procedimientos para la selección y diseño de los componentes que se utilizarán en la implementación de una Inyectora de Carbón, así como las pruebas de funcionamiento.

Debido a que estamos abocados solamente a la especialidad de Ingeniería Mecánica, no forman parte del alcance temas relacionados con Procesos Metalúrgicos, Sistema Eléctrico, Sistema Electrónico, Sistema de Control, condiciones estructurales de las instalaciones existentes ni equipos auxiliares.

1.4 LIMITACIONES

El presente informe de suficiencia se limita al Horno Eléctrico de la Planta de Acería - SIDERPERU, no siendo válido para otro tipo de proceso de fundición de chatarra ya que cada parámetro es ajustado de acuerdo a la realidad de cada proceso.

1.5 JUSTIFICACIÓN

En los últimos 8 años la producción de acero en el mundo creció a una tasa promedio 5,8% anual, sin embargo, a pesar de la caída por la crisis del 2009, la producción de acero se ha recuperado en el 2010 y se augura un crecimiento del consumo mundial del acero del 6,5% para este año y del 5,4% para 2013.

Considero necesario resaltar que actualmente en SIDERPERU se producen 200, 000 toneladas de acero sólido anual, mediante el proceso de fundición de la chatarra en un Horno Eléctrico de 30 tn, lo que relacionado al aumento de la demanda del acero en el mundo, nos obliga a mejorar nuestro proceso aplicando las mejoras tecnológicas y la Ingeniería para el aumento de la producción y disminución de interrupciones imprevistas.

CAPÍTULO II

GENERALIDADES SOBRE EL HORNO ELÉCTRICO DE FUNDICIÓN E INYECCIÓN DE CARBÓN

2.1 PROCESO DE FABRICACIÒN DEL ACERO

EL ACERO

Los metales y las aleaciones empleados en la industria y en la construcción pueden dividirse en dos grupos principales: Materiales FERROSOS y NO FERROSOS. Ferroso viene de la palabra Ferrum que los romanos empleaban para el fierro o hierro. Por lo tanto, los materiales ferrosos son aquellos que contienen hierro como su ingrediente principal; es decir, las numerosas calidades del hierro y el acero.

Los materiales No Ferrosos no contienen hierro. Estos incluyen el aluminio, magnesio, zinc, cobre, plomo y otros elementos metálicos. Las aleaciones el latón y el bronce, son una combinación de algunos de estos metales No Ferrosos y se les denomina Aleaciones No Ferrosas.

Uno de los materiales de fabricación y construcción más versátil, más adaptable y más ampliamente usado es el ACERO. A un precio relativamente bajo, el acero combina la resistencia y la posibilidad de ser trabajado, lo que se presta para fabricaciones mediante muchos métodos. Además, sus propiedades pueden ser manejadas de acuerdo a las necesidades específicas mediante tratamientos con calor, trabajo mecánico, o mediante aleaciones.

El Acero es básicamente una aleación o combinación de hierro y carbono (alrededor de 0,05% hasta menos de un 2%). Algunas veces otros elementos de aleación específicos tales como el Cr (Cromo) o Ni (Níquel) se agregan con propósitos determinados.

Ya que el acero es básicamente hierro altamente refinado (más de un 98%), su fabricación comienza con la reducción de hierro (producción de arrabio) el cual se convierte más tarde en acero.

El hierro puro es uno de los elementos del acero, por lo tanto consiste solamente de un tipo de átomos. No se encuentra libre en la naturaleza ya que químicamente reacciona con facilidad con el oxígeno del aire para formar óxido de hierro herrumbre. El óxido se encuentra en cantidades significativas en el mineral de hierro, el cual es una concentración de óxido de hierro con impurezas y materiales térreos.

Existen dos tipos fundamentales de aceros: acero al carbono (Σ aleantes $< 8\%$) y acero aleado (Σ aleantes $>8\%$)

2.1.1 Clasificación del Acero

2.1.1.1 Acero al Carbono

Más del 90% de todos los aceros son aceros al carbono. Estos aceros contienen diversas cantidades de carbono y menos del 1,65% de manganeso, el 0,60% de silicio y el 0,60% de cobre. Entre los productos fabricados con aceros al carbono figuran máquinas, carrocerías de automóvil, la mayor parte de las estructuras de construcción de acero, cascos de buques, etc.

Por otro lado, dentro de los aceros al carbono, según su contenido, se pueden diferenciar los siguientes grupos:

• Aceros de muy bajo % de carbono

Estos aceros son usados para piezas que van a estar sometidas a un conformado en frío.

Los aceros no calmados se utilizan para embutidos profundos por sus buenas cualidades de deformación y terminación superficial. Los calmados son más utilizados cuando van a ser sometido a procesos de forjados o de tratamientos térmicos.

Son adecuados para soldadura y para soldadura fuerte. Su maquinabilidad se mejora mediante el estirado en frío. Son susceptibles al crecimiento del grano, y a fragilidad y rugosidad superficial si después del conformado en frío se los calienta por encima de 600°C.

• Aceros de bajo % de carbono

Este grupo tiene mayor resistencia y dureza, pero menor capacidad de deformación. Son los comúnmente llamados aceros de cementación. Los calmados se utilizan para forjas.

El comportamiento al temple de estos tipos de aceros depende del % de C y Mn. Así los que presentan mayores porcentajes de C tienen mayor templabilidad en el núcleo, y los de más alto % de Mn, se endurecen más principalmente en el núcleo y en la capa.

Son aptos para soldadura y soldadura fuerte. La maquinabilidad de estos aceros mejora con el forjado o normalizado, y disminuye con el recocido.

• Aceros de medio % de carbono

Estos aceros son seleccionados en usos donde se necesitan propiedades mecánicas más elevadas y frecuentemente llevan tratamiento térmico de endurecimiento.

Se utilizan en amplia variedad de piezas sometidas a cargas dinámicas, como ejes y árboles de transmisión. Los contenidos de C y Mn son variables y dependen de una serie de factores, como las propiedades mecánicas o la templabilidad que se requiera.

Los de menor % de carbono se utilizan para piezas deformadas en frío, aunque los estampados se encuentran limitados a plaqueados o doblados suaves, y generalmente llevan un recocido o normalizado previo. Todos estos aceros se pueden aplicar para fabricar piezas forjadas y su selección depende del tamaño y propiedades mecánicas después del tratamiento térmico.

Los de mayor % de C, deben ser normalizados después de forjados para mejorar su maquinabilidad. Son también ampliamente usados para piezas maquinadas, partiendo de barras laminadas. Dependiendo del nivel de propiedades necesarias, pueden ser o no tratadas térmicamente.

Estos tipos de aceros pueden soldarse pero deben tenerse precauciones especiales para evitar fisuras debido al rápido calentamiento y posterior enfriamiento.

• Aceros de alto % de carbono

Se usan en aplicaciones en las que es necesario incrementar la resistencia al desgaste y conseguir altos niveles de dureza en el material que no pueden lograrse con aceros de menor contenido de C.

En general no se utilizan conformados en frío, salvo plaqueados o el enrollado de resortes.

Prácticamente todas las piezas con acero de este tipo son tratadas térmicamente antes de usar, debiéndose tener especial cuidado en estos procesos para evitar distorsiones y fisuras

2.1.1.2 Aceros Aleados

Estos aceros contienen un proporción determinada de vanadio, molibdeno y otros elementos, además de cantidades mayores de manganeso, silicio y cobre que los aceros al carbono normales. Estos aceros de aleación se pueden subclasificar en

- Estructurales: Son aquellos aceros que se emplean para diversas partes de máquinas, tales como engranajes, ejes y palancas. Además se utilizan en las estructuras de edificios, construcción de chasis de automóviles, puentes, barcos y semejantes. El contenido de la aleación varía desde 0,25% a un 6%.

- Para Herramientas: Aceros de alta calidad que se emplean en herramientas para cortar y modelar metales y no-metales. Por lo tanto, son materiales empleados para cortar y construir herramientas tales como taladros, escariadores, fresas, terrajas y machos de roscar
- Especiales: Los Aceros de Aleación especiales son los aceros inoxidables y aquellos con un contenido de cromo generalmente superior al 12%. Estos aceros de gran dureza y alta resistencia a las altas temperaturas y a la corrosión, se emplean en turbinas de vapor, engranajes, ejes y rodamientos.

2.1.1.3 Aceros de Baja Aleación Ultra Resistentes

Esta familia es la más reciente de las cuatro grandes clases de acero. Los aceros de baja aleación son más baratos que los aceros aleados convencionales ya que contienen cantidades menores de los costosos elementos de aleación. Sin embargo, reciben un tratamiento especial que les da una resistencia mucho mayor que la del acero al carbono. Por ejemplo, los vagones de mercancías fabricados con aceros de baja aleación pueden transportar cargas más grandes porque sus paredes son más delgadas que lo que sería necesario en caso de emplear acero al carbono. Además, como los vagones de acero de baja aleación pesan menos, las cargas pueden ser más pesadas. En la actualidad se construyen muchos edificios con estructuras de aceros de baja aleación. Las vigas pueden ser más delgadas sin disminuir su resistencia, logrando un mayor espacio interior en los edificios

2.1.1.4 Aceros Inoxidables

Contienen cromo, níquel y otros elementos de aleación, que los mantienen brillantes y resistentes a la herrumbre y oxidación a pesar de la acción de la humedad o de ácidos y gases corrosivos. Algunos aceros inoxidables son muy duros; otros son muy resistentes y mantienen esa resistencia durante largos periodos a temperaturas extremas. Debido a sus superficies brillantes, en arquitectura se emplean muchas veces con fines decorativos. El acero inoxidable se utiliza para las tuberías y tanques de refinerías de petróleo o plantas químicas, para los fuselajes de los aviones o para cápsulas espaciales. También se usa para fabricar instrumentos y equipos quirúrgicos, o para fijar o sustituir huesos rotos, ya que resiste a la acción de los fluidos corporales. En cocinas y zonas de preparación de alimentos los utensilios son a menudo de acero inoxidable, ya que no oscurece los alimentos y pueden limpiarse con facilidad.

Se dividen en los siguientes grupos:

• Austeníticos:

Los aceros inoxidables austeníticos no son duros ni templables, además de poseer una alta capacidad de deformarse plásticamente. El más ampliamente utilizado es el 304.

A esta categoría pertenecen los aceros refractarios (elevada resistencia a altas temperaturas). Ejemplo, 30330 (35% Ni, 15% Cr).

• Martensíticos

Contenido de Cromo entre 11 - 18 %.

Estos son templables. Si se persigue conseguir durezas más elevadas se debe aumentar el % Cr (formación de carburos de Cr). Se usan para cuchillería, dado que tienen excelente resistencia a la corrosión.

• Ferríticos

Poseen bajo % de C y alto Cr (10 - 27 %) por lo que pueden mantener la estructura ferrítica aún a altas temperaturas.

2.1.2 Proceso de fabricación del Acero

Se inicia con la industrialización de la chatarra, luego es cargada al Horno Eléctrico para realizarla fundición y se transforma en acero líquido y finalmente el acero líquido es transformado en acero sólido en el área de Colada Continua.

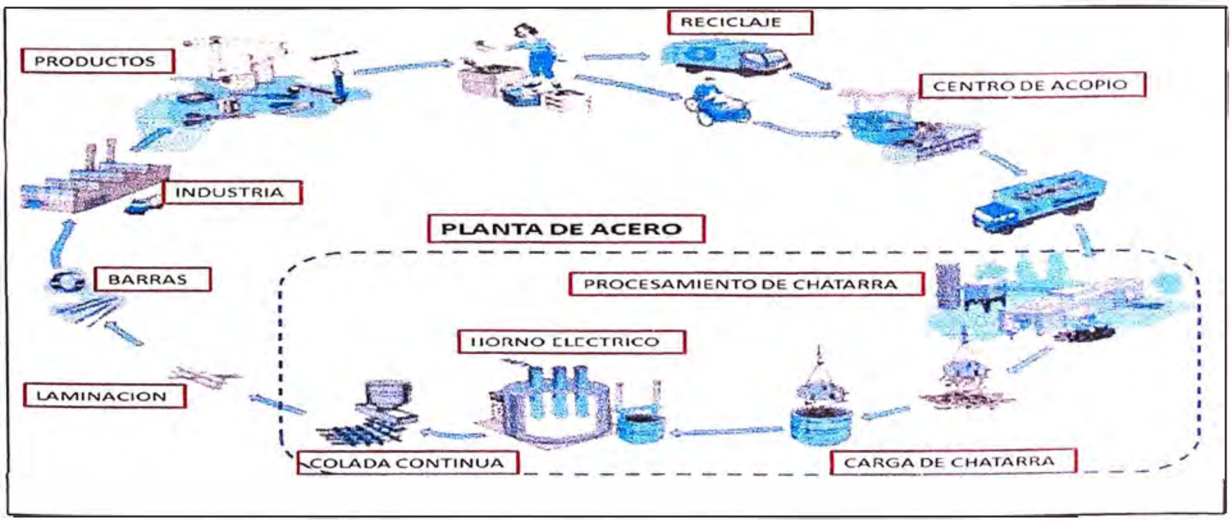


Figura 2.1 Macro proceso del Acero

2.1.2.1 Procesamiento de la chatarra

La chatarra es todo aquel material que ha sido desechado para su uso (metálico, plástico, vidrio, etc.) y que se volverá a reciclar para la obtención de un producto nuevo.

Contaminantes: Cobre (Cu), Fósforo (P), Cromo (Cr), Azufre (S), Níquel (Ni), Silicio (Si), Molibdeno (Mo), Arsénico (As), Estaño (Sn), Plomo (Pb) .

Impurezas: Madera, tierra, plásticos, papel, cartón, neumáticos, espuma, vidrio, lana de vidrio, cemento, etc.

Influencia de las impurezas en la Chatarra:

Chatarra Limpia → Consume 380 kWh/t

Tierra → Consume 570 kWh/t

- Consumo de energía adicional para fundir algo que no se incorpora al acero
- La tierra tiene consumo de energía mas alto que el propio acero
- Cuando se tiene tierra en exceso, se necesita colocar cal adicional, para neutralizar la acción de erosión de la tierra sobre los refractarios del Horno.
- Esta cal tiene un consumo más elevado que la propia tierra (800 kWh/t)

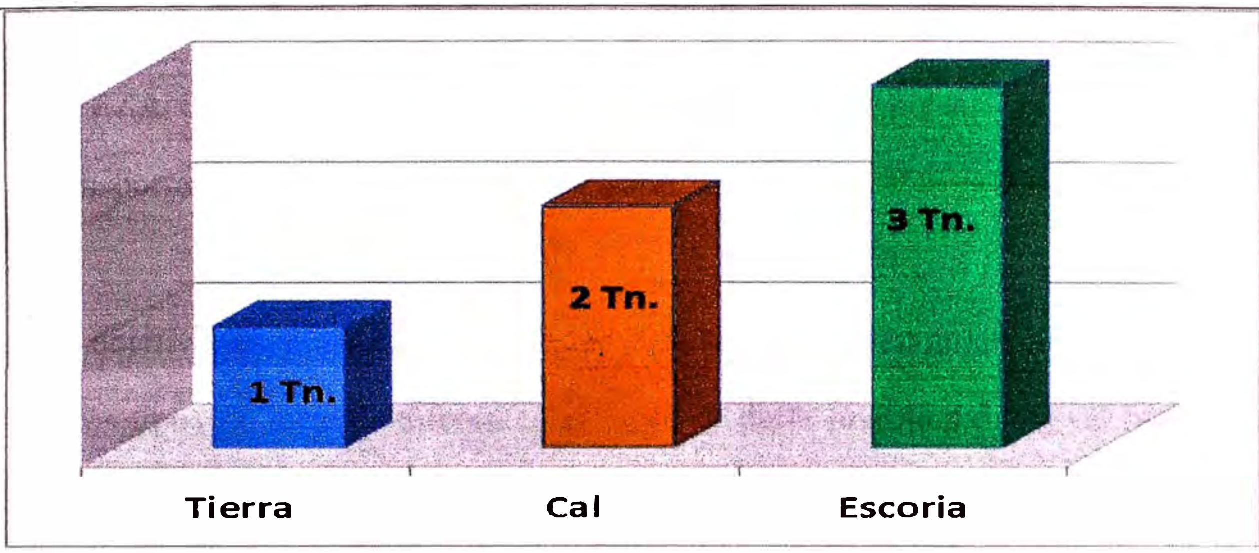


Figura 2.2 Una tonelada de tierra necesita dos toneladas de cal formando tres toneladas de escoria

La industrialización de la chatarra presenta una gran influencia en la productividad del Horno Eléctrico, por ejemplo:

- Densidades típicas de chatarras sin industrializar:
  - Mixta pesada: 0,3 t/m^3
  - Mixta liviana: 0,25 t/m^3
  - Para oxicorte: 0,3 t/m^3
- Por ejemplo, un horno de 30t y 17 m^3 puede recibir cargas de 5 a 6 toneladas lo que significa realizar 6 cargas o 6 cestas.
- El tiempo promedio de la carga de una cesta esta entre 2.0 a 2.5 minutos.
- Cargar 6 cestas requerirán de 12 a 15 minutos de parada de producción.
- A menor número de cargas (cestas), menor tiempo de parada de producción, lo que indica aumento de la productividad.

La chatarra es la materia prima procesada en la Cizalla Compactadora VEZZANI, esta chatarra es suministrada por empresas externas que la transportan hasta nuestra planta.

El objetivo es aumentar su densidad aparente, eliminar contaminantes, separar otros tipos de metales diferentes al hierro y darle una medida de tal modo que pueda mejorar la productividad del Horno Eléctrico.

Actualmente la planta de procesamiento de chatarra produce a un ritmo de 350 Tn/dia.

Figura 2.3 Suministro de chatarra a planta

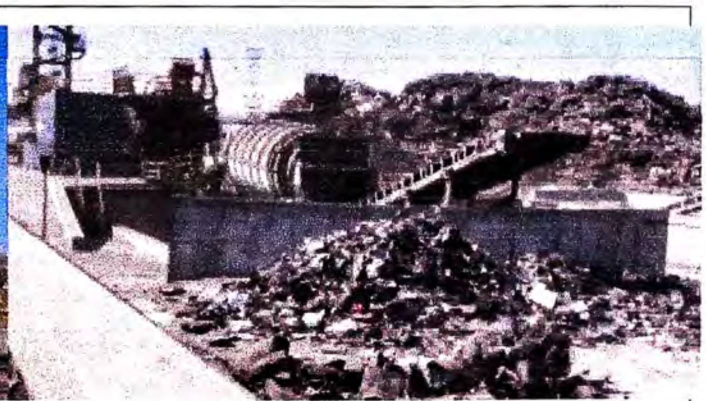


Figura 2.4 Sistema de limpieza de la chatarra

Figura 2.5 Planta de procesamiento de chatarra. Producción diaria 350 Toneladas por día.

2.1.2.2 Fundición en el Horno Eléctrico

Por ser el equipo de análisis los detalles se presentan en el punto 2.2.

2.1.2.3 Solidificación del Acero

El acero que viene desde el Horno Eléctrico se encuentra en estado líquido teniendo que pasar por un sistema de enfriamiento para la solidificación, este proceso se lleva a cabo en la Colada Continua, que en nuestra planta, produce dos formatos de barras cuadradas de 100 x 100 x 6000 mm ó 224 x 224 x 3000 mm.

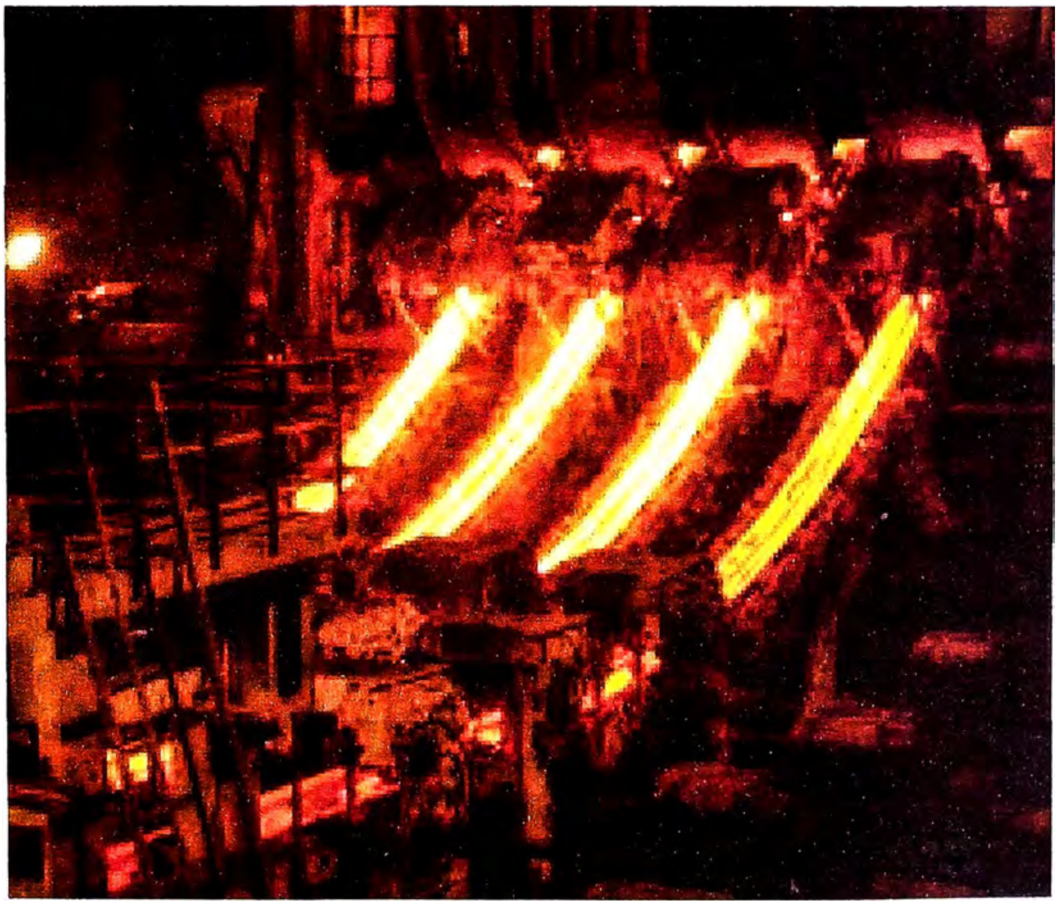


Figura 2.6 Colada Continua

2.2 EL HORNO ELÉCTRICO

SIDERPERU cuenta actualmente con un Moderno Horno Eléctrico con un transformador de 30 MVA .

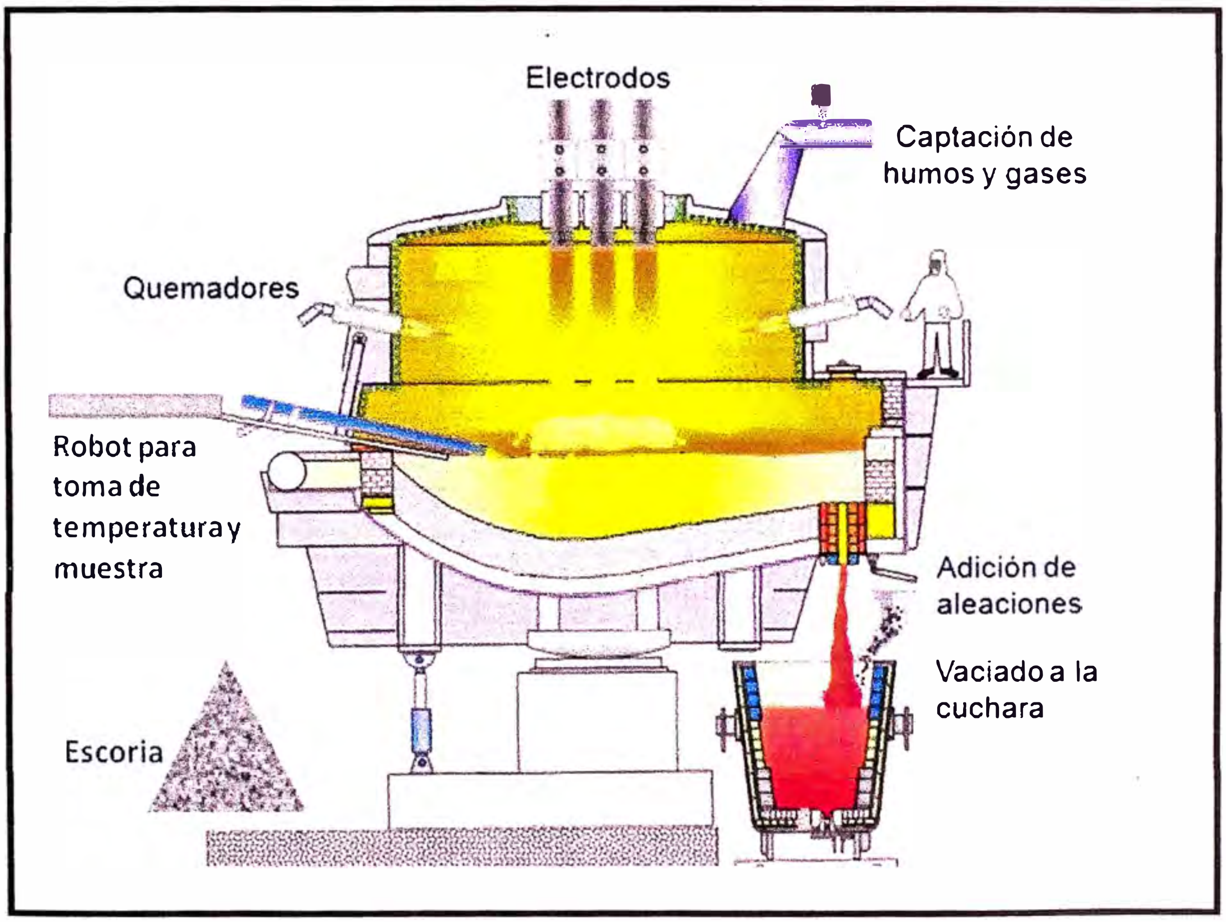


Figura 2.7 Esquema del Horno Eléctrico

2.2.1 Datos Técnicos del Horno Eléctrico

Tipo de Horno	Tagliaferri, EBT (Sangrado Excéntrico Inferior)
Capacidad Nominal	30 Tn. (Acero Líquido) + 8 Tn. (Carga Caliente)
Diámetro	4,200 mm.
Tipo de Carga	Chatarra
Tipo de Sangrado	Excéntrico Inferior (EBT)
Diámetro de Electrodo	400 mm.
Potencia del Transformador	30 MVA
Voltaje Primario	13,8 kV – 60 Hz
Normas de Fabricación	IEC/ISO, UNI
Tipo de Paneles	Tubulares, refrigerados internamente
Cilindros de Basculamiento	Dos cilindros hidráulicos de doble efecto
Angulo de Sangrado	+15°
Angulo de Desescoreo	-15°
Cilindro hidráulico de bóveda	Carrera 378 mm, simple efecto
Cilindro Hidráulico de giro de Bóveda	Simple efecto, ángulo de 78°
Regulación de Velocidad de Electrodos	Hasta 150 mm/s
Máxima Velocidad de Electrodos	450 mm/s
Velocidad de giro en Sangrado	1,5°/s
Velocidad de giro en Retorno	4°/s
Regulación electrónica de Electrodos	TDR (Regulación Digital TAGLIAFERRI)
Sistema de Automatización	PLC y lógica de PC

2.2.2 Proceso de fundición de Chatarra en el Horno Eléctrico

2.2.2.1 Carga de Chatarra

La chatarra es adicionada al horno a través de cestas preparadas en el Patio de Preparación de Cestas, normalmente, se utilizan 3 o 4 cestas por colada de acero.

La carga de chatarra se debe preparar de forma que permita:

- Minimizar el impacto sobre el revestimiento.
- Optimizar el rellenado del volumen del horno.
- Evitar cargas altas que impidan el cierre del horno.
- Facilitar la penetración de los electrodos al inicio de la fusión, sin que ocurra la rotura de los mismos.
- Formación rápida de una piel líquida sobre la solera, protegiéndola contra la acción directa de los arcos.
- Tiempos de fusión mínimos.
- Ausencia de contacto de los electrodos con cuerpos no conductores que causan ruptura de los electrodos.

La colada de acero comienza en la preparación de la carga, en la cesta.

Proceso de Carga de Chatarra en el Horno Eléctrico

	
Figura 2.8 Llenado de chatarra en Cesta	*Figura 2.9 Traslado de Cesta al Horno*
	
Figura 2.9 Carga de chatarra al Horno	*Figura 2.10 Regreso de Cesta para llenado de chatarra*

2.2.2.2 Fusión

Después de cargar la primera cesta se inicia la fusión, se bajan los electrodos para que toquen levemente la chatarra liviana de la parte superior y abran el arco, cuando la chatarra esté suficientemente fundida, se adiciona la segunda cesta.

Generalmente la fusión es acompañada de inyección de O_2 para aumentar la energía calorífica, se forman cantidades importantes de FeO auxiliando el afino oxidante.

El tiempo de fusión depende de: La potencia del transformador, del tipo de carga, y de la utilización de otras fuentes de calor.

Durante el proceso de fusión se adiciona oxígeno y **carbono**.

2.2.2.3 Afino Oxidante

Se inicia después de la última etapa de fusión.

Tiene una función de disminuir el contenido de carbono (descarburación) y de fósforo (desfosforación) del baño líquido.

Para esto se adiciona oxígeno y carbono a través de lanza manual o por sistema automatizado.

El oxígeno reacciona con diversos elementos, formando la escoria del horno.

2.2.2.4 Sangrado

Consiste en la evacuación del acero líquido del horno a través de un agujero excéntrico ubicado en la parte inferior hacia un recipiente metálico revestido internamente con refractario llamado Cuchara. Actualmente el tonelaje de acero sangrado tiene un promedio de 30 Tn.

2.3 INYECCIÓN DE CARBÓN AL HORNO ELÉCTRICO

El Carbón es transmitido a través de un transporte neumático hasta el Inyector de Carbón.

La principal característica del Inyector es su posición, así dentro de la zona de escoria, de modo que el 100% del Carbón se dirija directo a la escoria dentro del Horno Eléctrico.

La primera consecuencia de ésto es el incremento de la productividad.

Este sistema comprende desde el almacenamiento, transporte e inyección de Carbón dentro del Horno Eléctrico en la etapa de afino para realizar la reducción del FeO.

2.3. INYECCIÒN DE CARBON AL HORNO ELECTRICO

El Carbón se almacena en una tolva de 1 tonelada de capacidad que está conectada mediante dos válvulas en serie, una neumática y otra manual, con un recipiente inferior llamado Dispensador, que es de donde conecta la tubería de carbón y va hacia la Inyectora. La capacidad del dispensador de carbón es de 800 kg y 2 m^3. Ver disposición en plano 6P&I-77588. (Ver Anexo adjunto).

El dispensador está conectado a una línea de aire comprimido que está comandada por un sistema de válvulas y electroválvulas ya existentes que "arrastran" al Carbón del Dispensador transportándolo hacia la inyectora.

2.3.1 Carbón Suministrado

Es suministrado mediante bolsones de 1,000 kg. (ver características técnicas del carbón en el anexo adjunto).

CAPÌTULO III

CARACTERÍSTICAS TÉCNICAS DEL SISTEMA AUTOMÁTICO DE INYECCIÓN DE CARBÓN

3.1 CONSIDERACIONES DE SELECCIÓN

Se ha seleccionado el tipo de inyectora llamada "KT" debido a que se considera que abarca tanto los aspectos de seguridad, fácil mantenimiento y requerimientos técnicos que exige nuestro proceso. Es un diseño patentado por su fabricante TENOVA.

3.1.1 Consideraciones de Seguridad

La hermetización del sistema debe ser garantizado en las condiciones de trabajo actuales, cabe destacar que el carbón es un elemento inflamable y una posible fuga podría ocasionar daños serios.

Es necesario considerar que el equipo cuente con un sistema seguro de refrigeración, la mezcla de agua con acero líquido ocasiona explosiones e incendios que en otras unidades ya ha ocasionado fatalidades.

3.1.2 Normas Aplicables

Para el mantenimiento del sistema es necesario que los componentes estén diseñados bajo un estándar internacional que facilite el reconocimiento de los repuestos y la facilidad para su adquisición en el mercado.

La implementación del equipo debe ser establecido bajo normas estandarizadas consideradas en el diseño, en lo que sea aplicable: tuberías, codos, bridas, soldadura, pruebas de hermeticidad y equipos.

Los principales equipos para la implementación de nuestra inyectora son tuberías de carbón, tuberías de agua de refrigeración y mangueras

3.2 CARACTERÍSTICAS TÉCNICAS

El Inyector KT de Carbón es una herramienta para formación de escoria espumosa y control de FeO en el aceo líquido dentro del Horno.

Principales partes de la Inyectora:

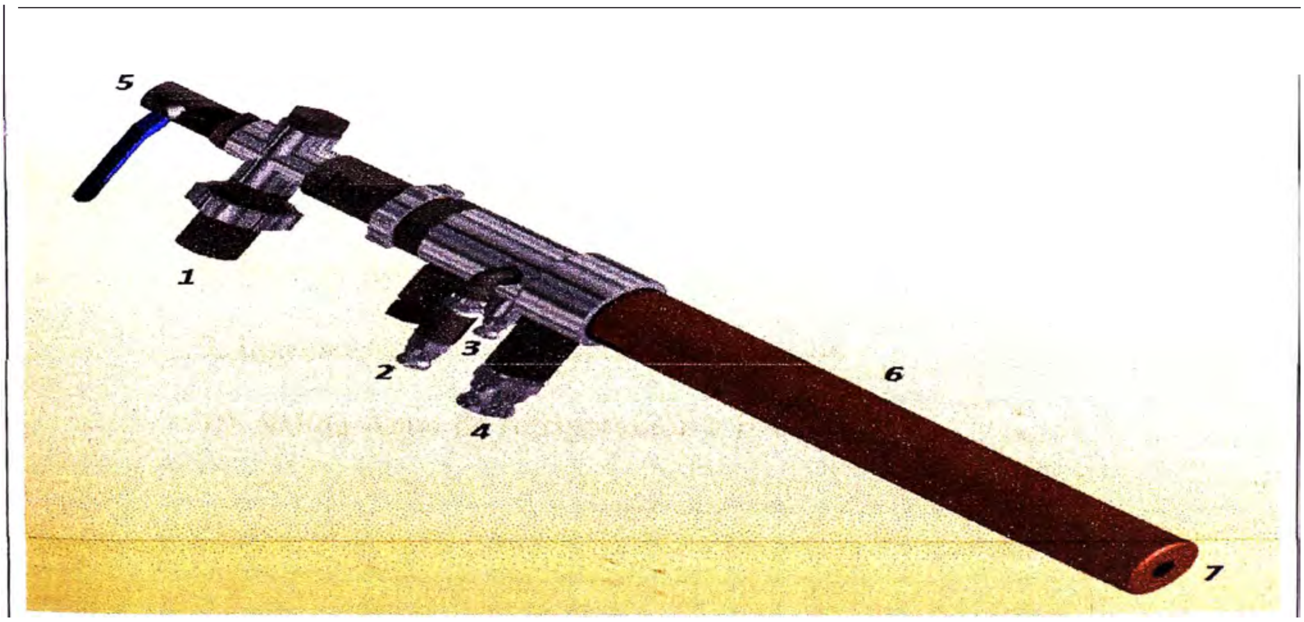


Figura 3.1 Inyectora de Carbón.

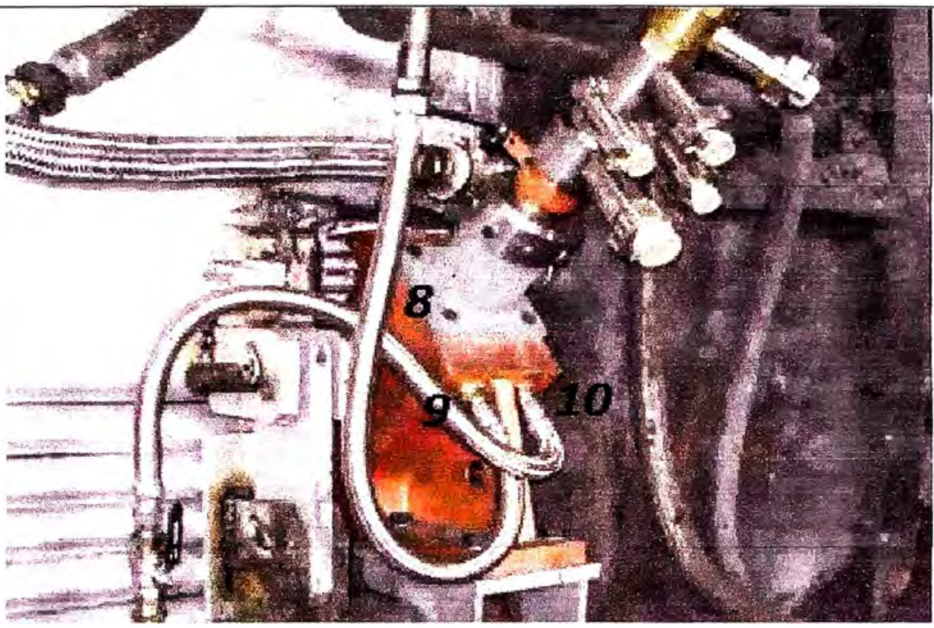


Figura 3.2 Bloque de Refrigeración

1. Ingreso de Carbón pulverizado.
2. Ingreso de Agua de refrigeración.
3. Ingreso de Aire Comprimido.
4. Salida de mezcla Aire – Agua.
5. Válvula de bola para mantenimiento.
6. Cuerpo de Cobre.
7. Boquilla.
8. Bloque Refrigerado.
9. Ingreso Agua de refrigeración a Bloque
10. Salida Agua de refrigeración a Bloque

- Cuerpo de Cobre

Longitud del Cuerpo Refrigerado	1000 mm
Material del Cuerpo Refrigerado	Cobre
Sistema de Refrigeración	USCS – *Sistema de Refrigeración Ultraseguro*
Diámetro Externo	110 mm
Diámetro Interno	60 mm
Sistema de Refrigeración Ultraseguro	
Presión de Agua (Entrada)	Mínimo 2 Bar
Calidad del Agua	Calidad Normal para el Horno *(Ver Anexo adjunto)*
Presión de Aire Comprimido (Entrada)	Mínimo 2 Bar
Calidad de Aire Comprimido	Calidad Normal de Aire
Flujo de Agua	2 m^3/h
Flujo de Aire Comprimido	50 m^3/h
Presión de Flujo de Refrigeración (Salida)	Atmosférica

- Boquilla

Diámetro Interno	28 mm
Material	Acero al Manganeso
Tiempo de vida	2000 Coladas
Presión de Aire Comprimido para Transporte	Desde 2. 5Bar hasta 3.5 Bar
Presión de Aire Comprimido para Purga	Desde 1. 5Bar hasta 2. 5Bar
Flujo de Carbón	Mayor a 50 kg/min

- Manguera de Carbón

Diámetro Nominal	1. 1/2"
Diámetro Interno	38 mm
Norma	DIN 20022 – 2SN
Diámetro Externo	62.5 mm
Presión de Trabajo	150 PSI
Material	SBR/NR / CUBIERTA: EPDM/NR
Refuerzo	2 Lonas (Tela sintética de alta tensión)
Longitud	2800 mm
Marca de Referencia	SELFLEX/PHOENIX
Tipo	SANDBLAST
Código SAP	10057113

- Manguera de Ingreso de Agua

El Agua es suministrado de la línea principal, aprovechando las instalaciones ya existentes.

Diámetro Nominal	3/4"
Pared Interior	Ondulada de Acero Inoxidable AISI 321
Pared Exterior	Malla de alambre de Acero Inoxidable AISI 316
Tipo	TM7AX
Longitud	1200 mm
Acoplamientos	Giratorios NPT, hembra Ø 3/4"
Código SAP	10057113
Norma	ISO 10380

- Manguera de Ingreso de Aire Comprimido

El Aire es suministrado de la línea principal, aprovechando las instalaciones ya existentes.

Diámetro Nominal	3/4"
Pared Interior	Ondulada de Acero Inoxidable AISI 321
Pared Exterior	Malla de alambre de Acero Inoxidable AISI 316
Tipo	TM7AX
Longitud	1800 mm
Acoplamientos	Giratorios NPT, hembra Ø 3/4"
Norma	ISO 10380
Código SAP	10057111

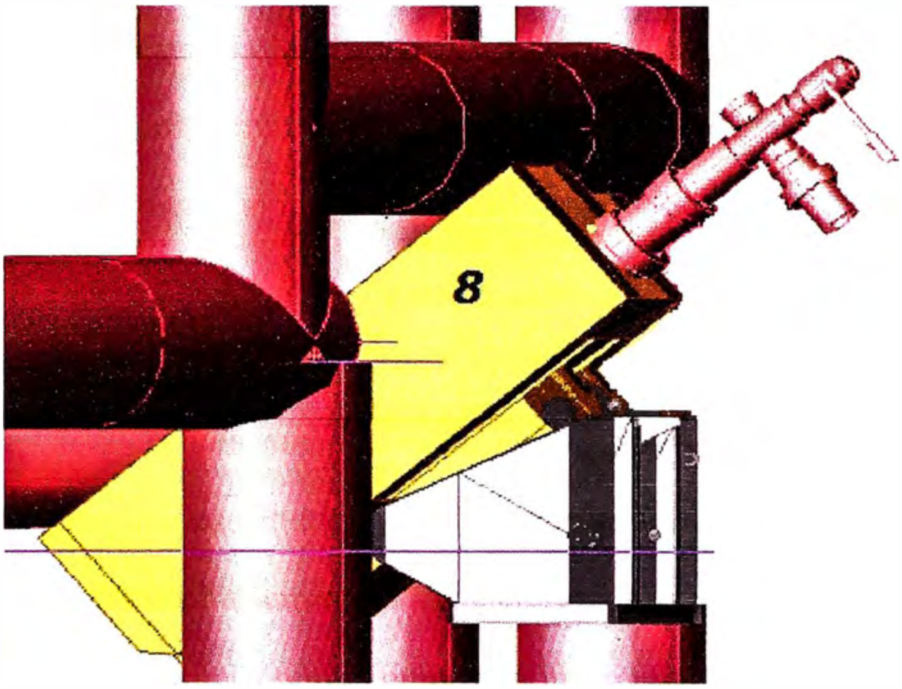
Ver disposición en plano 6TUB-77579, Pos. 69. (Ver Anexo adjunto)

- Manguera de Mezcla Aire – Agua

Diámetro Nominal	1. 1/2"
Pared Interior	Ondulada de Acero Inoxidable AISI 321
Pared Exterior	Malla de alambre de Acero Inoxidable AISI 316
Tipo	TM7AX
Longitud	1800 mm
Acoplamientos	Giratorios NPT, hembra Ø 3/4"
Norma	ISO 10380
Código SAP	10057122

Ver disposición en plano 6TUB-77579, Pos. 36. (Ver Anexo adjunto)

Bloque Refrigerado



El bloque de refrigeración es usado para:

- Instalar y corregir las lanzas e inyectoras KT sobre el Horno EAF
- Proteger las lanzas e inyectoras KT durante la carga de chatarra

El Bloque de Refrigeración está conectado a una entrada y una salida de agua Está fijada a la caja del horno con un soporte de acero, que permite la variación del ángulo de la instalación, por lo que el carbón podría ser inyectado con diferentes inclinaciones.

Material	Cobre
Fabricación	Colado
Peso Aproximado	400 kg
Presión de Agua de Entrada	5 Bar
Flujo de Agua	8 m^3/h

3.3 DISEÑO DE TUBERÍAS PARA INYECCIÓN DE CARBÓN

Es importante tener en cuenta que el transporte del carbón desde la tolva de almacenamiento hasta la propia inyectora es realizado por el movimiento del aire comprimido a 5 Bar que arrastra al carbón a través de un tendido de tuberías que conectan a una manguera para el ingreso a la inyectora.

Este carbón impulsado por el aire genera un efecto abrasivo en la tubería y manguera ocasionando el desgaste de éstos por lo que es importante realizar medición de espesores de las tuberías con frecuencias trimestrales para tener un mejor control del desgaste, además de un cambio preventivo de la manguera después de 4 meses de vida útil (por recomendación del fabricante).

Tubería:

Para la selección de la tubería se ha considerado las tomas de la tolva de almacenamiento ya existentes y las conexiones de la Inyectora que son de diámetro 2".

Por lo tanto:

Diámetro Nominal	2"
Norma	API 5L
Cédula	160
Espesor de Pared	8.71 mm
Peso Métrico	11.07 kg/m

Ver especificación Completa en Anexo adjunto

Codo:

Para la selección de los codos se ha tenido que realizar un diseño especial diferente a los codos convencionales de alta presión, puesto que, en los cambios de dirección del flujo de carbón son las zonas más críticas de abrasión y desgaste. Son llamados "codos tipo tambor". Ver anexo adjunto.

Bridas:

Las bridas son accesorios de unión entre tuberías, codos y mangueras, debido a que no están en contacto directo con el carbón pulverizado se ha seleccionado bridas estándares de 2" ANSI 150.

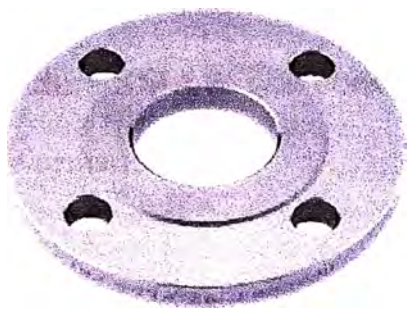


Figura 3.4 Brida para tuberías de Carbón

3.3.1 Proceso de Soldadura de las Tuberías y Accesorios

Para nuestro caso nuestro metal base es una tubería de 2" API 5L, por lo que se consideró trabajar con las normas de soldadura API 1104, ya que dicha norma contempla el procedimiento de soldadura de nuestra tubería.

Cabe resaltar que si bien la norma API 1104 no especifica la aplicación de ésta soldadura para el transporte de aire más carbón pulverizado, es necesario mencionar que la norma API 5L sí hace mención de la aplicación para un Horno Eléctrico, además de presentar mayor espesor de pared con el objetivo de tener más tiempo de vida útil en cuanto a presión, temperatura y abrasión.

Soldadura Manual

Intervienen cinco (5) componentes importantes llamado las 5M: Mano de obra, materiales, máquinas, medio ambiente y medios escritos (procedimientos). La unión satisfactoria implica que debe pasar las pruebas mecánicas (tensión, doblez). Las técnicas son los diferentes procesos (SMAW, SAW, GATW, etc.).

En nuestro caso, teniendo en cuenta los equipos propios con los que contamos en planta se ha utilizado la soldadura SMAW que considera el proceso de soldadura de todos los componentes pre armados.

El proceso SMAW, consiste en la utilización de un electrodo con un determinado recubrimiento, según sea las características específicas. A través del mismo se hace circular un determinado tipo de corriente eléctrica, ya sea esta de tipo alterna o directa. Se establece un corto circuito entre el electrodo y el material base que se desea soldar o unir, este arco eléctrico puede alcanzar temperaturas del orden de los 3500 °C, depositándose el núcleo del electrodo fundido al material que se está soldando, de paso se genera mediante la combustión del recubrimiento, una atmosfera que permite la protección del proceso, esta protección se circunscribe a evitar la penetración de humedad y posibles elementos contaminantes. También se produce una escoria que recubre el cordón de soldadura generado.

A continuación se indicará el proceso típico general de soldadura.

- Traslado de tuberías y accesorios a la zona de soldadura
- Limpieza de las zonas a soldar
- Soldado de tuberías y conexiones
- Limpieza de escorias de soldadura

3.4 MODFICACIÓN DEL PANEL REFRIGERADO

Nuestro Horno Eléctrico presenta dos partes estructurales importantes: cuba y carcaza.

La cuba o lower shell es la parte inferior que consta de una chapa metálica en forma ovoidal de 4.2 metros de diámetro que internamente contiene ladrillos y masa refractaria, que está en contacto directo con el acero líquido.

La carcaza o upper shell está fijada encima de la cuba y consta de paneles hechos de tuberías de 2" refrigerada internamente por agua a 5.5 Bar. Su función principal es hermetizar el interior del Horno para evitar filtrado de acero líquido.

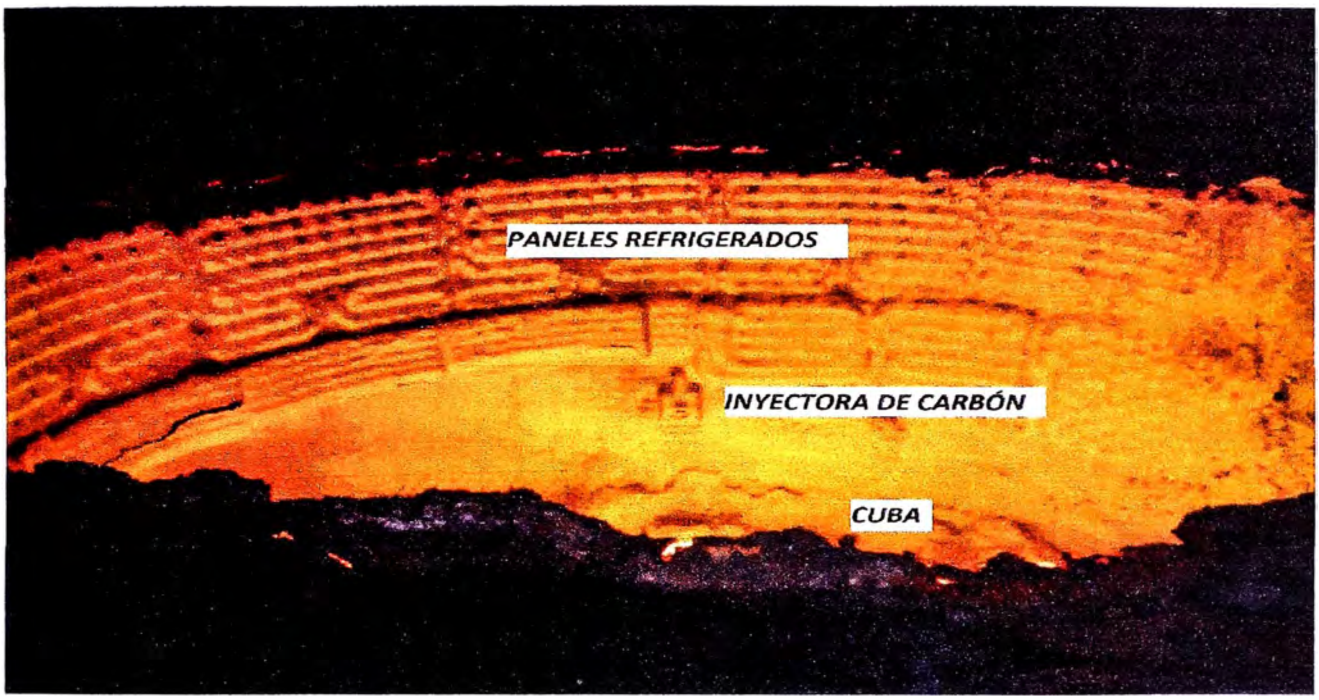


Figura 3.5 Interior del Horno Eléctrico

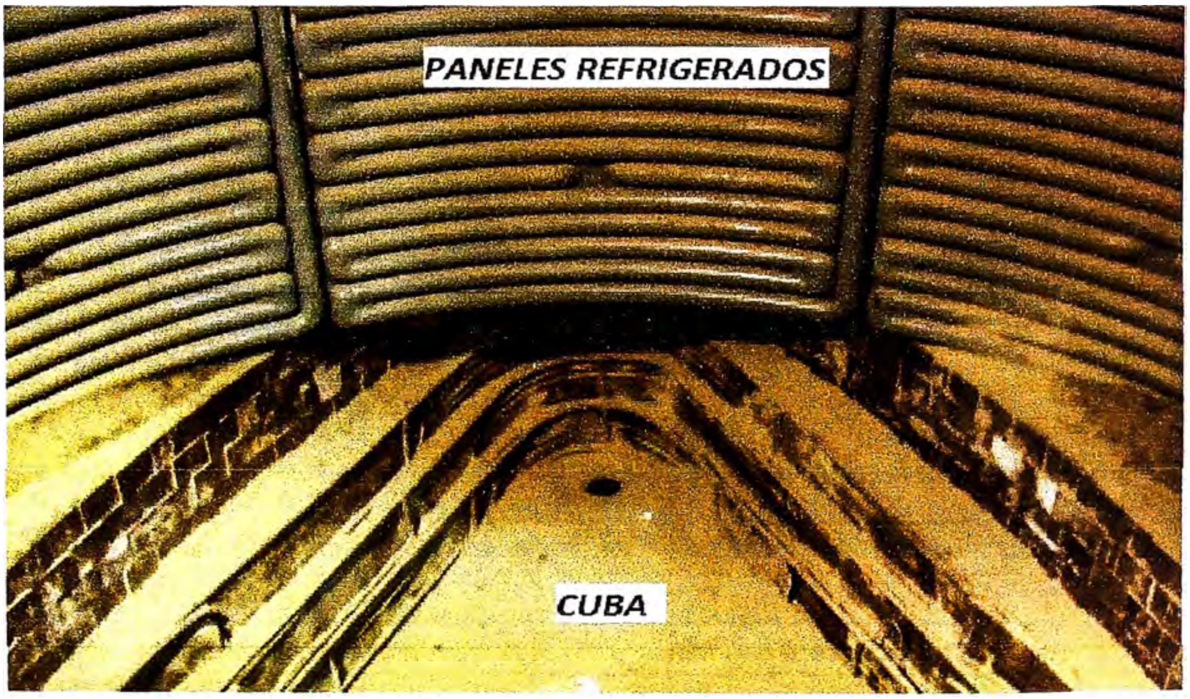


Figura 3.6 Paneles Refrigerados zona EBT

Figura 3.7 Paneles Refrigerados zona puerta de escoreo

Descripción técnica del Panel refrigerado

Tuberías

Diámetro Nominal	2"
Diámetro Exterior	73 mm
Diámetro Interior	53.96 mm
Espesor de Pared	9.52 mm
Cédula	160
Material	St. 35.8 DIN 17175

Codo 180°

Diámetro Nominal	2"
Paso (Distancia entre centros)	85 mm
Diámetro Exterior	73 mm
Diámetro Interior	53.96 mm
Espesor de Pared	9.52 mm
Cédula	160
Material	Fe410-1Kw-UNI 5689

Uniones Simples para entrada y salida de agua

Diámetro Nominal	2”
Rosca Interior	NPT
Norma	ANSI 3000
Material	ASTM A106-B

Originalmente el panel refrigerado fue diseñado para alojar a una lanza de oxígeno, sin embargo, debido a la implementación de la inyectora se realizó la modificación para crear un espacio de alojamiento adicional para dicha inyectora.

Proceso de Levantamiento de Plano

Se tomó como referencia el plano original 6INV-78596-A, además de las medidas geométricas del bloque refrigerado y la base de la inyectora, puesto que éstas hacen interferencias con el panel original. El plano modificado fue el CQ129-4059-101.

Proceso de Corte

Esta actividad considera los procesos de trazo, corte y esmerilado de los materiales a modificar.

El oxicorte es una técnica auxiliar de la soldadura, que se utiliza para la preparación de los bordes de las piezas a soldar cuando son de espesor considerable y para realizar el corte de chapas, tubos, barras de acero, etc.

El oxicorte consta de dos etapas: en la primera, el acero se calienta a alta temperatura (850°C – 950°C) con la llama producida por el oxígeno y un gas combustible; en la segunda, una corriente de oxígeno corta el metal y remueve los óxidos de hierro producidos.

En éste proceso se utiliza un gas combustible cualquiera (acetileno, hidrógeno, propano, hulla, etc.), cuyo efecto es producir una llama para calentar el material, mientras que como gas comburente siempre ha de utilizarse oxígeno a fin de causar la oxidación necesaria para el proceso de corte.

Bien sea una única cabeza o por separado, todo soplete cortador requiere de dos conductos por el que circule el gas y otro para el oxígeno. El soplete de oxicorte calienta al acero con su llama carburante y la apertura de la válvula de oxígeno provoca una reacción con el hierro de la zona afectada que lo transforma en óxido férrico (Fe_2O_3), que se derrite en forma de chispas al ser su temperatura de fusión inferior a la del acero.

Este proceso es estándar para todo tipo de corte de acero inclusive para las tuberías refrigeradas del panel.

Proceso de soldadura de un panel refrigerado

Tomando en cuenta la recomendación del fabricante la norma utilizada fue la norma italiana UNI 11001, sin embargo, por facilidad de información aplicaremos la norma AWS 5.1.

Para la selección del material de aporte se tuvieron los siguientes datos de la tubería:

Metal Base: St. 35.8 DIN 17175

Límite de Fluencia: Mínimo 235 MPa

Resistencia a la tracción: Desde 360 – 480 MPa

De acuerdo a la norma AWS 5.1 , se procedió a seleccionar bajo el proceso SMAW el electrodo E-6011 para el pase de raíz y E-7018 para el pase de relleno, el bisel de acuerdo a:

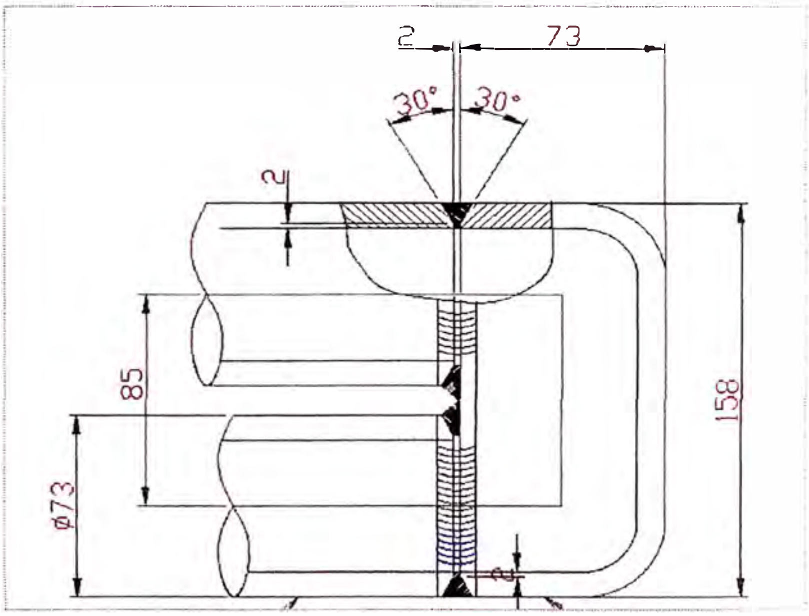


Figura 3.8 Bisel para tuberías de panel refrigerado (Ver plano CQ127-4059-101)

CAPÍTULO IV

IMPLEMENTACIÓN DEL SISTEMA AUTOMÁTICO DE INYECCIÓN DE CARBÓN

Las actividades de implementación de tuberías, montaje de inyectora y montaje de panel refrigerado se realizaron en parada programada de planta cuyo tiempo fue de 48 horas, siendo realizadas en su totalidad por el personal de mantenimiento mecánico.

4.1 DISPOSICIÓN DEL SISTEMA DE ALMACENAMIENTO DE CARBÓN Y AIRE COMPRIMIDO

Aunque el presente informe no contempla la implementación de estos sistemas (puesto que ya son existentes) se ha considerado importante mencionar su disposición en Planta para tener un mejor panorama véase anexo, plano 6P&I-77574-B.

El sistema está diseñado para almacenar 10 m3 de carbón en la tolva superior y 2 m3 de carbón en la tolva inferior la cual está conectada al sistema de aire a 6 Bar mediante un panel de electroválvulas neumáticas, el aire ejerce una presión negativa en la válvula de la línea de carbón que succiona a éste y lo transporta a la Inyectora.

Estas instalaciones ya son existentes, puesto que se utilizaban en el sistema anterior (sistema de inyección manual), sin embargo, se han hecho algunos cambios para la modernización de los componentes electrónicos como electroválvulas, sensores de humedad, presión y flujo, filtros y secadores de aire.

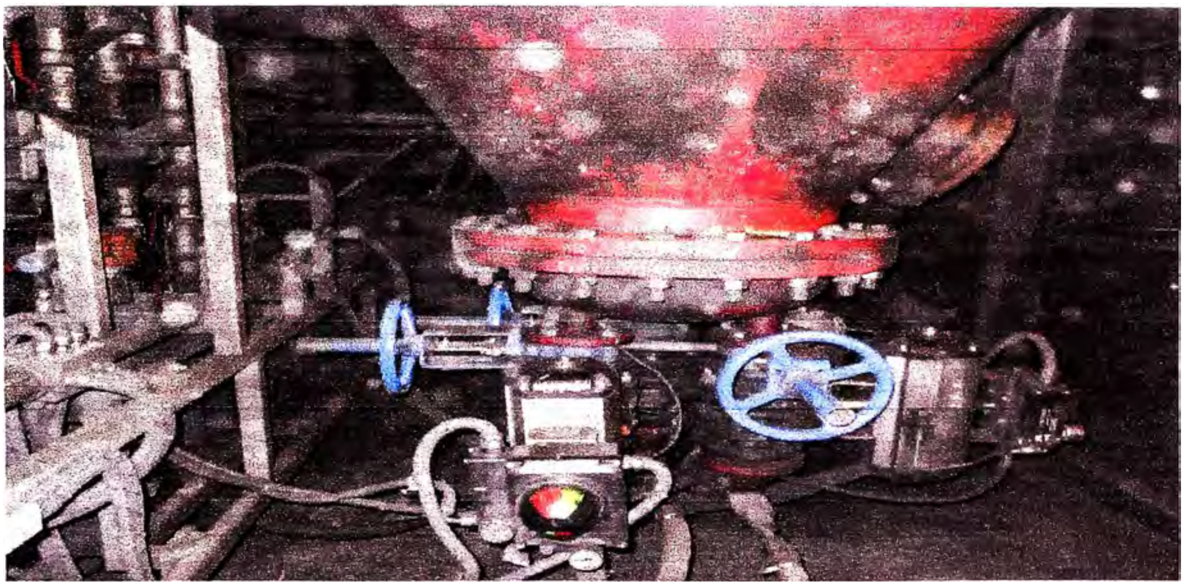


Figura 4.1 *Dispensador de Carbón*

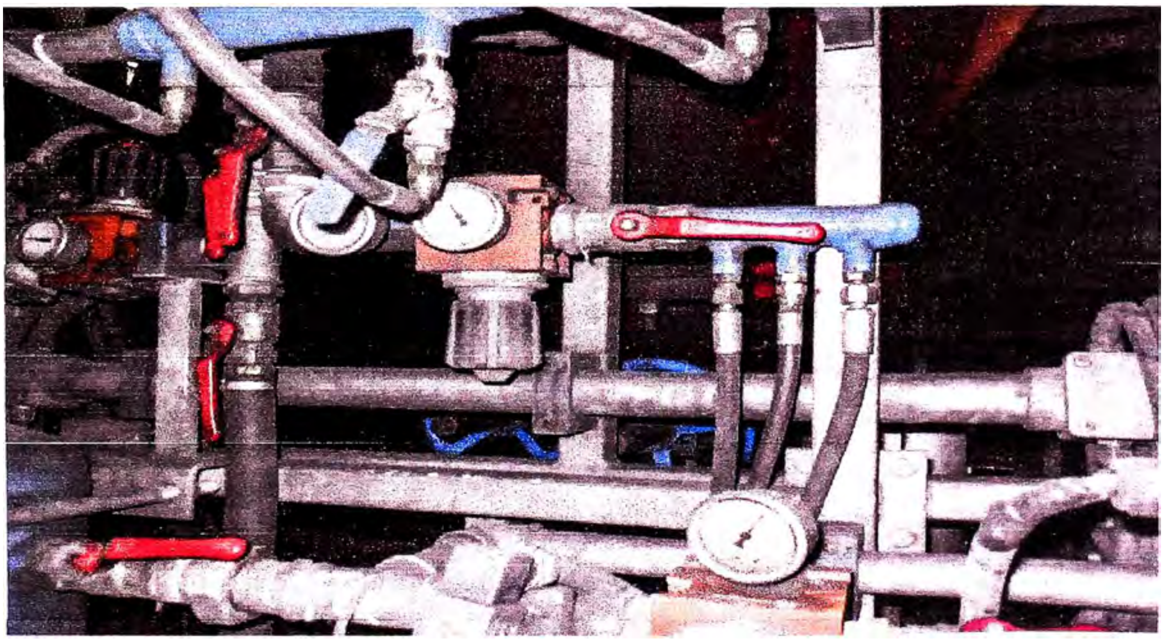


Figura 4.2 *Panel de válvulas neumáticas*

4.2 IMPLEMENTACIÓN DE MATERIALES PARA EL TRANSPORTE DEL CARBÓN

Está enfocado principalmente al tendido de tuberías para la inyección de carbón así como sus accesorios descritos en 3.3, es necesario resaltar que se hizo un pre armado de las tuberías y bridas en el taller de soldadura por lo tanto en campo se realizaron los trabajos de empalme de las bridas y codos tipo tambor. El montaje se realizó de acuerdo a plano 6P&I-77574-B (ver adjunto).

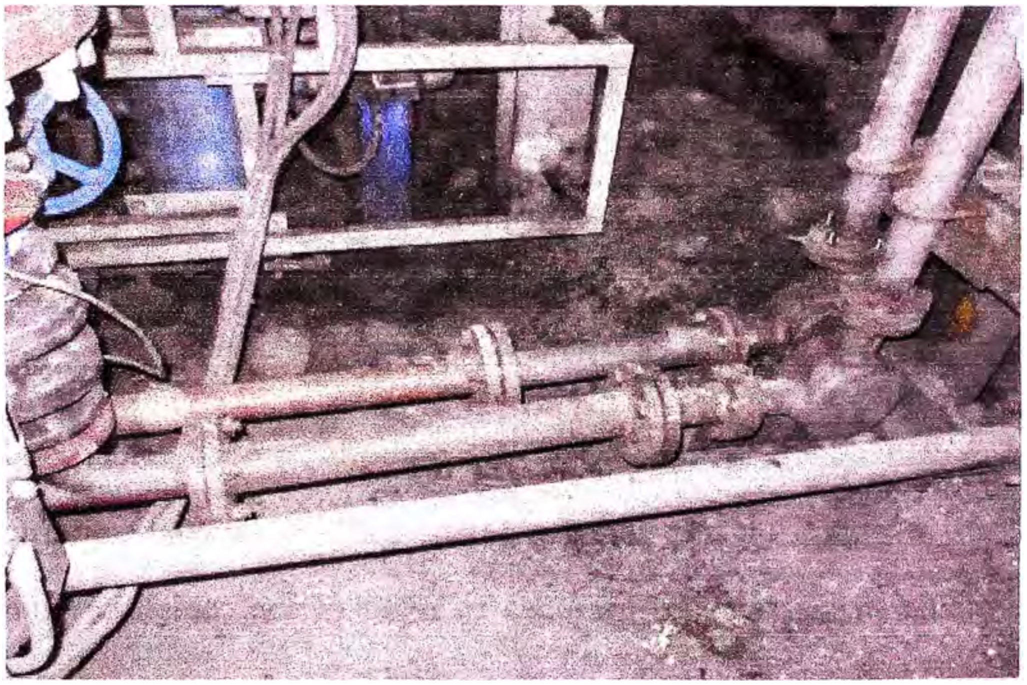


Figura 4.3 Disposición de tuberías de Carbón.

4.3 IMPLEMENTACIÓN DE PANEL REFRIGERADO

Al igual que la inyectora el panel refrigerado por sus dimensiones y peso (350 kg aprox.) necesita de un trabajo de izaje y maniobra en campo. El cambio de paneles refrigerados del Horno es normalmente realizado por personal de mantenimiento planta.

Es necesario resaltar que las líneas de agua y aire son existentes por lo que se tuvo que adaptar las mangueras según la disposición de las tuberías en el físico.

4.4 IMPLEMENTACIÓN DE LA INYECTORA DE CARBÓN

Consiste en realizar trabajos de izaje con grúa puente (existente en planta) y maniobras mecánicas del equipo para ser instalado en el panel refrigerado que fue modificado.

De acuerdo a lo mencionado en el punto 3.2 (Datos técnicos del bloque refrigerado) el peso es aproximadamente 400 kg además que el espacio donde se realizará el montaje es muy reducido, por lo tanto es necesario realizar las maniobras con el personal debidamente capacitado, EPP´s, radios portátiles para coordinación con el gruero.

A continuación se indica el procedimiento a seguir para el correcto montaje de la inyectora:

Actividad	Materiales, equipos y herramientas
1. Bloqueo de Energías.	Candado y etiqueta
2. Colocar eslinga a bloque refrigerado	Eslinga 4" x 6 mts. de Poliester 5 Tn). Guantes de seguridad NRF – 114.
3. Izar con grúa.	Grúa puente 90 Tn. Radio Motorola PRO 5150 para comunicación.
4. Trasladar a Horno Eléctrico.	Radio Motorola Modelo PRO 5150.
5. Colocar tecle de 2 Tn. para maniobras.	Tecle de 2 Tn.
6. Con movimientos de la grúa y maniobras de tecle, introducir bloque refrigerado a panel.	Radio Motorola PRO 5150. Tecle. 04 técnicos mecánicos.
7. Fijar base, colocar pasador de posición.	Pasador de posición.
8. Montar manualmente el cuerpo de cobre (Inyectora).	01 técnico mecánico.
9. Conectar mangueras.	Llave neumática con encastre de 3/4".
10. Desbloqueo	Candado, etiqueta.

Implementos de Seguridad e Izaje

	
Figura 4.4 Candados y etiquetas de bloqueo	*Figura 4.5 Guantes de seguridad NRF – 114*
	
Figura 4.6 Tecle de 2 Tn	*Figura 4.7 Eslinga de poliéster 5 Tn*

4.5 PUESTA EN MARCHA

4.5.1 Consideraciones antes de la puesta en marcha

Para la puesta en marcha y demás pruebas varias condiciones de funcionamiento deben cumplirse para garantizar un desarrollo del proyecto sin dificultades

a) Chatarra:

Durante la duración de la prueba, la chatarra en una cantidad aceptable, así como una adecuada calidad.

Calidad de chatarra, quiere decir, que la chatarra debe ser cargada al Horno adecuadamente y con una densidad entre 0.8 – 1.2 t/m^3.

b) Inyección de Carbón:

La velocidad de flujo requerida de la máquina de carbono a los lugares de lanza debe estar garantizada para evitar problemas en la creación de escoria espumosa y por lo tanto mantener el desgaste del refractario bajo control.

Todos los medios de enfriamiento y purga de la lanza de carbono tienen que estar disponibles durante toda la prueba.

c) Carbón:

Para la inyección de carbón los valores establecidos en la especificación EM-500-004 Rev.0 (Ver anexo adjunto) deben cumplirse para garantizar un buen efecto escoria espumosa y una buena protección del refractario.

4.5.2 Prueba en Vacío

Después de la instalación y antes de iniciar la primera colada se debe inspeccionar la inyectora de carbón también de en el interior del horno con respecto a la posición exacta, el ángulo y la distancia al refractario, así como la distancia a los electrodos. Si es necesario la posición debe ajustarse o el refractario debe ser corregido.

4.5.3 Prueba con Carga

Antes de arrancar el horno por primera vez o después de una larga parada, éste opera en condiciones en frío. Por lo tanto el sistema no puede ser operado desde el principio. En primer lugar el Horno tiene que ser operado hasta un cierto nivel de temperatura, hasta que el sistema pueda ser iniciado para garantizar una auto-ignición debido a los gases calientes.

Para el sistema de carbón el flujo de aire de purga debe ser garantizado desde el principio de la primera colada.

Después de que todos los controles están verificados la puesta en marcha será seguida por aproximadamente dos días período de prueba en la que se probarán diferentes velocidades de flujo de carbón.

CAPÍTULO V

COSTOS

El control de los costos se hizo con el programa SAP durante todo el proyecto y se consideró la siguiente estructura:

- Costos de Equipos
- Costos de Materiales
- Costos de Mano de Obra
- Costo Final

Todos los valores a continuación se presentan en Dólares Americanos.

5.1 COSTOS DE EQUIPOS

Consta de todos los equipos eléctricos, mecánicos, electrónicos y de control que fueron suministrados por el proveedor de la Inyectora de Carbón.

Descripción	Cantidad	Costo Unitario (US$)	Costo Parcial (US$)
Bloque Refrigerado	1	38,000.00	38,000.00
Cuerpo de Cobre (Inyectora)	2	25,000.00	50,000.00
Secador de aire.+3°C,CNX ø1.1/2"	1	6,800.00	6,800.00
Bomba Booster 2" AIR CONTROL	1	4,000.00	4,000.00
Tablero Electroneumático	1	16,000.00	16,000.00
Separador de Agua ø1.1/2 purga automática	1	2,000.00	2,000.00
Costo Total Equipos			**116,800.00**

5.2 COSTO DE MATERIALES

Considerados los accesorios adicionales de los equipos, normalmente la función de estps materiales es menos compleja que la de un equipo, por ejemplo: tuberías, paneles refrigerados, termoresistencias, etc.

Descripción	Unidad	Cantidad	Costo Unitario (US$)	Costo Parcial (US$)
Panel Refrigerado N°9 para Horno	UN	1	13,500.00	13,500.00
Termoresistencia RTD PT 100 OHM 0-10	UN	5	3,000.00	15,000.00
Tubería 2" SCH160 ACERO API 5L	M	150	40	6,000.00
Codo 90° Tipo tambor	UN	10	480	4,800.00
Soldadura 7018 1/8"	Kg	100	35	3,500.00
Adaptador rápido para manguera 2 1/2" HEM NPT INOX	UN	30	100	3,000.00
Soldadura 6011 1/8"	Kg	50	48	2,400.00
Brida ø2" ANSI 150	UN	24	87.5	2,100.00
Tubería 1 1/2 PG X 6.00 MT, SCH 80, AST	M	72	27.78	2,000.00
Manguera arenadora 1 1/2 PG 150 PSI	UN	10	200	2,000.00
Válvula de bola 2 " NPT 1000PSI INOX AISI316	UN	10	200	2,000.00
Empaquetadura ø 2" 150# RF	UN	20	74.3	1,486.00
Acoplamiento 1 1/2" NPT 3000 LBS ACERO ASTM	UN	20	72.8	1,456.00
Niple 1 1/2" X 5" DE ACERO 10 KG/CM2 S	UN	100	9.68	968
Manguera metálica flexible 3/4" X 1.80 M	UN	10	40	400
Manguera metálica flexible 1/2"x1.80 Mt	UN	10	40	400
Manguera metálica flexible 1/4" x 0.5 Mts	UN	10	40	400
Manguera metálica flexible ø1/2 X 0.5m	UN	10	40	400
Costo Total de Materiales				**61,810.00**

5.3 COSTO DE MANO DE OBRA

Personal contratado para realizar trabajos de Ingeniería, transporte, servicios mecánicos, eléctricos y electrónicos.

Descripción	Unidad	Cantidad	Costo Unitario (US$)	Costo Parcial (US$)
Servicio de Ingeniería	UN	1	1	25,000
Configuración electrónica en el HMI	UN	1	1	18,000
Tendido de Tuberías	UN	1	1	12,000
Implementación de Tablero Electroneumático	UN	1	1	11,000
Instalación de Bomba Booster, Secador.	UN	1	1	6,000
Costo Total de Mano de Obra				**72,000**

5.4 COSTO FINAL

Engloba todos los costos del proyecto.

Descripción	Unidad	Cantidad	Costo Unitario	Costo Parcial
Costo Total Equipos	UN	1		116,800.00
Costo Total de Materiales	UN	1		61,810.00
Costo Total de Mano de Obra	UN	1		72,000.00
Costo Total del Proyecto				**250,610.00**

5.5 RETORNO DE LA INVERSIÓN

Consideremos:

- Para la producción de 27.5t de acero líquido, se requiere una carga de 31t (carga metálica de chatarra).
- Las 31t de carga metálica, generan 3000 Kg de escoria.
- De los 3000 Kg, 962.10 Kg, son FeO, este representa el 32.07% del volumen de escoria.

- La lanza de carbón adicional permitirá reducir aún más el FeO (Oxido Ferroso) de la escoria de 32.07% a 18.00%, y asi aumentar el rendimiento de acero por colada.

Recuperación de Acero **$FeO + C \rightarrow Fe + CO$**

Kg. Escoria	CARACTERICAS	%FeO	Kg FeO	Kg Fe metálico
3000	% FeO Inicial	32.07	962.1	748
	% FeO Después de la implementación	12.1	361	281.00
		14.07	422.1	**467**

Del **Fe metálico** 467.00Kg, se pierde un 2.0% en el proceso de desescoreo por tanto:

El porcentaje de ganancia efectivo 1.48%, representa la proyección en el escenario probable de la implementación de la Inyectora de carbón, a continuación verificaremos los beneficios cuantificables

Se pierde un 2% en el desescoreo	458.00	kg
Carga metálica	31.00	t
Acero líquido sangrado	27.50	t
Rendimiento de Acero Líquido sin Inyectora	88.70	%
Ahora sangrar 27.500t+0.458t con lanza	27.96	t
Rendimiento de Acero Líquido con Inyectora	90.18	%
Porcentaje de ganancia efectivo	**1.48**	**%**

Área: ACERIA

DESCRIPCIÓN	UNID.	Jul-10 CANTID./t.	Jul-10 PRECIO UNIT.	Jul-10 COSTO/t	Proyeccion + 1.5% Rend Solido CANTID./t.	Proyeccion + 1.5% Rend Solido PRECIO UNIT.	Proyeccion + 1.5% Rend Solido COSTO/t	DESVIO EFECTO PRECIO	DESVIO EFECTO CONSUMO	DESVIO EFECTO VOL. PROD.	DESVIO DESVIO TOTAL
COSTO TOTAL	US$/t	0.0	-	561.22	0.0	-	374.15	(0.00)	4.15	0.00	4.15
MATERIA PRIMA	Kg	0.0	-	355.10	0.0	-	236.73	(0.00)	3.52	0.00	3.52
PATIO METALICOS	Kg	0.0	-	15.25	0.0	-	10.17	0.00	0.15	0.00	0.15
CARGA METALICA	Kg	1.1562	-	279.73	1.1447	-	186.49	(0.00)	2.77	0.00	2.77
FERROALEACIONES	Kg	0.0000	-	60.12	0.0000	-	40.08	(0.00)	0.60	0.00	0.60
OPERACIONAL		0.00	0.00	206.12	0.00	0.00	137.41	0.00	1.48	0.56	2.04
PERSONAL		0.0	-	12.39	0.0	-	8.26	0.00	0.00	0.12	0.12
ENERGÉTICOS		0.0	-	64.47	0.0	-	42.98	0.00	0.64	0.00	0.64
REFRACTARIOS		0.0	-	12.55	0.0	-	8.37	0.00	0.12	0.00	0.12
MAT ESPECIFICOS		0.0	-	66.46	0.0	-	44.31	0.00	0.66	0.00	0.66
MANTENIMIENTO		0.0	-	19.35	0.0	-	12.90	0.00	0.06	0.13	0.19
MANT. - VARIABLE		0.0	-	6.18	0.0	-	4.12	0.00	0.06	0.00	0.06
MANT. - FIJO		0.0	-	13.17	0.0	-	8.78	0.00	0.00	0.13	0.13
OTROS COSTOS OPERACIONALES		0.0	-	30.91	0.0	-	20.61	0.00	(0.00)	0.31	0.31
PRODUCCION				13,696.59			13,902.55				205.47

Cuadro. Producción de Acero del Julio 2010 con proyección del 1.5% Rendimiento Solido

El desvío total de 205.47t corresponde al 1.5% de 13696.59t de acero sólido, con esta premisa podemos concluir los siguiente:

Beneficio Acero Sólido (t)	205.4
Rendimiento en Desbastador (Jul-10)	94.63%
Cantidad Marginal (US$)	194.4
Rentabilidad (BM)	124
Total Beneficio mes (US$)	24,101.88
Total Beneficio año (US$)	289,222.59
Total de Inversion (US$)	255,000.00
Retorno de la Inversión Mensual	**9.5%**
Tiempo de Retorno de la Inversión	**11 meses**

CONCLUSIONES

1. De acuerdo al análisis de costos el proyecto es factible ya que se recupera la inversión en menos de un año.

2. La inyectora de Carbón a pesar que se encuentra dentro del Horno Eléctrico y cerca del acero líquido tiene una protección adicional, que es la escoria que se adhiere a las paredes del bloque refrigerado y actúa como un aislante.

3. Cabe resaltar que se ha eliminado totalmente el riesgo del operador para inyectar carbón manualmente, ésta era una actividad comúnmente realizada con el sistema manual y producía constantes accidentes en el personal.

4. La producción aumentó, debido a la mejora del rendimiento metálico producto de un ángulo fijo de inyección, control automático que garantiza la cantidad exacta de carbón en el momento adecuado maximizando el pase de hierro de la escoria al baño líquido. Ver cuadro a continuación.

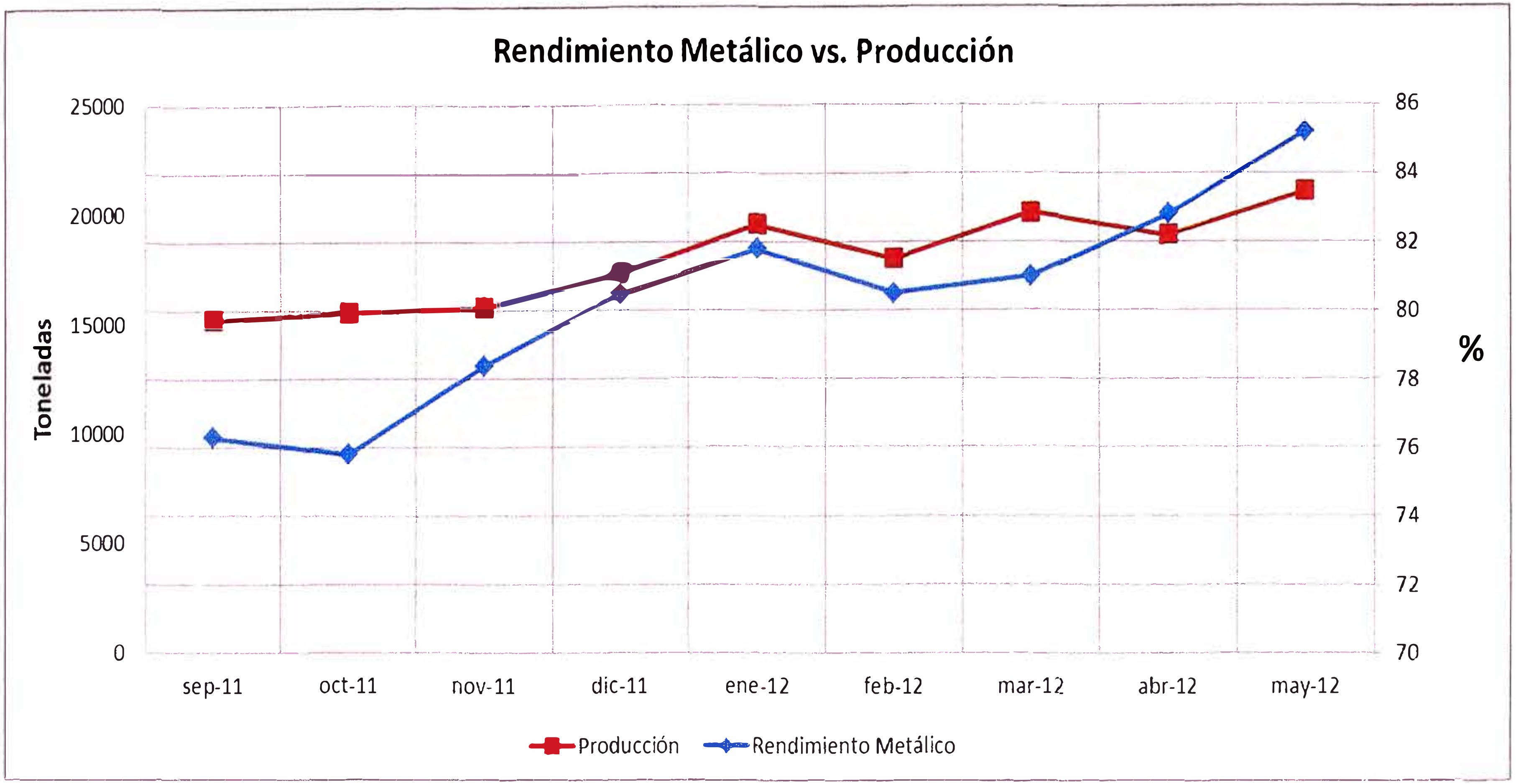


Figura A1. Gráfico Rendimiento Metálico vs. Producción - Planta de Acería SIDERPERU, fecha de análisis a partir del arranque de la inyectora automática de carbón.

RECOMENDACIONES

1. Es necesario capacitar al personal de mantenimiento en las reparaciones de soldadura de algún componente, se deben seguir estrictamente los procedimientos de soldadura, montaje, pruebas e inspecciones ya que alguna filtración de agua al acero líquido podría ocasionar una explosión con daños muy serios.

2. Es necesario inspeccionar semanalmente el carbón en la tolva y dispensador, verificar humedad y granulometría.

3. Se recomienda soldar tuberías en Y a las existentes para facilitar la limpieza en caso de un trabamiento de carbón.

4. Siempre mantener la Inyectora con aire para mantener limpia la boquilla, de lo contrario la escoria podría obstaculizar el pase de carbón.

Ed. SPAINFO, S.A.

Primera edición, 1998

Páginas web:

1. www.serchtemuco.cl/soldaduras/Manual%20de%20Soldadura%20Oerlicon.pdf
2. www.ihobe.net/publicaciones/descarga/EPER/Acero_c.PDF
3. www.gcelsa.com
4. www.sidelpa.com/especiales_.htm
5. www.bfi.de
6. www.mundoacero.com/

ANEXOS

fication	**API 5L** NPS 1/8 – 26
	Covers WELDED and SEAMLESS pipe suitable for use in conveying gas, water, and oil in both the oil and natural gas industries.
f Steel Permitted e Material	Open-hearth Basic-oxygen Electric-fumace
ped izing	May be ordered galvanized.
sible Variations Thickness	(see table below)
cal ements	(see table below)
ements	Lists minimum yield and tensile strength for all grads as well as a maximum tensile strength for X80. Maximum yield-to-tensile ratios outlined for cold-expanded pipe–may be waived when a fracture toughness requirement is specified.
tatic	Lists hydrostatic inspection test pressures for all sizes and grades covered by the specification. Test Pressures are held for not less than: Seamless (all sizes) – 5 seconds Welded (NPS 18 and smaller) – 5 seconds (NPS 20 and larger) – 10 seconds
sible Variations ghts per Foot	For each length of Standard Weight, Regular Weight, Extra Strong, and Double Extra Strong – Not more than plus 10% minus 3.5%. For Special Plain End – Not more than plus 10% minus 5%. For Carload Lots – Not more than minus 1.75%.

sible Variations Thickness

	Grade A, B, A25	X42 through X80
NPS 2 1/2 and smaller – Seamless and welded, %	+20 – 12.5	+15 – 12.5
NPS 3 – Seamless and welded, %	+18 – 12.5	+15 – 12.5
NPS 4 through 18 – Seamless and welded, %	+15 – 12.5	+15 – 12.5
NPS 20 and larger – Welded, %	+17.5 – 10.0	+19.5 – 8.0
NPS 20 and larger – Seamless, %	+15.0 – 12.5	+17.5 – 10.0

cal ements

	C max %	Mn max %	P max %	S max %
Seamless or ERW				
Grade A	0.25	0.95	0.05	0.06
Grade B	0.30	1.20	0.05	0.06
Continuous-weld	-	-	0.08	0.06

sible Variations side Diameter

Outside Diameter at any point shall not vary from standard specified more than:

Sizes	Over	Under
NPS 1 1/2 and smaller	1/64"	1/32"
NPS 2 through 4	1%	1% (Buttweld Only)
NPS 2 through 18	.75%	.75%
NPS 20 through 26		
Non-expanded	1%	1%

nical Tests ied

Tensile Test
Seamless and Buttwelded – All Sizes – Longitudinal Specimens
Electric Weld – NPS 6 and smaller – Longitudinal
NPS 8 and Larger – Transverse

Bending Test (Cold) – 2" and smaller Buttweld.

	Degree of Bend	Diameter of Mandrel
For all API Uses	90	12 x OD of pipe

er of Required

	NPS	On One Length From Each Lot of
Tensile	5 and smaller	40 or less
	6 through 12	200 or less
	14 and larger	100 or less
	2 and smaller (Buttweld)	25 tons or less
Bending	1 1/2 and smaller (Buttweld)	50 tons or less

Flattening
Non-Expanded Electric-Weld for single lengths crop ends from each length. For multiple lengths, crop ends from each length, plus 2 intermediate rings.

hs

Threaded & Coupled Pipe	Shortest Length In Entire Shipment	Shortest Length in 95% of Entire Shipment	Minimum Average Length of Entire Shipment
Single Random	16' 0"	18' 0"	–
Double Random	22' 0"	–	35' 0"

ired Markings ch Length ags attached to Bundle in case ndled Pipe)

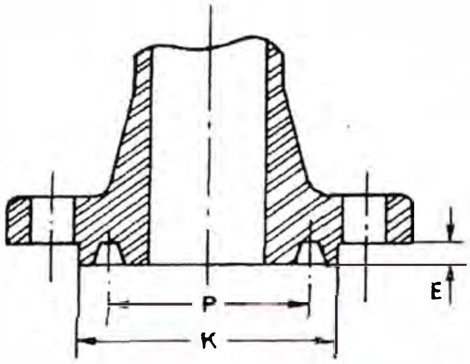
Paint Stenciled or Die Stamped (by agreement).
Manufacturer's name or mark. Spec 5L, size, weight per foot, grade, process of manufacture, type of steel, length (NPS 4 and larger only). Test pressure when higher than labulated(NPS 2 and larger only).
Heat treat symbols, as applicable – HN, HS, HA or HQ.

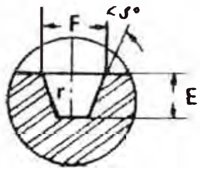
ral nation

Supplementary Requirements available when specified. SR5–Charpy impact Testing–Welded Pipe 20" & larger–Grade X52 or higher.
SR3 – Color Identification.
SR4 – Nondestructive Inspection of Seamless Pipe.
SR6 – Drop Weight Tear Testing–Welded Pipe 20" & larger–Grade X52 or higher.
SR8 – Fracture Tough ness Testing of Line Pipe.

Tablas y normas de bridas
ANSI 600 LB. - 900 LB.

ANSI 600 LB. -900 LB.

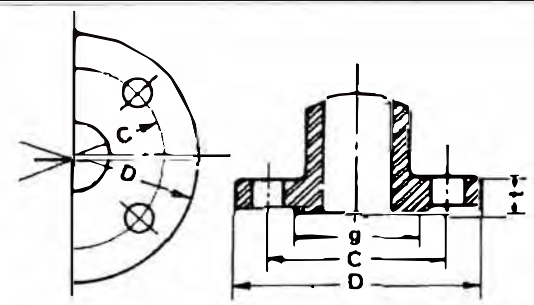




Bridas junta de anillo. ANSI B16.5 ANSI B16.5 Ring Joint Flanges

ANSI	Ø Pulgadas Size *Inches*		K		P		GROOVE	E		F		r	
			inch	mm.	inch	mm.	No.	inch	mm.	inch	mm.	inch	mm.
600 Lb.	1/2	15	2	50.8	1.11/32	34,131	R11	7/32	5.6	9/32	7,144	1/32	0.7
	3/4	20	2.1/2	63.5	1.11/16	42,862	R13	1/4 .	6.4	11/32	8,731	1/32	0.7
	1	25	2.3/4	69.8	2	50,800	R16	1/4	6.4	11/32	8,731	1/32	0.7
	1.1/4	32	3.1/8	79.4	2.3/8	60,325	R18	1/4	6.4	11/32	8,731	1/32	0.7
	1.1/2	04	3.9/16	90.5	2.11/16	68,262	R20	1/4	6.4	11/32	8,731	1/32	0.7
	2	50	4.1/4	108.0	31/4	82,550	R23	5/16	8.0	15/32	11,906	1/32	0.7
	2.1/2	65	5	127.0	4	101,600	R26	5/16	8.0	15/32	11,906	1/32	0.7
	3	80	5.3/4	146.0	4.7/8	123,825	R31	5/16	8.0	15/32	11,906	1/32	0.7
	4	100	6.7/8	174.6	5.7/8	149,225	R37	5/16	8.0	15/32	11,906	1/32	0.7
	5	125	8.1/4	209.6	7.1/8	180,975	R41	5/16	8.0	15/32	11,906	1/32	0.7
	6	150	9.1/2	241.3	8.5/16	211,138	R45	5/16	8.0	15/32	11,906	1/32	0.7
	8	200	11.7/8	301.6	10.5/8	269,875	R49	5/16	8.0	15/32	11,906	1/32	0.7
	10	250	14	355.6	12.3/4	323,850	R53	5/16	8.0	15/32	11,906	1/32	0.7
	12	300	16.1/4	412.8	15	381,000	R57	5/16	8.0	15/32	11,906	1/32	0.7
	14	350	18	457.2	16.1/2	419,100	R61	5/16 .	8.0	15/32	11,906	1/32	0.7
	16	400	20	508.0	18.1/2	469,900	R65	5/16 -	' 8.0	15/32	11,906	1/32	0.7
	18	450	22.5/8	547.7	21	533,400	R69	5/16	8.0	15/32	11,906	1/32	0.7
	20	500	25	635.0	23	584,200	R73	3/8	9.6	17/32	13,494	1/16	1.5
900 Lb.	1/2	15	2.3/8	60.3	1.9/16	39,688	R12	1/4	6.4	11/32	8,731	1/32	0.7
	3/4	20	2.5/8	66.7	1.3/4	44,450	R14	1/4	6.4	11/32	8,731	1/32	0.7
	1	25	2.13/16	71.4	2	50,800	R16	1/4	6.4	11/32	8,731	1/32	0,7
	1.1/4	32	3.3/16	81.0	2.3/8	60,325	R18	1/4	6.4	11/32	8,731	1/32	0.7
	1.1/2	40	3.5/8	92.1	2.11/16	68,262	R2Q	1/4	6.4	11/32	8,731	1/32	0.7
	2	50	4.7/8	123.8	3.3/4	95,250	R24	5/16	8.0	15/32	11,906	1/32	0.7
	2.1/2	65	5.3/8	136.5	4.1/4	107,950	• R27	5/16	8.0	15/32	11,906	1/32	0.7
	3	80	6.1/8	155.6	4.7/8	123,825	R31	5/16	8.0	15/32	11,906	1/32	0.7
	4	100	7.1/8	181.0	5.7/8	149,225	R37	5/16	8.0	15/32	11,906	1/32	0.7
	5	125	8.1/2	215.9	7.1/8	180,975	R41	5/16	8.0	15/32	11,906	1/32	0.7
	6	150	9.1/2	241.3	8.5/16	211,138	R45	5/16	8.0	15/32	11,906	1/32	0.7
	8	200	12.1/8	308.0	10.5/8	269,875	R49	5/16	8.0	15/32	11,906	1/32	0.7
	10	250	14.1/4	362.0	12.3/4	323,850	R53	5/16	8,0	15/32	11,906	1/32	0.7
	12	300	16.1/2	419.1	15	381,000	R57	5/16	8.0	15/32	11,906	1/32	0.7
	14	350	18.3/8	466.7	16.1/2	419,100	R62	5/16	11.2	21/32	16.669	1/32	1.5
	16	400	20.5/8	523.9	18.1/2	469,900	R66	7/16	12.7	21/32	16.669	1/16	1.5
	18	450	23.3/8	593.7	21	533,400	R70	1/2	12.7	25/32	19,844	1/16	1.5
	20	500	25	647.7	23	584,200	R74	1/2	12.7	25/32	19,844	1/16	1.5

Tablas y Normas de Bridas ANSI 150LB – 300LB
Tables of Flanges



ANSI 150 Lb. RF 300 Lb. RF

Bridas ANSI 150 Lb. ANSI 150 Lb. Flange

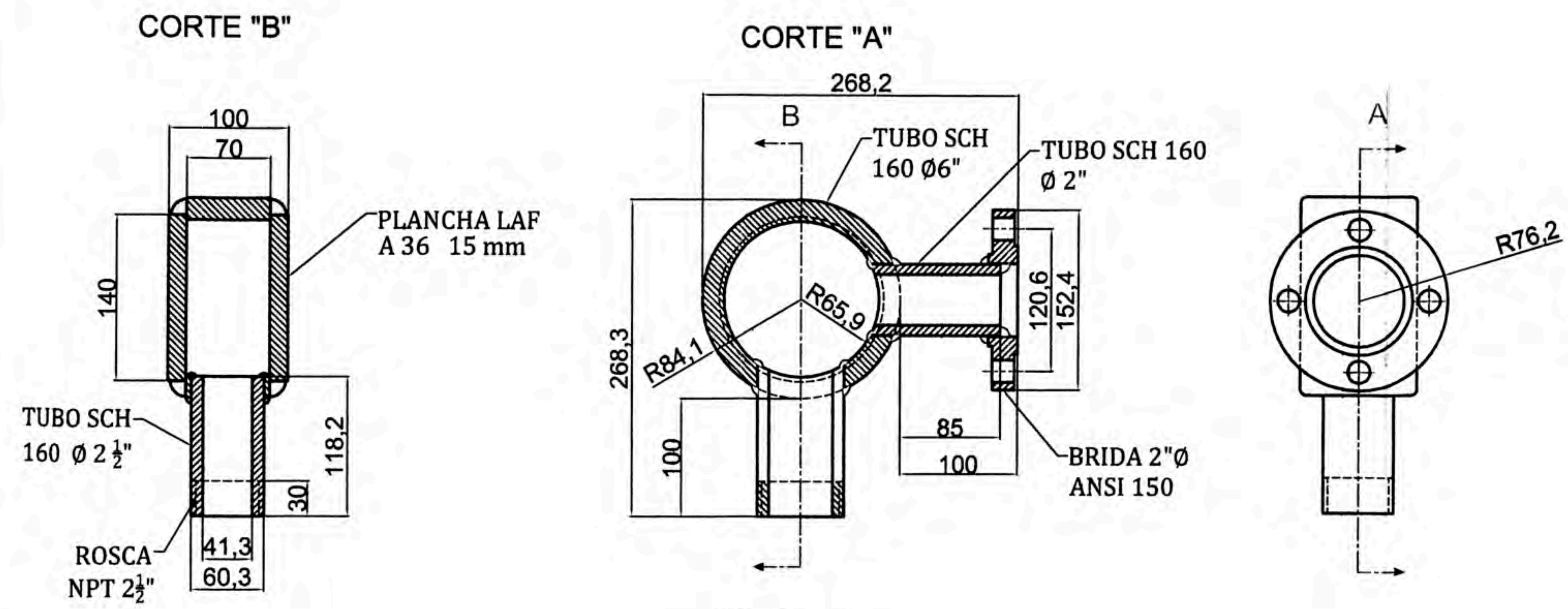
0 Pulgadas ,; Size *Iches*		D		t		C		9		Tomillo *Bolt*		Taladro *M Bolt Hole*	
		inch	mm.	inch	mm.	inch	mm.	inch	mm.	Numero *Numbers*	Dia	inch	mm.
1/2	15	3.1/2	89	7/16	11.2	2.3/8	60.5	1.3/8	35	4	1/2	5/8	16
3/4	20	3.7/8	98	7/16	11.2	2.3/4	70.0	1.11/16	43	4	1/2	5/8	16
1	25	4.1/4	108	7/16	11.2	3.1/8	79.5	2	51	4	1/2	5/8	16
1.1/4	32	4.5/8	117	1/2	12.7	3.1/2	89.0	2.1/2	64	4	1/2	5/8	16
1.1/2	40	5	127	9/16	14.3	3.7/8	98.5	2.7/8	73	4	1/2	5/8	16
2	50	6	152	5/8	15.9	4.3/4	120.5	3.5/8	92	4	5/8	3/4	19
2.1/2	65	7	178	11/16	17.5	5.1/2	139.5	4.1/8	105	4	5/8	3/4	19
3	80	7.1/2	191	3/4	19.1	6	152.5	5	127	4	5/8	3/4	19
4	100	9	229	15/16	23.9	7.1/2	190.5	6.2/16	157	8	5/8	3/4	19
5	125	10	254	15/16	23.9	8.1/2	216.0	7.5/16	186	8	3/4	7/8	22
6	150	11	279	1	25.4	9.1/2	241.5	8.1/2	216	8	3/4	7/8	22
8	200	131/2	343	1.1/8	28.6	11.3/4	298.5	10.5/8	270	8	3/4	7/8	22
10	250	16	406	1.3/16	30.2	14.1/4	362.0	12.3/4	324	12	7/8	1	25
12	300	19	483	1.1/4	31.8	17	432.0	15	381	12	7/8	1	25
14	350	21	533	1.3/8	35.0	18.3/4	476.0	16.1/4	413	12	1	1.1/8	29
16	400	23.1/2	597	1.7/16	36.6	21.1/4	539.5	18.1/2	470	16	1	1.1/8	29
18	450	25	635	1.9/16	39.7	22.3/4	578.0	21	533	16	1.1/8	1.1/4	32
20	500	27.1/2	698	1.11/16	42.9	25	635.0	23	584	20	1.1/8	1.1/4	32

Altura del resalte de la cara 1/16" Height of raised face 1/16' **Bridas**

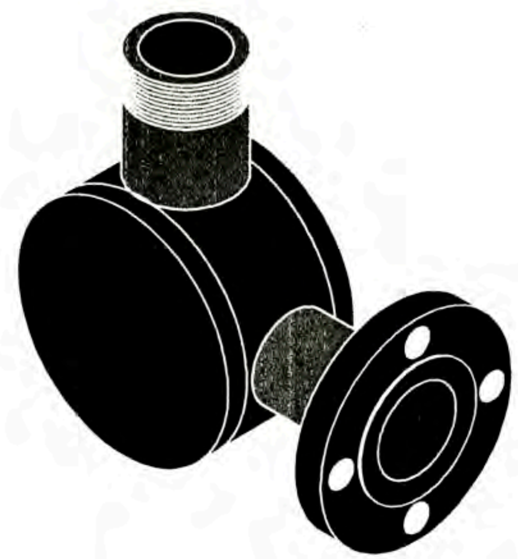
ANSI 300 Lb.ANSI 300 Lb. Flange

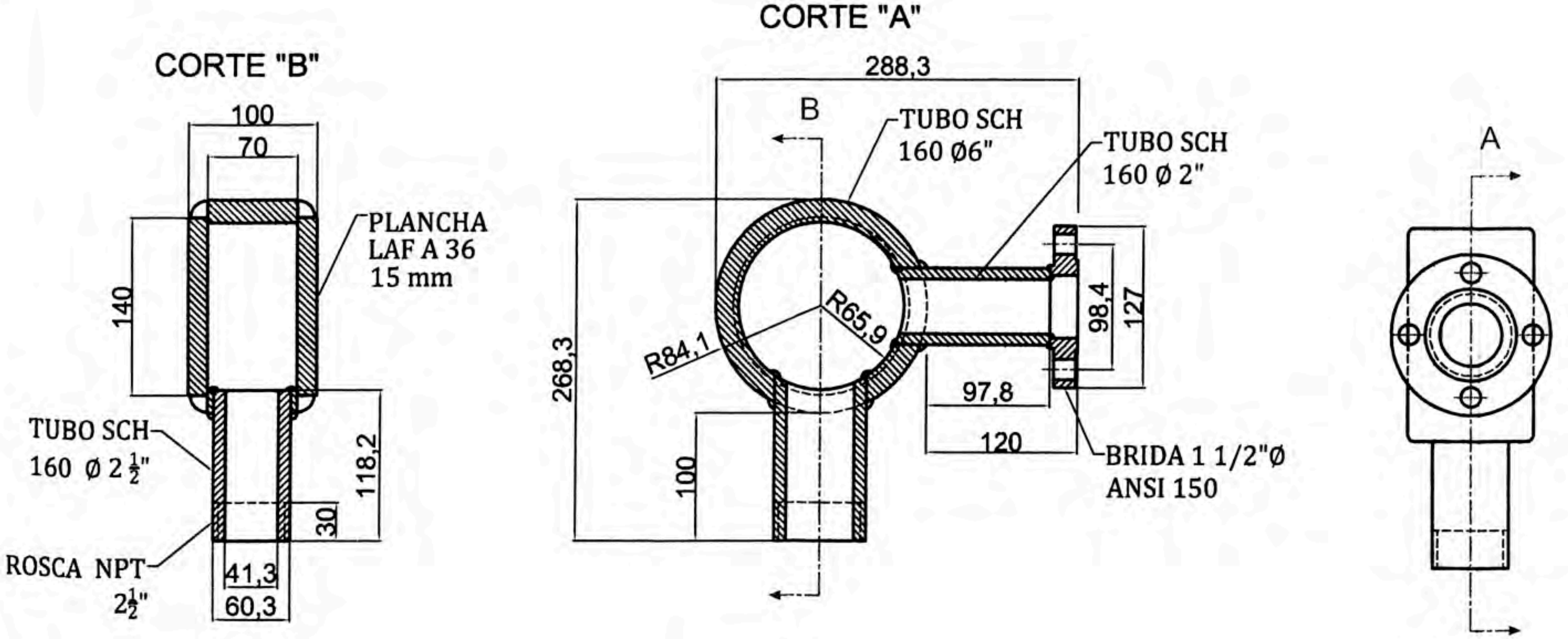
0 Pulgadas St'ze *Iches*		D		t		C		9		Tomillo *Bolt*		Taladro *W Bolt Hole*	
		inch	mm.	inch	mm.	inch	mm.	inch	mm.	Numero *Numbers*	Dia	inch	mm.
1/2	15	3.3/4	95	9/16	14.3	2.5/8	66.5	1.3/8	35	4	1/2	5/8	16
3/4	20	4.5/8	117	5/8	15.9	3.1/4	82.5	1.11/16	43	4	5/8	3/4	19
1	25	4.7/8	124	11/16	17.5	3.1/2	89	2	51	4	5/8	3/4	19
1.1/4	32	5.1/4	133	3/4	19.1	3.7/8	98.5	2.1/2	64	4	5/8	3/4	19
1.1/2	40	6.1/8	156	13/16	20.7	4.1/2	114.5	2.7/8	73	4	3/4	7/8	22
2	50	6.1/2	165	7/8	22.3	5	127	3.5/&	92	8	5/8	3/4	19
2.1/2	65	7.1/	190	1	25.4	5.7/8	149	4.1/8	105	8	3/4	7/8	22
3	80	8.1/4	210	1.1/8	28.6	6.5/8	168	5	127	8	3/4	7/8	22
4	100	10	254	1.1/4	31.8	7.7/8	200	6.3/16	157	8	3/4	7/8	22
5	125	11	279	1.3/8	35.0	9.1/4	235	7.5/16	186	8	3/4	7/8	22
6	150	12.1/2	318	1.7/16	36.6	10.5/8	270	8.1/2	216	12	3/4	7/8	22
8	200	15	381	1.5/8	41.3	13	330	10.5/8	270	12	7/8	1	25
10	250	17.1/2	144	1.7/8	47.7	15.1/4	387.5	12.3/4	324	16	1	1.1/8	29
12	300	20.1/2	521	2	50.8	17.3/4	451	15	381	16	1.1/8	1.1/4	32
14	350	23	584	2.1/8	54.0	20.1/4	514.5	16.1/4	413	20	1.1/8	1.1/4	32
16	400	25.1/2	648	2.1/4	57.2	22.1/2	571.5	18.1/2	470	20	1.1/4	1.3/8	35
18	450	28	711	2.3/8	60.4	24.3/4	628.5	21	533	24	1.1/4	1.3/8	35
20	500	30.1/2	775	2.1/2	63.5	27	686	23	584	24	1.1/4	1.3/8	35

Altura del resalte de la cara 1/16" Height of raised face 1/16'



POSCICION 1





POSCICION 2

GERDAU

ACERIA
SISTEMA INYECCION CARBON HORNO ELECTRICO
CODOS TIPO TAMBOR

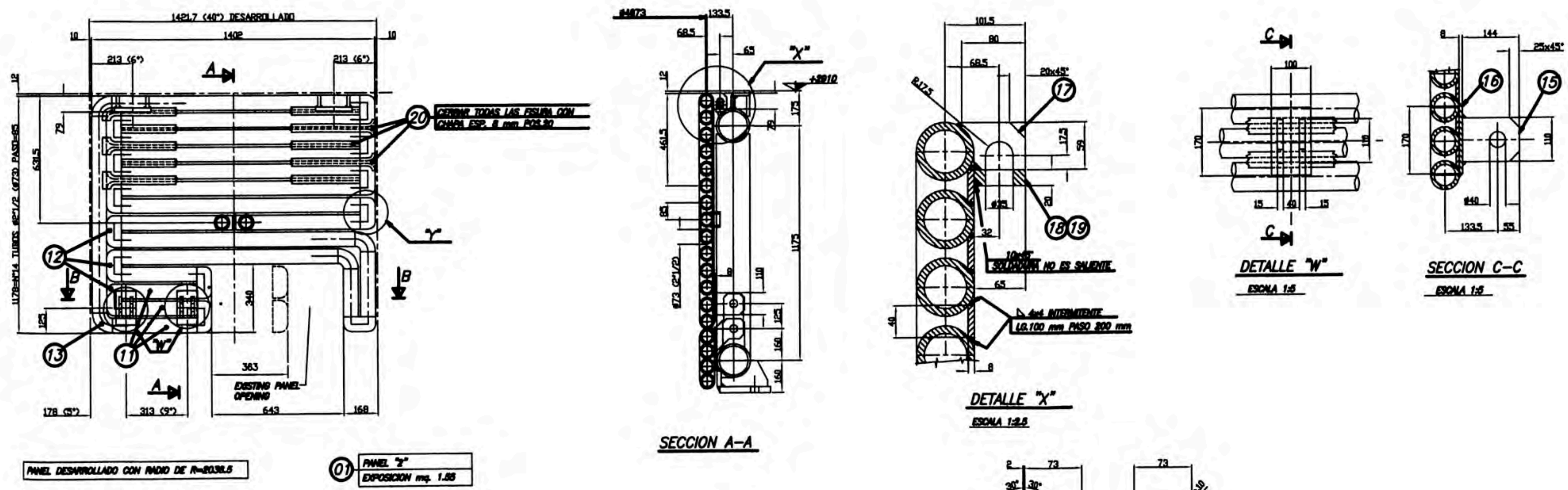
EMPRESA: GERDAU – SIDERPERU

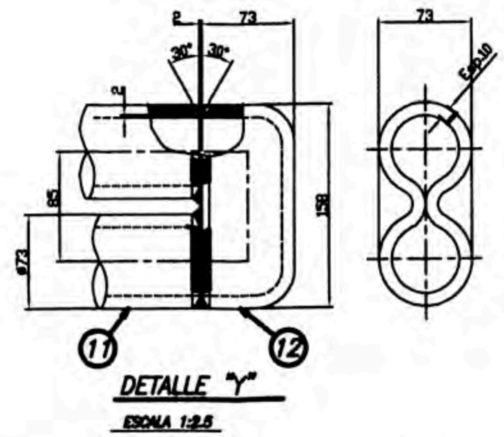
SP	000-00-00-M-0001	Rev.:

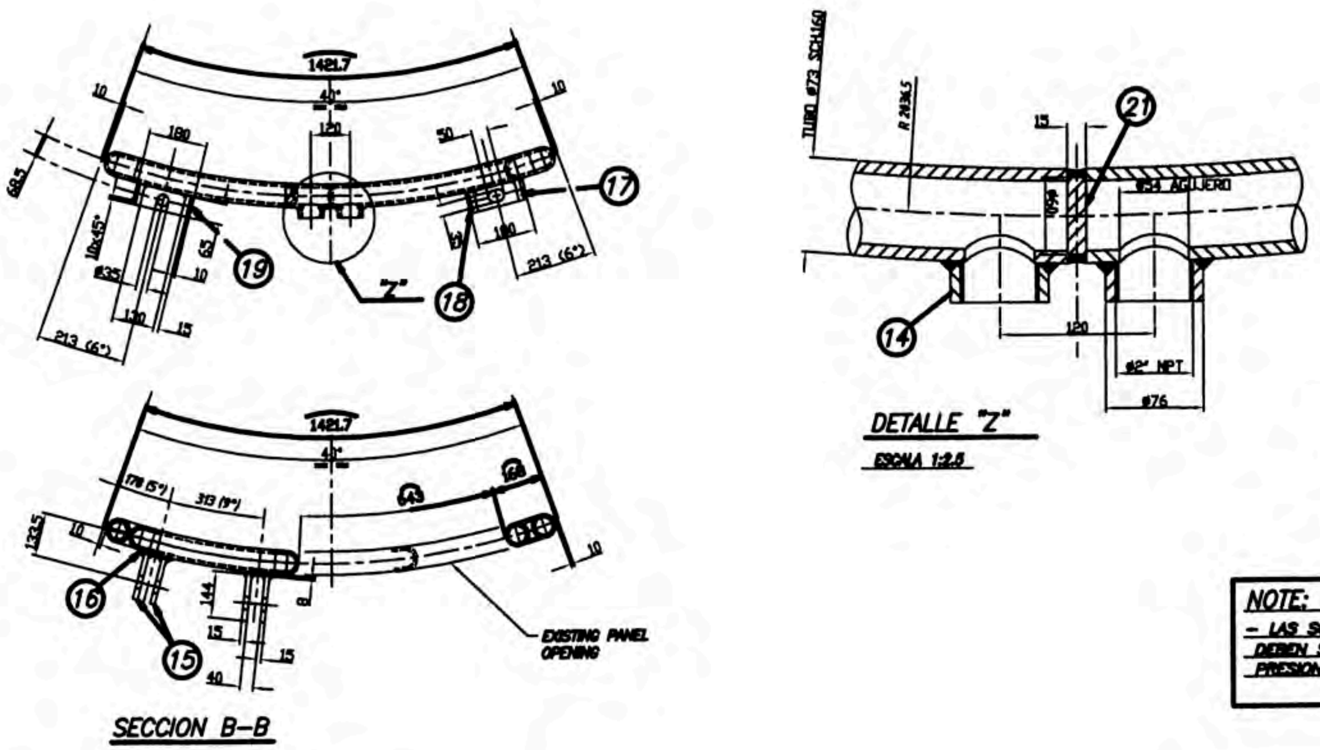
ESC: | DOC. DE REF.: | VINCULADO A:

ARCHIVO

A4 - 420x297mm







21	N°	1	RODONDO Ø40 L=15	Fe410-1Kv-UNI 5869	0.4
20	mq.	0.6	CHAPA ESP.8	" " "	30
19	N°	1	CHAPA ESP.20 100x65	" " "	2
18	N°	1	CHAPA ESP.20 100x65	" " "	2
17	N°	4	CHAPA ESP.15 60x50	" " "	0.4x4
16	N°	2	CHAPA ESP.8 100x170	" " "	1x2
15	N°	4	CHAPA ESP.15 110x144	Fe410-1Kv-UNI 5869	1.5x4
14	N°	2	MEDIO MANGUITO Ø 2" NPT ANSI3000	ASTM A 105 B	0.5x2
13	N°	4	CURVA SR 90° Ø 73 ESP.9.52 SCH.160	ASTM A 106 B	1.9x4
12	N°	13	CODO (tubo Ø 73 paso 85) ESP.10	Fe410-1Kv-UNI 5869	2x13
11	mt.	17	TUBO Ø 73 ESP.9.52 SCH.160	St. 35.8 DIN 17175	253
POS.	UN.	QUANT.	DESCRIPCION	MATERIALE	PESO KG.
ITEM	NO.	PIECES	DESCRIPTION	MATERIAL	WEIGHT KG

NOTE:
- PARA UBICACION DE PANELES VER PLANO 08W-77837

CHAFLAN DE SOLDADURAS - UNI 11001

DONDE NO INDICADO
LOS SOLDADURAS ES: Z=0.7
ESPESOR MINIMO DE CONEXION

NOTE:
- LAS SOLDADURAS DE CABEZA, SOBRE TUBOS, CAPA Y CODOS DEBEN SER A PLENA PENETRACION
PRESION DE PRUEBA: 2000 kPa PARA 8 HORAS (CONTINUAS)

NOTE:
ORIGINAL PANEL USING ONE BLOCK ON 08W-78098-A

FOR CONSTRUCTION
10/3/11

tenova
CORE

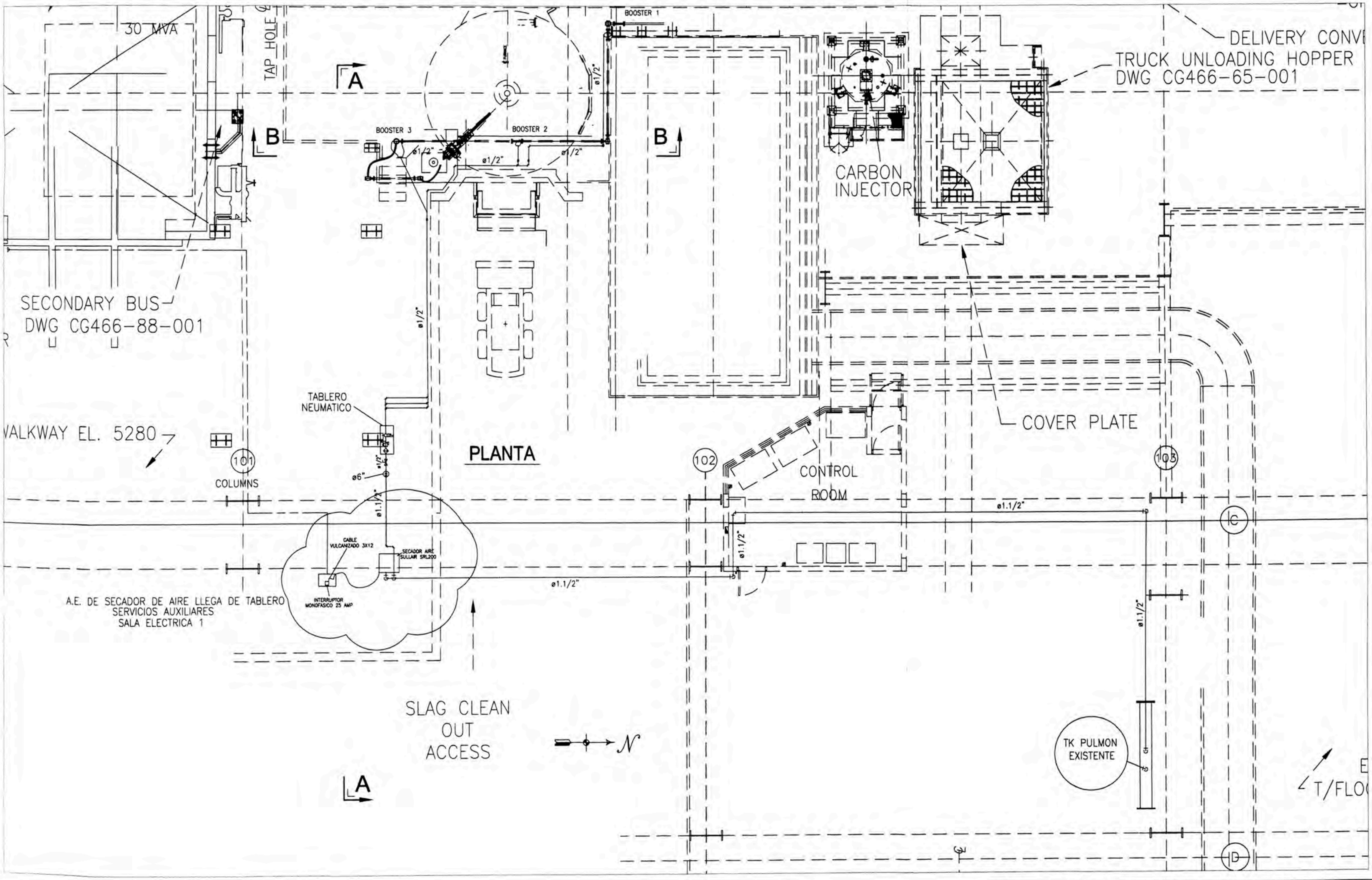
Metal Making

GERDAU SIDERPERU - CHIMBOTE, PERU
4.2 METER EBT EAF
PANEL No 2 MODIFICATION

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	EDV	9/26/11	1:10	CQ127-4059-101	0
CHECKED	SPB	9/26/11			
APPROVED					

REVISIONS
0 ISSUED FOR CONSTRUCTION EDV 10/3/11

MACHINING TOLERANCES
FRACTIONAL DIM. ± 1/16"
DECIMAL ± 0.010"



GERDAU APROBADO
CDOC FECHA 16/02/12

POS.	DENOMINACIÓN	DISEÑO/MATERIAL	CANT.	PESO TOTAL	APLICACIÓN

0/6	6/30	30/120	120/315	315/1000	1000/2000	2000/4000	4000/8000	8000/12000	12000/15000
±0,1	±0,2	±0,3	±0,5	±0,8	±1,2	±2	±3	±4	±5

COTAS SIN TOLERANCIA INDICADA (mm) — VALORES DE RUGOSIDAD SUPERFICIAL, EM Ra, NORMA ABNT B404 (ISO 468).

REV	TEXTO	DISEÑADOR	VISTO	APROBADO	FECHA
0	EMITIDO PARA CONSTRUCCION	J.D.S.	J.D.S	J.D.S	10-05-12

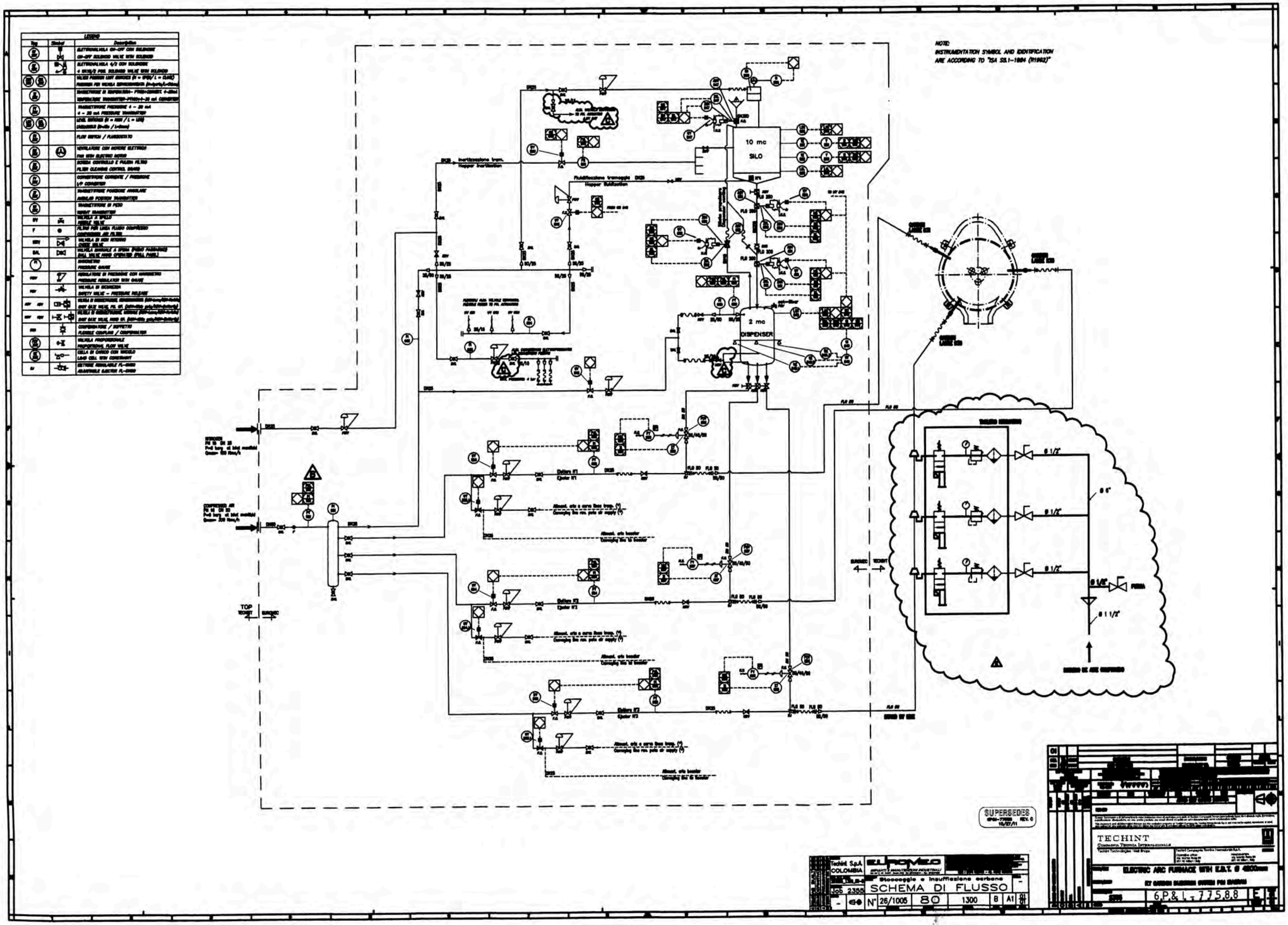
GERDAU

ACERIA
NUEVA LANZA KT6 – NUEVO HORNO ELECTRICO
RUTA TUBERIAS AIRE COMPRIMIDO BOOSTER – PLANTA

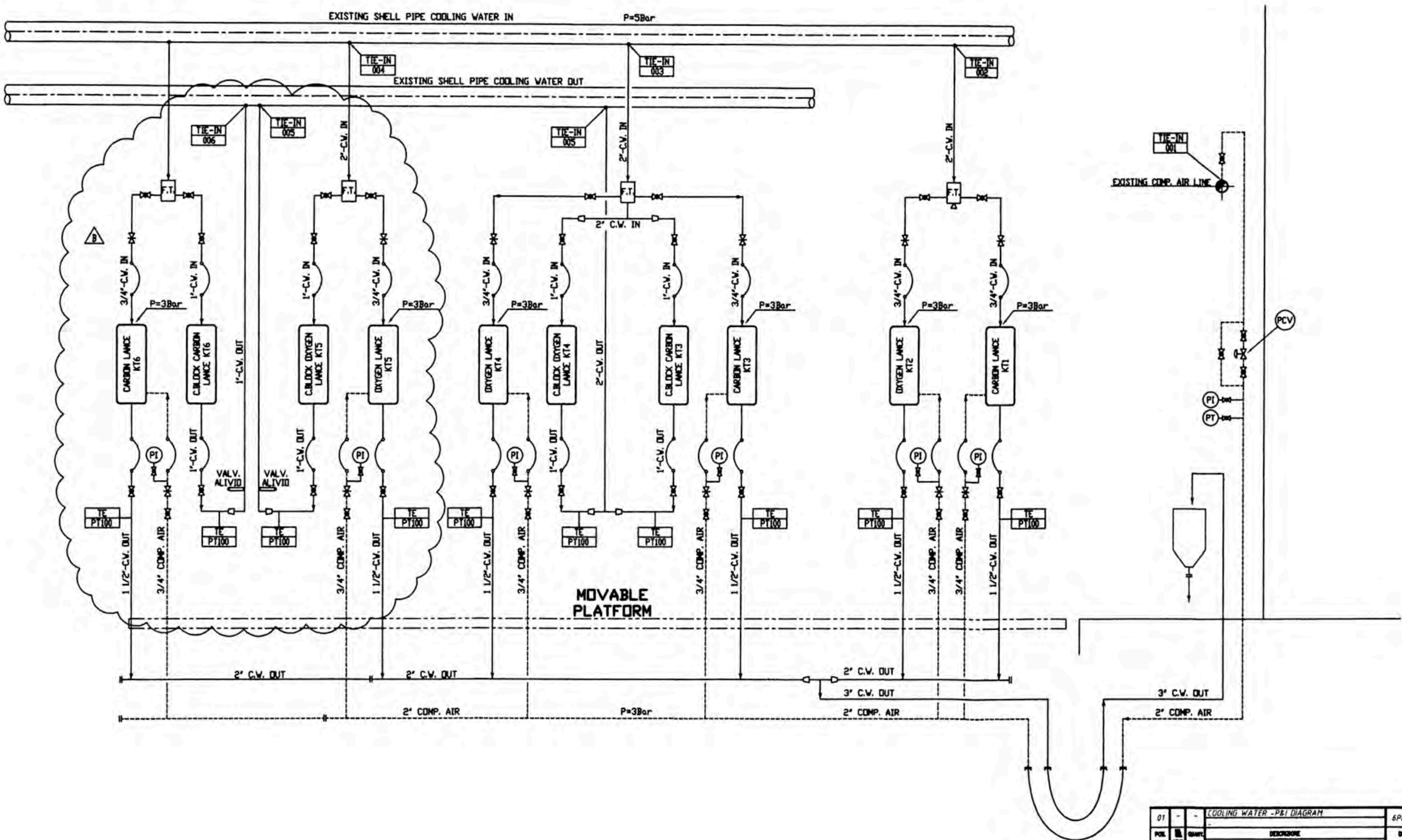
EMPRESA: GERDAU – SIDERPERU

S | 533.00–M–1000 | Rev.: 1

ESC: S/E | DOC. DE REF.: | VINCULADO A:



LEGEND
NOTE:
INSTRUMENTATION SYMBOL AND IDENTIFICATION ARE ACCORDING TO "ISA S5.1-1984 (R1992)"
10 mc
SILO
2 mc
DISPENSER
TOP
SUPERSEDES
10/27/11
Techint S.p.A.
COLOMBIA
IMPIANTI E MANUTENZIONI INDUSTRIALI
Stoccaggio e insufflazione carbone
SCHEMA DI FLUSSO
Job 2355
N° 26/1005
80
1300
B
A1
TECHINT
Techint Technologies / Melt Shops
ELECTRIC ARC FURNACE WITH E.B.T.
6P&L-77588



REFERENCE DRAWING	
OXYGEN NATURAL GAS & CARBON SYSTEM-PLANIMETRIC DIAGRAM	6P&I-77574
PIPING OXYGEN & CARBON LANCE-PLAN AT EL.±0.00	6TUB-77576

SUPERSEDES
6P&I - 77575 REV.A
10/24/11

01	-	-	COOLING WATER -P&I DIAGRAM	6P&I-77575-01	-	-	-
POS. ITEM		QUANT.	DESCRIZIONE / PART DESCRIPTION	DISEGNO/CODICE / DRAWING/PART NO.	MATERIALE / MATERIAL		

ST.GESS	3-11-08	MEMOLI	03-11-08	EPIS	03-11-08

Scale: 1:1

FILE CAD GEN-TITLE-DWG

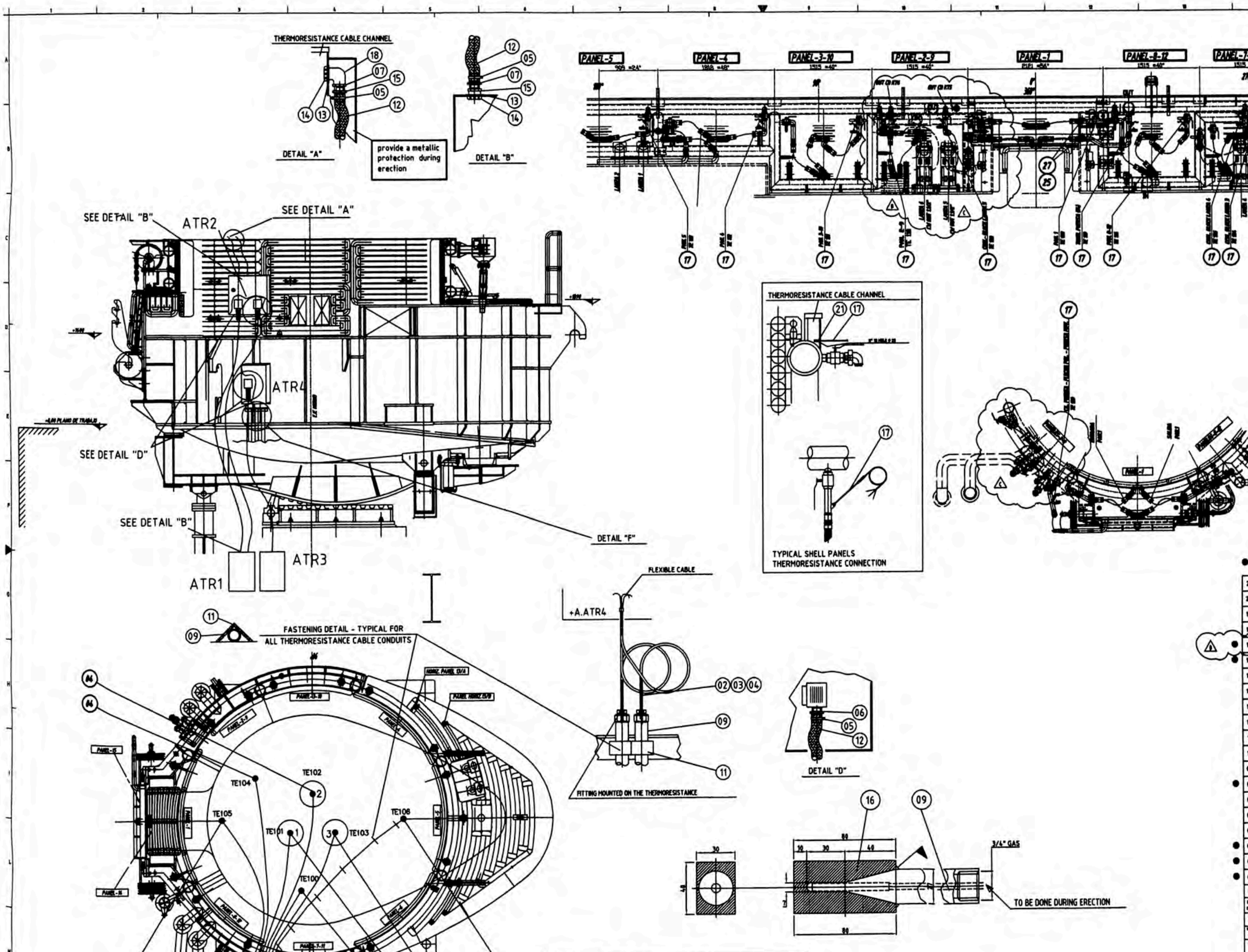
TECHINT
COMPAGNIA TECNICA INTERNAZIONALE
Techint Technologies / Melt Shops

Techint Compagnia Tecnica Internazionale S.p.A.
Operative office: via Monte Rosa 93, 20149 Milan / Italy
Headquarters: via Monte Rosa 93, 20149 Milan / Italy

TITOLO/TITLE: HORNO ELECTRICO DE ARCO CON EBT
COOLING WATER
P&I DIAGRAM

COMMESSA/JOB: 2355
6P&I-77575-
B
SHEET 01 / 01

FORMATO A1(594x841)-UNI 936



BOTTOM THERMORESISTANCE		
ITEM	ESTIMATED LENGTH (mm)	SUPPLIED LENGTH (mm)
TE100	2252 (+1000mm flexible cable)	2500 (+1000mm flexible cable)
TE101	2842 (+1000mm flexible cable)	3500 (+1000mm flexible cable)
TE102	3912 (+1000mm flexible cable)	4500 (+1000mm flexible cable)
TE103	3318 (+1000mm flexible cable)	3500 (+1000mm flexible cable)
TE104	3807 (+1000mm flexible cable)	4500 (+1000mm flexible cable)
TE105	3186 (+1000mm flexible cable)	3500 (+1000mm flexible cable)
TE106	4010 (+1000mm flexible cable)	4500 (+1000mm flexible cable)

● ALREADY BOUGHT WITH DB : 2355.00.03.11

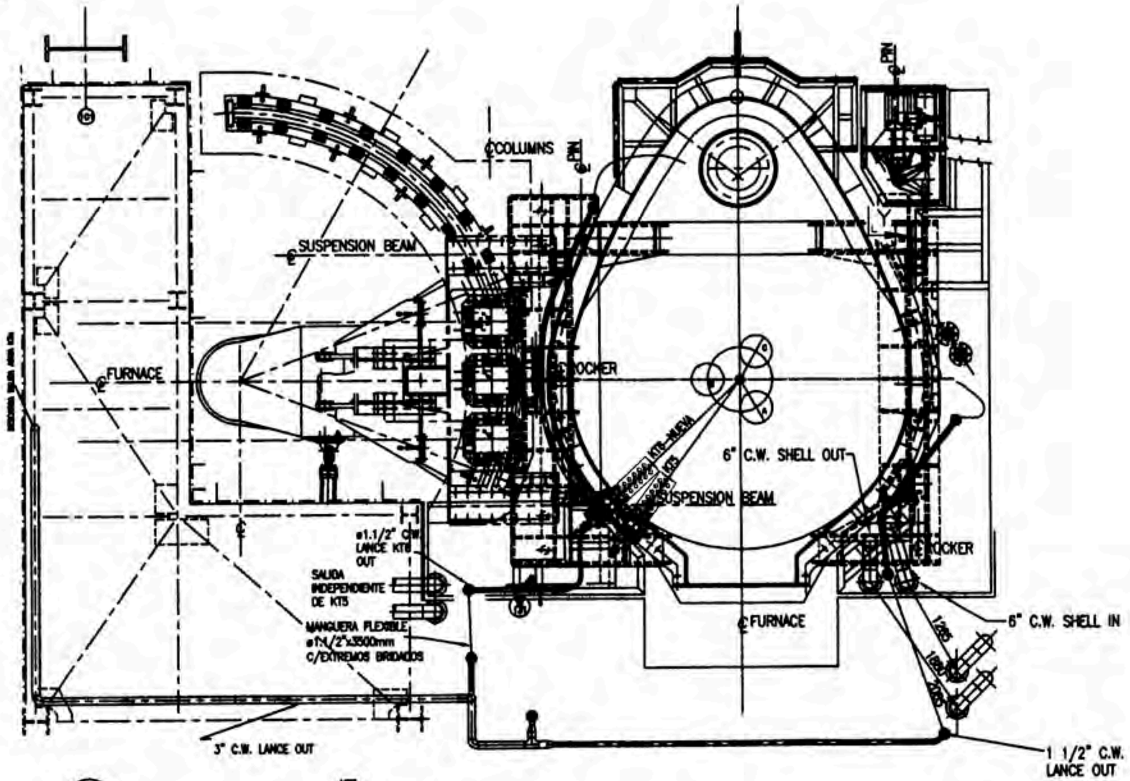
POS.	[illegible]	QUANT.	PART DESCRIPTION	DRAWING/PART NO.	MATERIAL
21	n°	[illegible]	1/2" GAS Bushing	6TRV-[illegible]-21	[illegible] RTA
20					
19					
18	n°	3	[illegible] 1 1/4" GAS male/female	6TRV-[illegible]-18	[illegible] RTA
● 17	n°	17	Thermoresistance L. [illegible] + 1000 mm with FP		THERMOMATRIK
● 16	n°	[illegible]	Thermoresistance fixing plate		AISI 304
15	n°	[illegible]	1"1/2 male - 1"1/4 female GAS reduction	6TRV-[illegible]-15	[illegible] RTA
14	n°	[illegible]	1"1/2 GAS bushing	6TRV-[illegible]-14	[illegible] RTA
13	n°	[illegible]	1"1/2 [illegible]	6TRV-[illegible]-13	[illegible] RTA
12	m	40	Flexible [illegible] mm dia with fire protection	6TRV-[illegible]-12	TYPE DALMAR [illegible]
11	m	4	EQUAL ANGLE 70 x 70 x 5	6TRV-[illegible]-11	ST 42.2
10					
09	m	30	Hot dip galvanised rigid steel conduit [illegible]	6TRV-[illegible]-09	
● 08	n°				
07	n°	[illegible]	1"1/4 GAS male fitting	6TRV-[illegible]-07	[illegible] RTA
06	n°	5	PG 36 Male fitting	6TRV-[illegible]-06	[illegible] RTA
05	n°	[illegible]	Packaging for fitting [illegible]	6TRV-[illegible]-05	[illegible] RTA
● 04	n°	4	Thermoresistance L. 4500 + 1000 mm with FP		THERMOMATRIK
● 03	n°	4	Thermoresistance L. 3500 + 1000 mm with FP		THERMOMATRIK
● 02	n°	1	Thermoresistance L. 2500 + 1000 mm with FP		THERMOMATRIK
01					

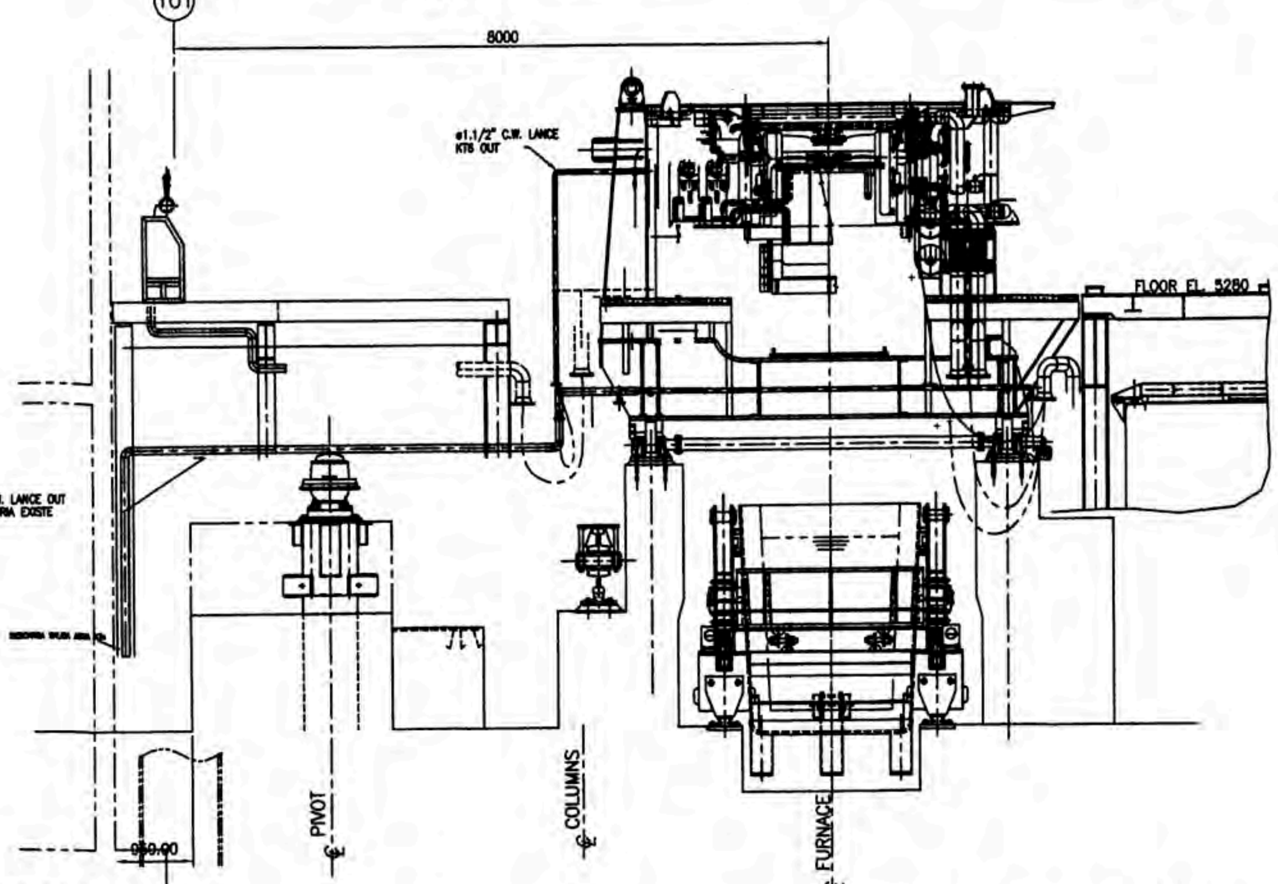
TECHINT
Compagnia Tecnica Internazionale
Techint Technologies / Melt Shops
Techint Compagnia Tecnica Internazionale S.p.A.

ELECTRIC ARC FURNACE 32 ton
SHELL AND BOTTOM THERMORESISTANCE ERECTION LAYOUT

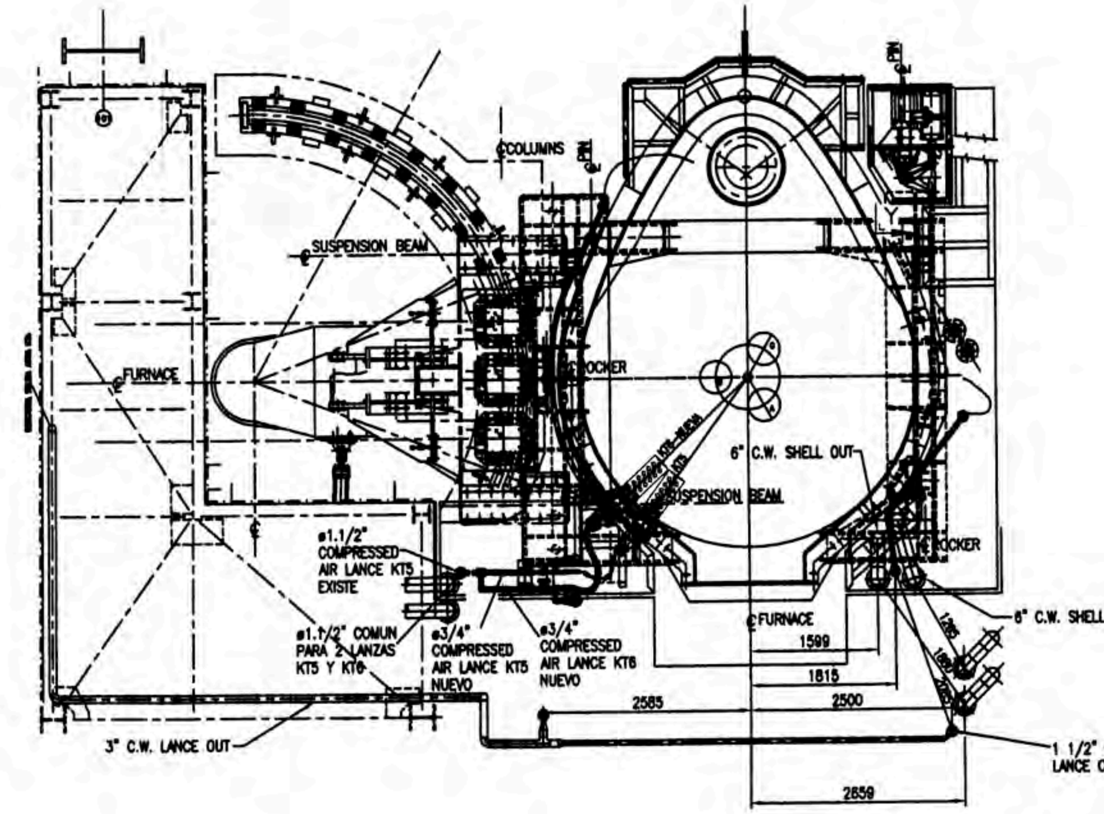
2355 XTRV
6TRV-78802 C
01 / 01

CG466-76-011 0





SALIDA AGUA ø1.1/2"-LANZA KT6



INGRESO AIRE COMPRIMIDO ø3/4" LANZA KT6

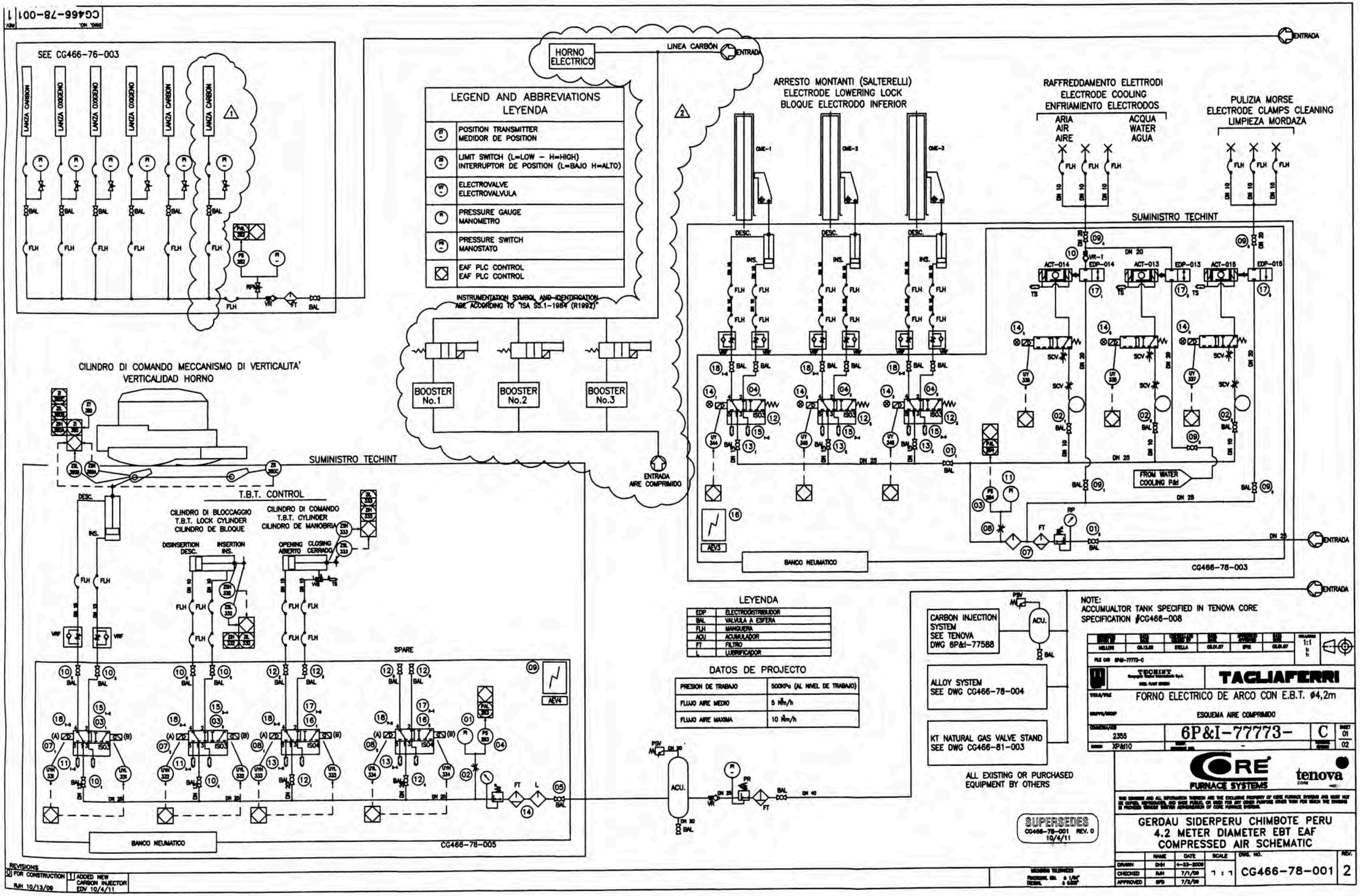
FOR CONSTRUCTION
10/12/09

REVISIONS
0 FOR CONSTRUCTION DQG 10/12/09

CORE FURNACE SYSTEMS
tenova

GERDAU SIDERPERU CHIMBOTE PERU
4.2 METER EBT EAF
HOSE LAYOUT LANCE, SHELL & SHUTTER

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	K.E.L.	9/17/09	1:40	CG466-76-011	1
CHECKED	SFG	10/12/09			
APPROVED	RJH	10/12/09			



LEGEND AND ABBREVIATIONS
LEYENDA

ZT	POSITION TRANSMITTER / MEDIDOR DE POSITION
ZS	LIMIT SWITCH (L=LOW – H=HIGH) / INTERRUPTOR DE POSITION (L=BAJO H=ALTO)
UY	ELECTROVALVE / ELECTROVALVULA
PI	PRESSURE GAUGE / MANOMETRO
PS	PRESSURE SWITCH / MANOSTATO
◇	EAF PLC CONTROL / EAF PLC CONTROL

LEYENDA

EDP	ELECTRODISTRIBUDOR
BAL	VALVULA A ESFERA
FLH	MANGUERA
ACU	ACUMULADOR
FT	FILTRO
L	LUBRIFICADOR

DATOS DE PROJECTO

PRESION DE TRABAJO	500KPa (AL NIVEL DE TRABAJO)
FLUJO AIRE MEDIO	5 Nm/h
FLUJO AIRE MAXIMA	10 Nm/h

NOTE:
ACCUMUALTOR TANK SPECIFIED IN TENOVA CORE SPECIFICATION #CG466-008

FILE CAD 6P&I-77773-C

TECHINT

TAGLIAFERRI

FORNO ELECTRICO DE ARCO CON E.B.T. ø4,2m

ESQUEMA AIRE COMPRIMIDO

2355 | 6P&I-77773- | C | 01 / 02

XP&I10

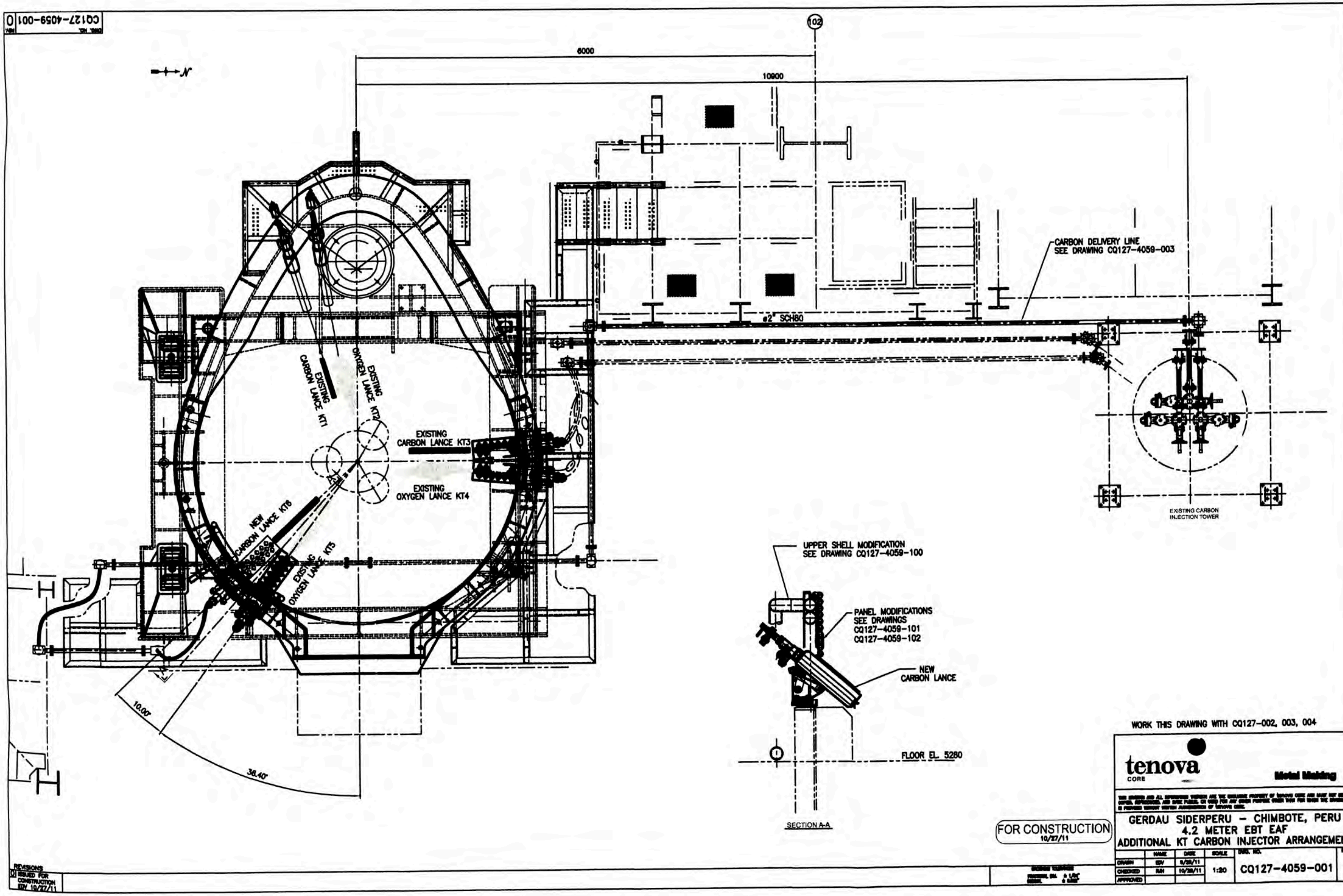
CORE FURNACE SYSTEMS — tenova CORE

GERDAU SIDERPERU CHIMBOTE PERU
4.2 METER DIAMETER EBT EAF
COMPRESSED AIR SCHEMATIC

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	DHH	4-23-2009	1 : 1	CG466-78-001	2
CHECKED	RJH	7/1/09			
APPROVED	SFD	7/2/09			

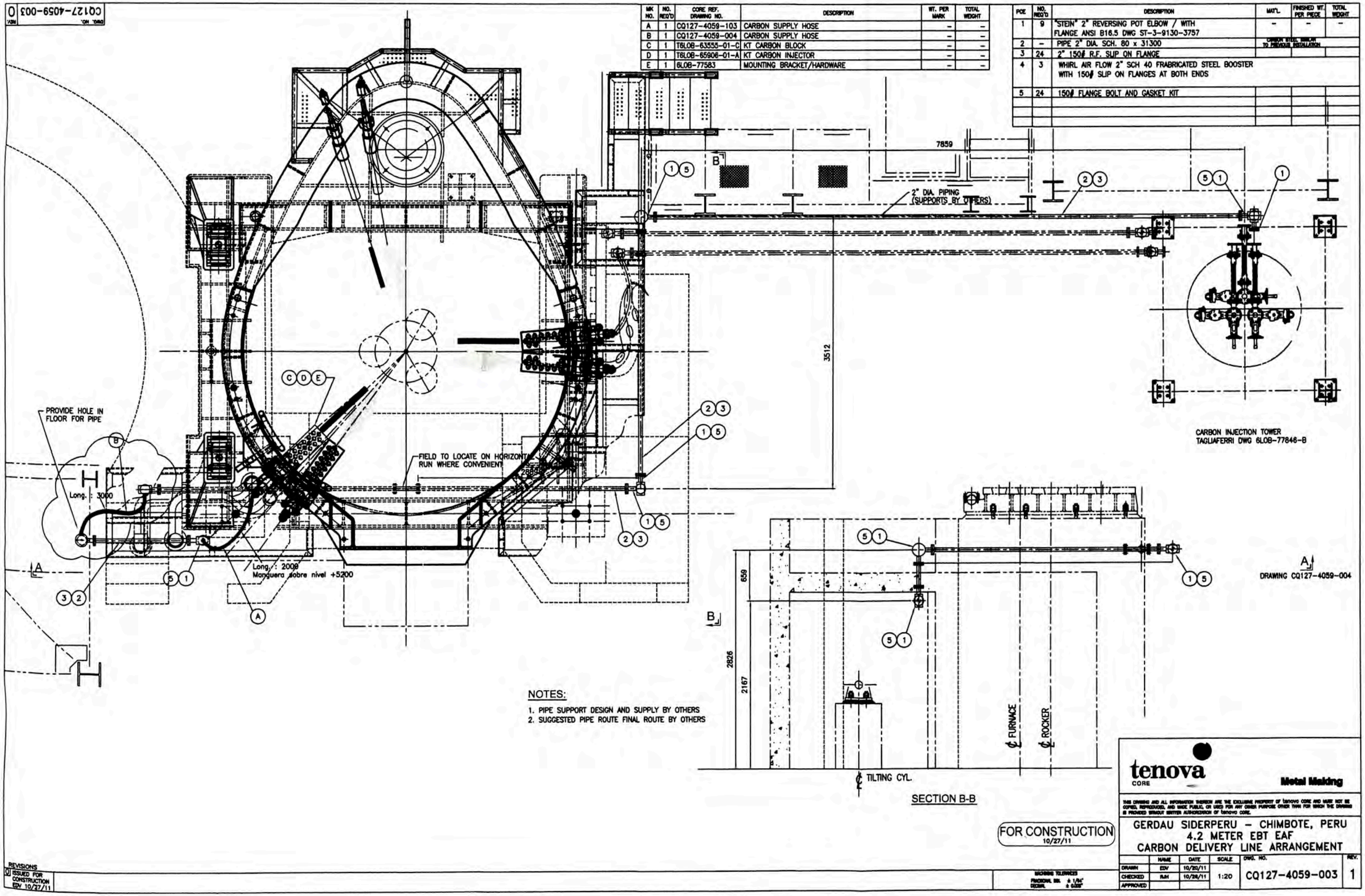
REVISIONS

0	FOR CONSTRUCTION	RJH 10/13/09
1	ADDED NEW CARBON INJECTOR	EDV 10/4/11


CQ127-4059-001 0
102
6000
10900
N
CARBON DELIVERY LINE
SEE DRAWING CQ127-4059-003
ø2" SCH80
EXISTING CARBON LANCE KT1
EXISTING OXYGEN LANCE KT2
EXISTING CARBON LANCE KT3
EXISTING OXYGEN LANCE KT4
NEW CARBON LANCE KT6
EXISTING OXYGEN LANCE KT5
EXISTING CARBON INJECTION TOWER
UPPER SHELL MODIFICATION
SEE DRAWING CQ127-4059-100
PANEL MODIFICATIONS
SEE DRAWINGS
CQ127-4059-101
CQ127-4059-102
NEW CARBON LANCE
FLOOR EL. 5280
SECTION A-A
10.00°
36.40°
WORK THIS DRAWING WITH CQ127-002, 003, 004
tenova
CORE
Metal Making
GERDAU SIDERPERU - CHIMBOTE, PERU
4.2 METER EBT EAF
ADDITIONAL KT CARBON INJECTOR ARRANGEMENT
FOR CONSTRUCTION
10/27/11
DRAWN EDV 9/28/11
CHECKED RAH 10/28/11
APPROVED
1:20
CQ127-4059-001
1
REVISIONS
0 ISSUED FOR CONSTRUCTION EDV 10/27/11

MK NO.	NO. REQ'D	CORE REF. DRAWING NO.	DESCRIPTION	WT. PER MARK	TOTAL WEIGHT
A	1	CQ127-4059-103	CARBON SUPPLY HOSE	–	–
B	1	CQ127-4059-004	CARBON SUPPLY HOSE	–	–
C	1	T6L0B-63555-01-C	KT CARBON BLOCK	–	–
D	1	T6L0B-65906-01-A	KT CARBON INJECTOR	–	–
E	1	6L0B-77583	MOUNTING BRACKET/HARDWARE	–	–

PCE	NO. REQ'D	DESCRIPTION	MAT'L.	FINISHED WT. PER PIECE	TOTAL WEIGHT
1	9	"STEIN" 2" REVERSING POT ELBOW / WITH FLANGE ANSI B16.5 DWG ST-3-9130-3757	–	–	–
2	–	PIPE 2" DIA. SCH. 80 x 31300	CARBON STEEL SIMILAR TO PREVIOUS INSTALLATION		
3	24	2" 150# R.F. SLIP ON FLANGE			
4	3	WHIRL AIR FLOW 2" SCH 40 FRABRICATED STEEL BOOSTER WITH 150# SLIP ON FLANGES AT BOTH ENDS			
5	24	150# FLANGE BOLT AND GASKET KIT			



NOTES:

1. PIPE SUPPORT DESIGN AND SUPPLY BY OTHERS
2. SUGGESTED PIPE ROUTE FINAL ROUTE BY OTHERS

FOR CONSTRUCTION
10/27/11

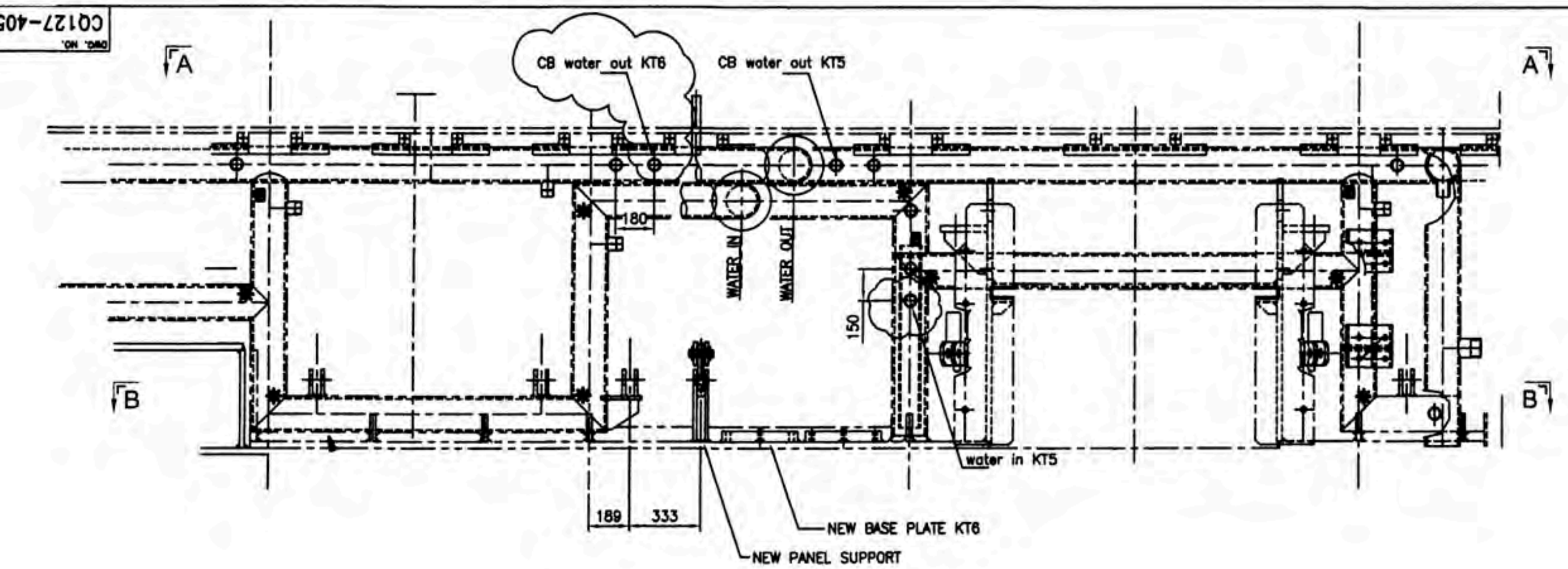
REVISIONS

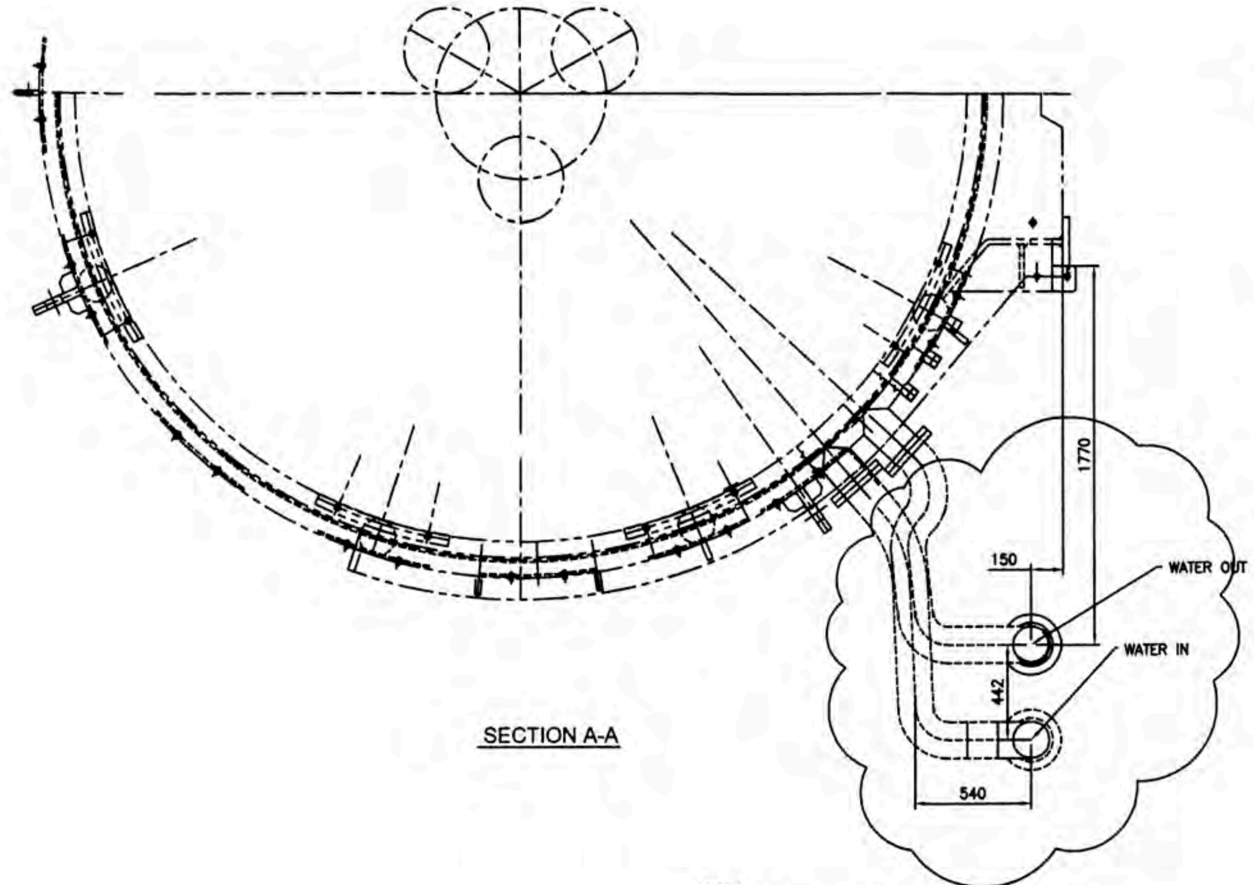
0	ISSUED FOR CONSTRUCTION EDV 10/27/11

tenova CORE — Metal Making

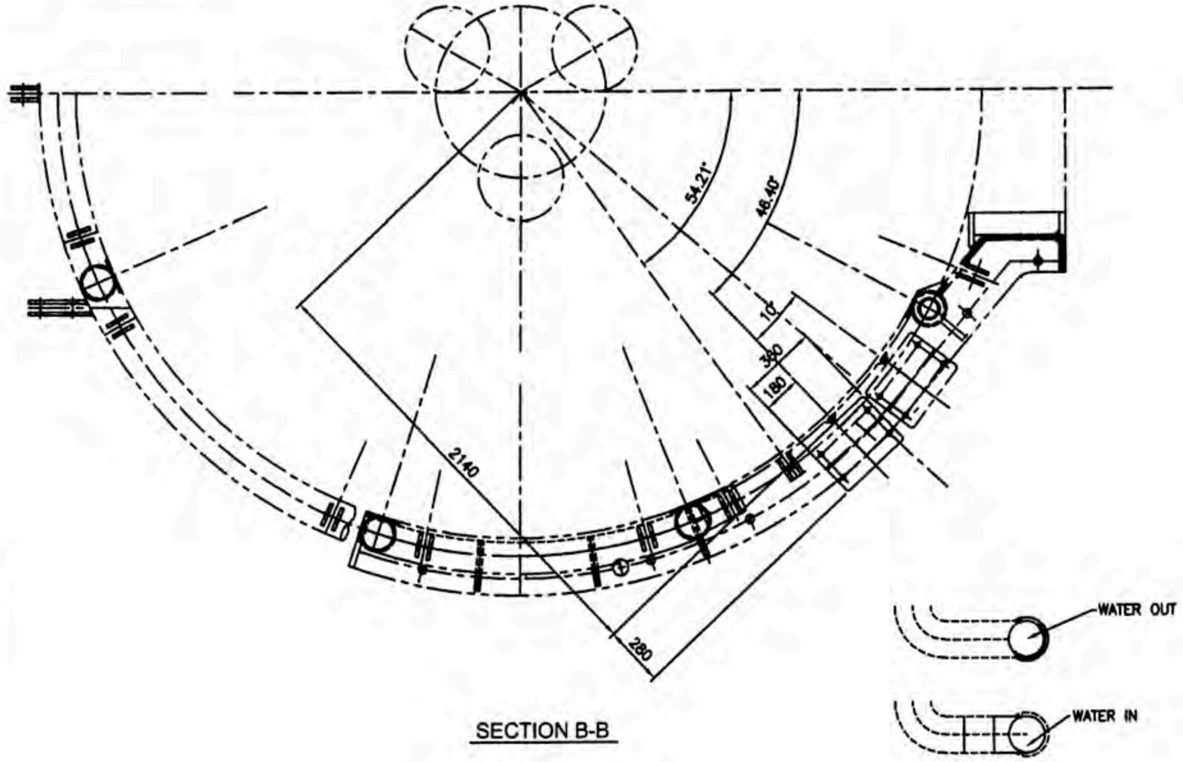
GERDAU SIDERPERU – CHIMBOTE, PERU
4.2 METER EBT EAF
CARBON DELIVERY LINE ARRANGEMENT

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	EDV	10/20/11	1:20	CQ127-4059-003	1
CHECKED	RJH	10/26/11			
APPROVED					





SECTION A-A



SECTION B-B

NOTE:
ORIGINAL SHELL DRAWING USING ONE BLOCK 6INV-78590

FOR CONSTRUCTION
10/27/11

tenova
CORE
Metal Making

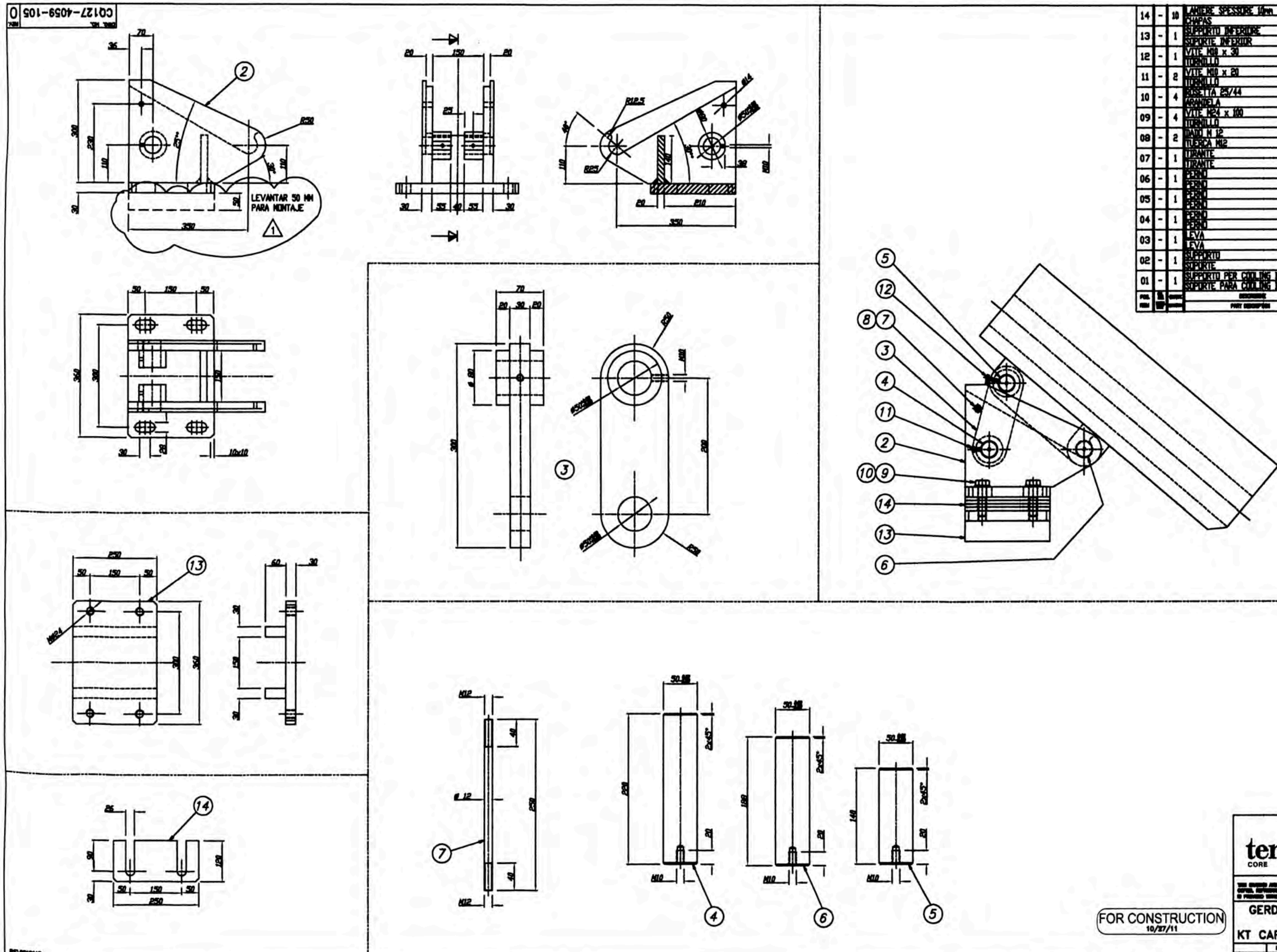
GERDAU SIDERPERU - CHIMBOTE, PERU
4.2 METER EBT EAF
UPPER SHELL MODIFICATION

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	EDV	9/30/11	1:15	CQ127-4059-100	1
CHECKED	RJH	10/27/11			
APPROVED					

MACHINING TOLERANCES
FRACTIONAL DIM. ± 1/64"
DECIMAL ± 0.005"

ISSUED FOR CONSTRUCTION / REVISIONS

DWG. NO. CQ127-4059-100 REV. 0



POS. ITEM		QUANT.	DESCRIZIONE / PART DESCRIPTION	DISEGNO/CODICE / DRAWING/PART NO.	MATERIALE / MATERIAL		
14	-	10	LAMIERE SPESSORE 10mm CHAPAS		- -	60	-
13	-	1	SUPPORTO INFERIORE SOPORTE INFERIOR		Fe 430 B -	90	-
12	-	1	VITE M10 x 30 TORNILLO		8.8 -	-	-
11	-	2	VITE M10 x 20 TORNILLO		8.8 -	-	-
10	-	4	ROSETTA 25/44 ARANDELA		C25 -	-	-
09	-	4	VITE M24 x 100 TORNILLO		8.8 -	-	-
08	-	2	DADO M 12 TUERCA M12		CL 8 -	-	-
07	-	1	TIRANTE TIRANTE		C45 -	1.5	-
06	-	1	PERNO PERNO		C45 -	9	-
05	-	1	PERNO PERNO		C45 -	3	-
04	-	1	PERNO PERNO		C45 -	12	-
03	-	1	LEVA LEVA		Fe 430 B -	21	-
02	-	1	SUPPORTO SOPORTE		Fe 430 B -	180	-
01	-	1	SUPPORTO PER COOLING BLOCK SOPORTE PARA COOLING BLOCK		- -	390	-

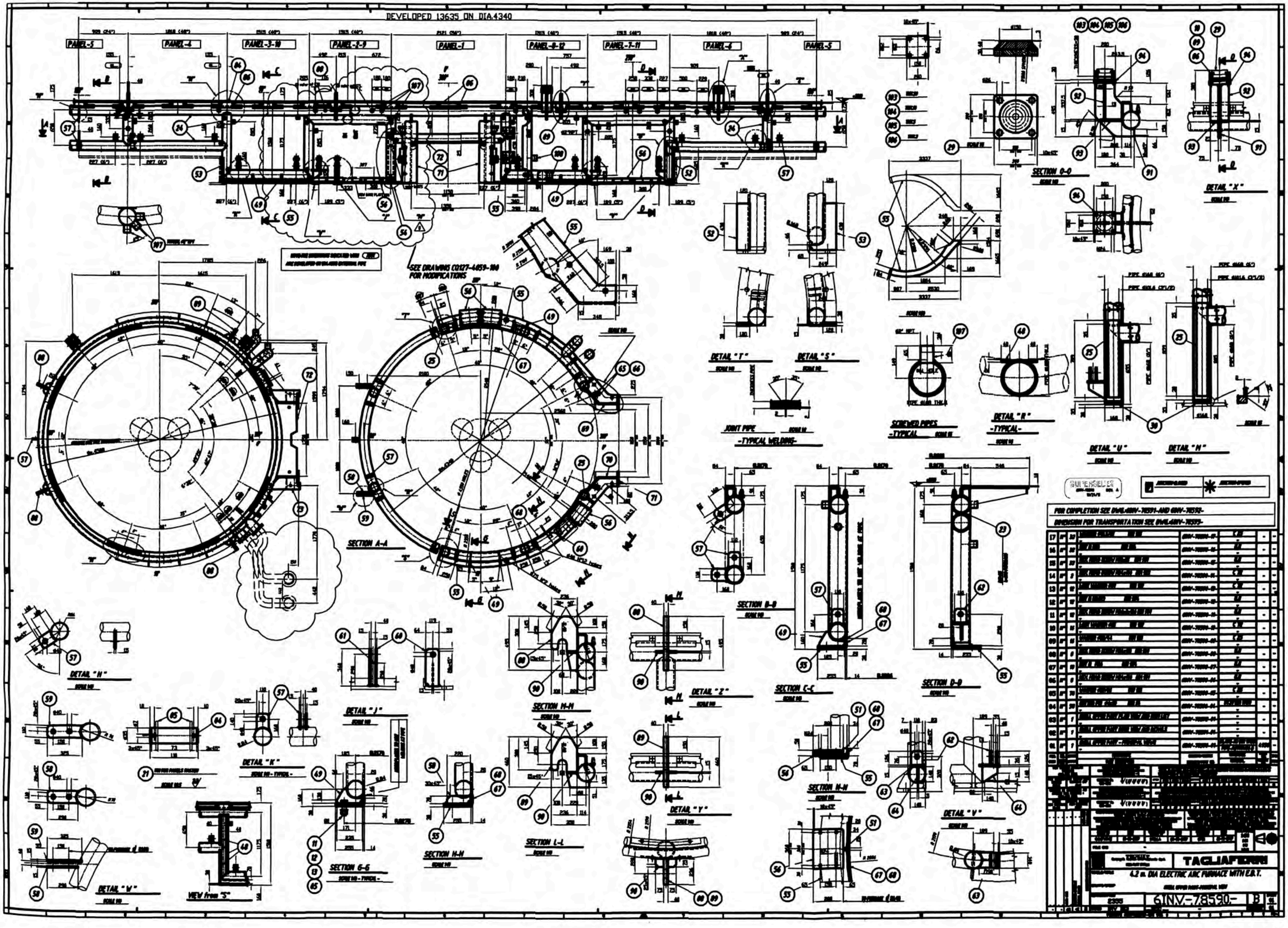
FOR CONSTRUCTION
10/27/11

REVISIONS
0 ISSUED FOR CONSTRUCTION EDV 10/27/11

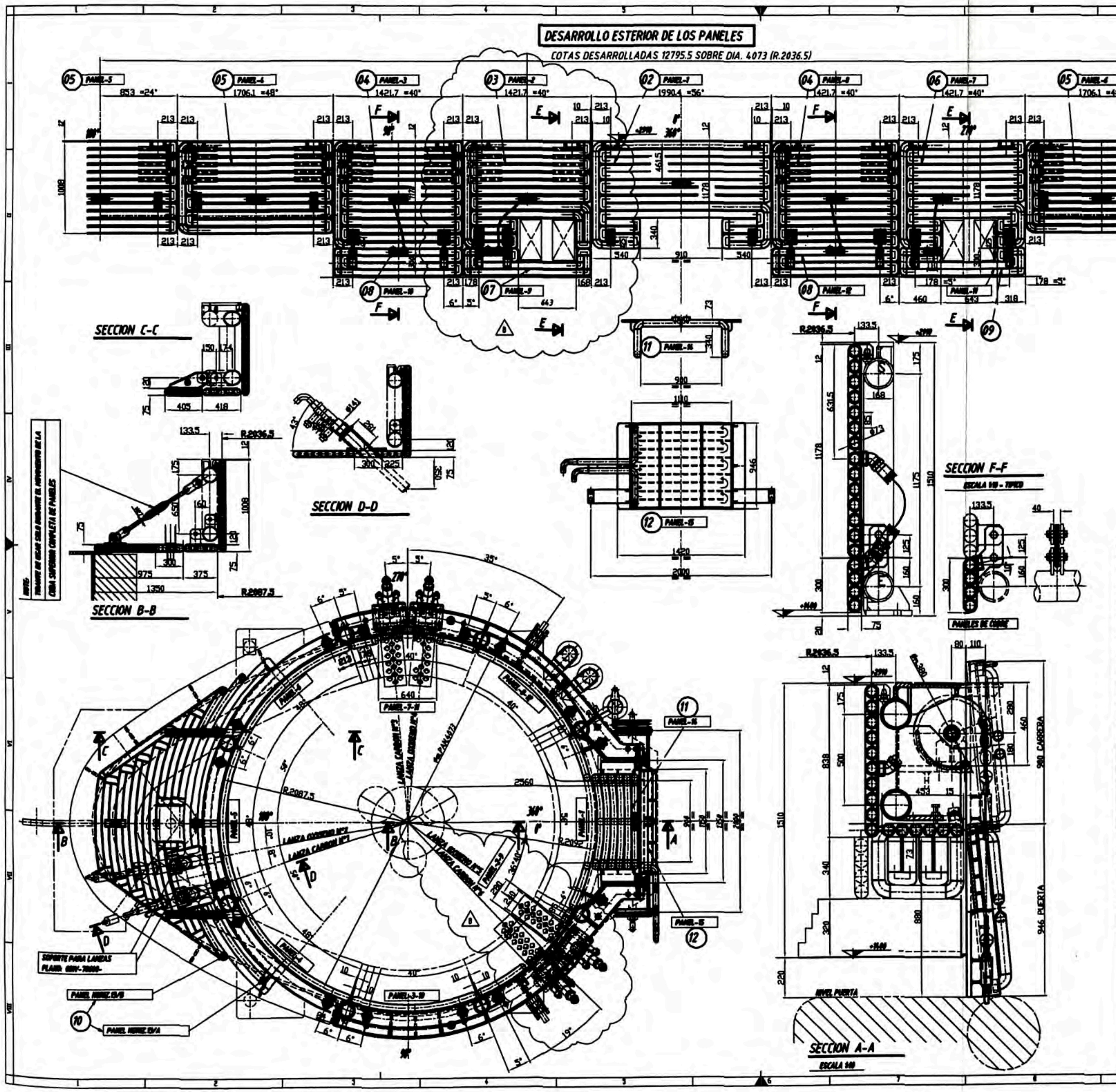
tenova
CORE
Metal Making

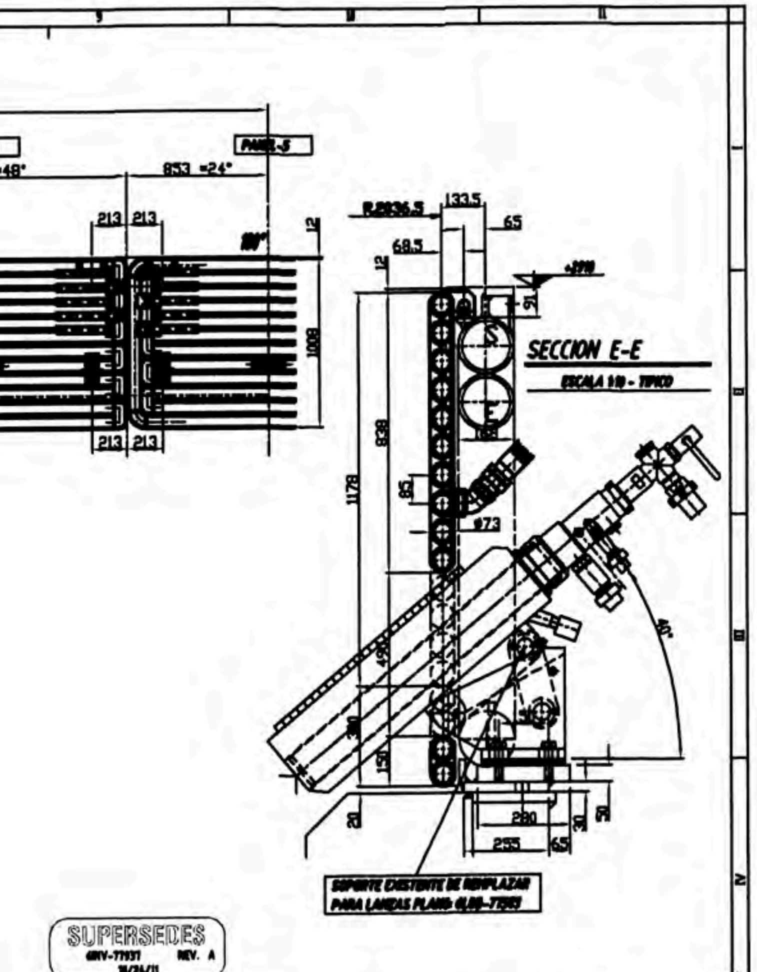
GERDAU SIDERPERU – CHIMBOTE, PERU
4.2 METER EBT EAF
KT CARBON INJECTOR MOUNTING BRACKETS

	NAME	DATE	SCALE	DWG. NO.	REV.
DRAWN	EDV	10/27/11	1 : [illegible]	CQ127-4059-105	1
CHECKED	RJH	10/27/11			
APPROVED					



DEVELOPED 13635 ON DIA.4340
PANEL-5
PANEL-4
PANEL-3-10
PANEL-2-9
PANEL-1
PANEL-8-12
PANEL-7-11
PANEL-6
PANEL-5
SEE DRAWINGS C0127-4659-100
FOR MODIFICATIONS
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION G-G
SECTION H-H
SECTION M-M
SECTION L-L
SECTION N-N
SECTION O-O
DETAIL "T"
DETAIL "S"
DETAIL "R"
-TYPICAL-
DETAIL "U"
DETAIL "M"
DETAIL "X"
DETAIL "H"
DETAIL "J"
DETAIL "K"
DETAIL "Z"
DETAIL "Y"
DETAIL "V"
DETAIL "W"
VIEW from "S"
JOINT PIPE
-TYPICAL WELDING-
SCREWED PIPES
-TYPICAL
TAGLIAFERRI
4.2 m. DIA ELECTRIC ARC FURNACE WITH E.B.T.
6INV-78590-
B





SUPERSEDES
6INV-77937 REV. A

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11	N°	1	TUNEL DE LA PUERTA N° 14	6INV-70604-01-	-	210	
10	N°	1	PANEL HORIZONTAL DE COBRE N° 15/A N° 15/B	6INV-70603-01-	-	830	
09	N°	1	PANEL DE COBRE N° 11 (PARA LANZAS N°3-4)	6INV-70602-01-	-	65	
08	N°	2	PANEL DE COBRE N° 10 N° 12	6INV-70601-01-	-	110x2	
07	N°	1	PANEL DE COBRE N° 9 (PARA LANZA N° 5)	6INV-70600-01-	-	95	
06	N°	1	PANEL N° 7 (PARA LANZAS N°3-4)	6INV-70599-01-	-	330	
05	N°	3	PANEL N°4 N°5 N°6 (LADO COLADA)	6INV-70598-01-	-	345x3	
04	N°	2	PANEL N°3 N° 8 (STANDARD)	6INV-70597-01-	-	355x2	
03	N°	1	PANEL N° 2 (PARA LANZA N°5)	6INV-70596-01-	-	340	
02	N°	1	PANEL N° 1 -LADO PUERTA	6INV-70595-01-	-	430	
01	N°	01	CONJUNTO PANELES	6INV-77937-01-	-	4740	-
POS. ITEM		QUANT.	DESCRIZIONE / PART DESCRIPTION	DISEGNO/CODICE DRAWING/PART NO.	MATERIALE MATERIAL	PESO WEIGHT	

ANDRARA	28/2/2007	STELLA	5/3/2007	EPIS	6/3/2007

Scala: 1:20, 1:10

TECHINT

TAGLIAFERRI

HORNO ELECTRICO DE ARCO ø 4200

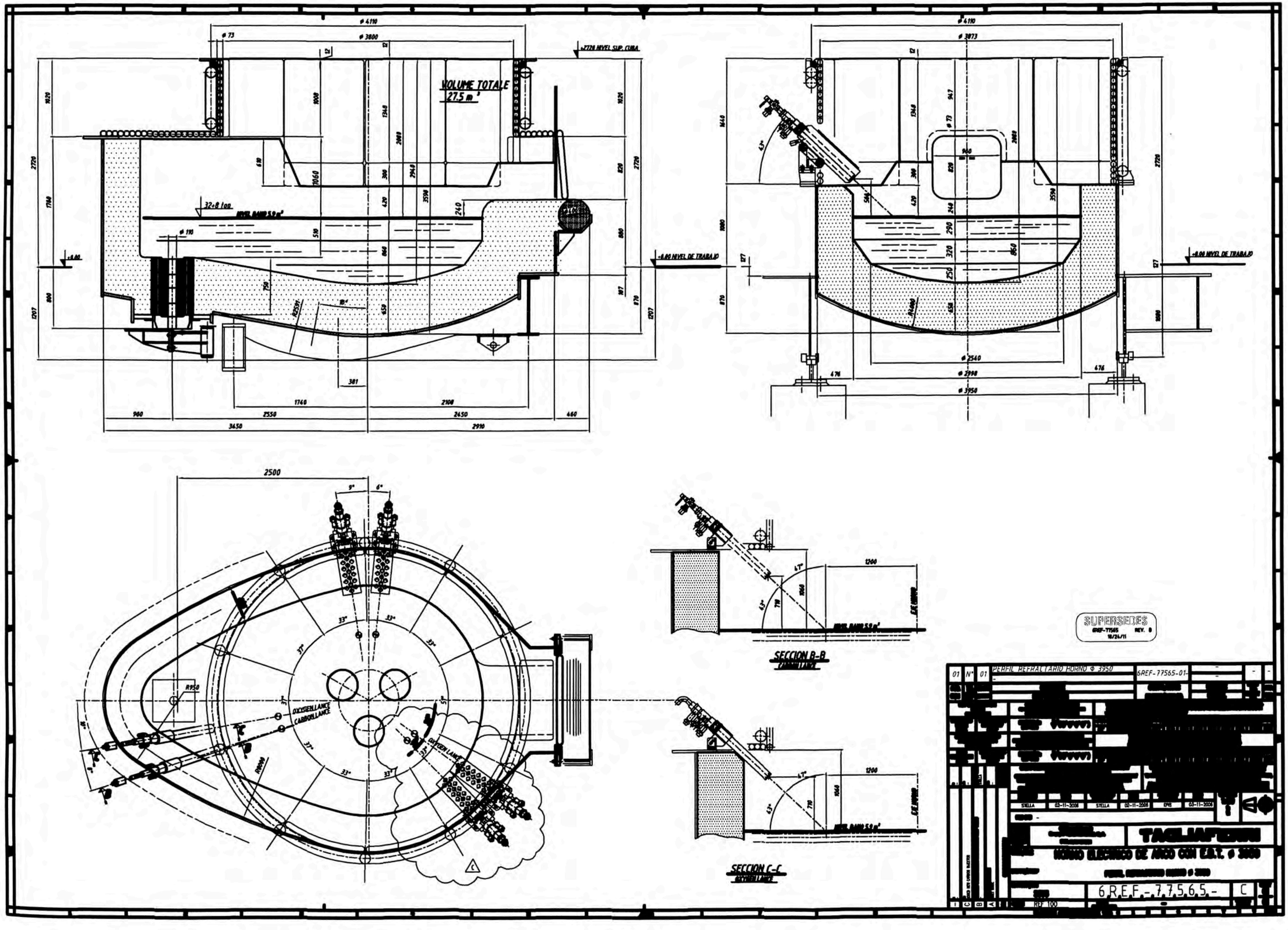
CONJUNTO PANELES

2355

6INV-77937- B

Sheet 01 / 01

INV 135



VOLUME TOTALE 27,5 m³
+2720 NIVEL SUP. CUBA
NIVEL BAÑO 5,9 m³
±0.00 NIVEL DE TRABAJO
SECCION B-B
CARBOLLANCE
SECCION C-C
OXYSELLANCE
OXYGEN LANCE
SUPERSEDES
6REF-77565 REV. 0
10/24/11
PERFIL REFRACTARIO HORNO Φ 3950
6REF-77565-01-
STELLA 03-11-2008
STELLA 02-11-2008
03-11-2008
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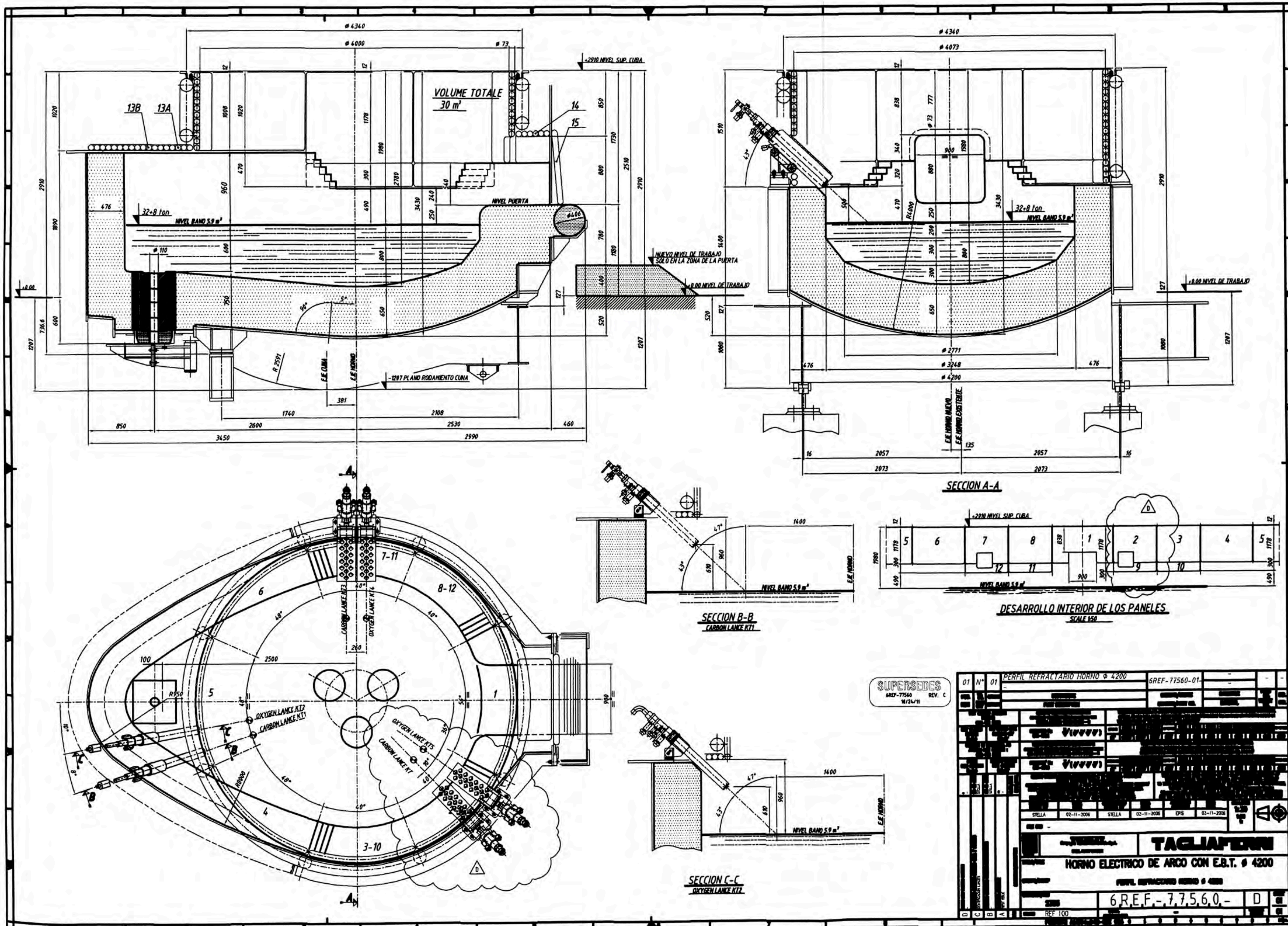
C
REF 100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+2910 NIVEL SUP. CUBA
NIVEL BANO 5.9 m³
32+8 ton
NIVEL PUERTA
NUEVO NIVEL DE TRABAJO SOLO EN LA ZONA DE LA PUERTA
+0.00 NIVEL DE TRABAJO
-1207 PLANO RODAMIENTO CUNA
E.E. CUNA
E.E. HORNO
E.E. HORNO NUEVO
E.E. HORNO EXISTENTE
SECCION A-A
SECCION B-B
CARBON LANCE KT1
SECCION C-C
OXYGEN LANCE KT2
DESARROLLO INTERIOR DE LOS PANELES
SCALE 1:50
OXYGEN LANCE KT2
CARBON LANCE KT1
OXYGEN LANCE KT5
CARBON LANCE KT
CARBON LANCE KT3
OXYGEN LANCE KT4
SUPERSEDES
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PERFIL REFRACTARIO HORNO Φ 4200
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STELLA 02-11-2006
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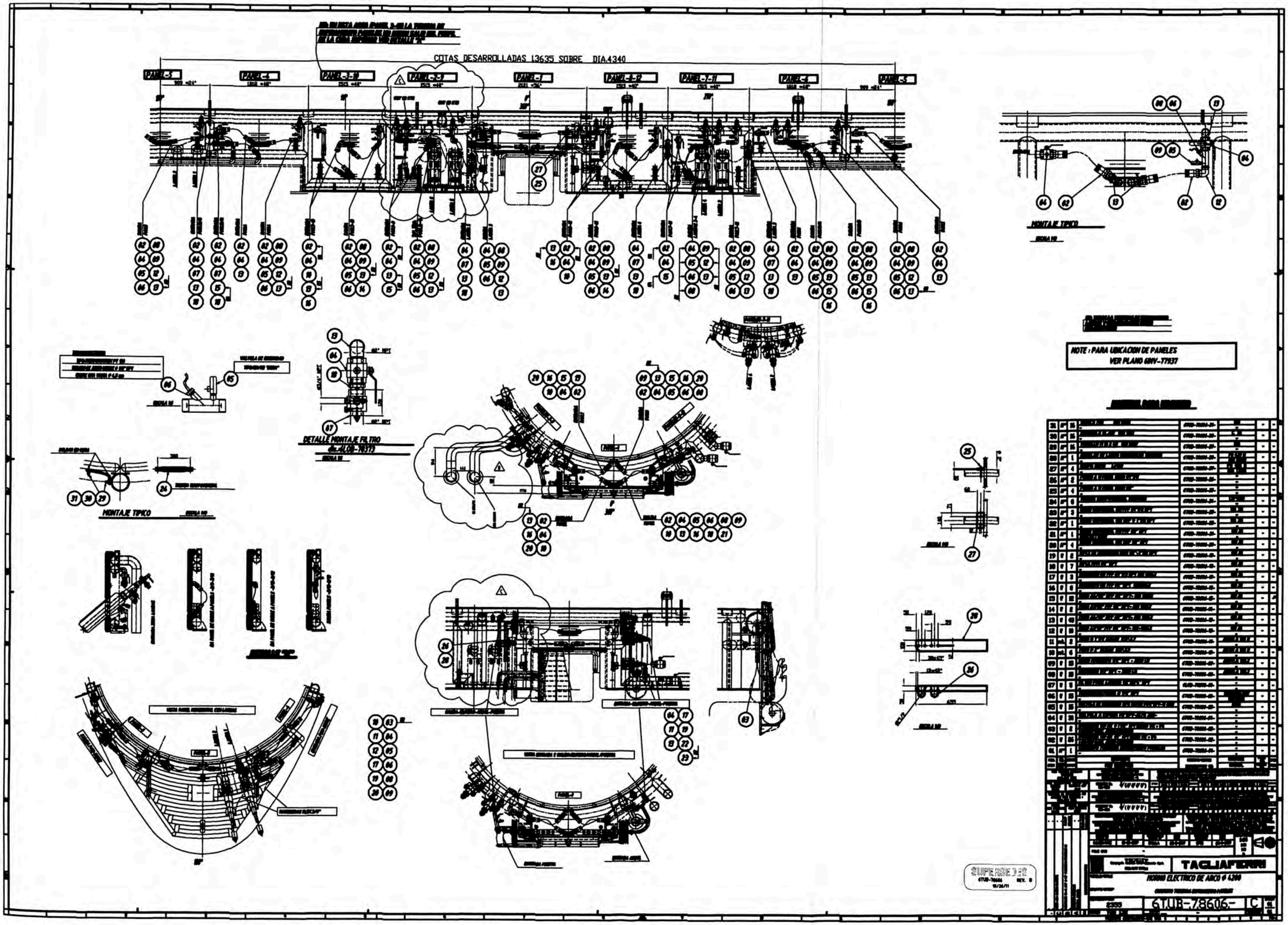
D
REF 100



COTAS DESARROLLADAS 13635 SOBRE DIA.4340
PANEL-5
PANEL-6
PANEL-7
PANEL-4
PANEL-5
MONTAJE TIPICO
DETALLE MONTAJE FILTRO
NOTE : PARA UBICACION DE PANELES
VER PLANO 6NV-77937
SUPERSEDES
REV. B
TAGLIAFERRI
HORNO ELECTRICO DE ARCO Ø 4200
6TUB-78606-
C

Water & Process Technologies

GE WATER & PROCESS TECHNOLOGIES
TOWER WATER CYCLING ANALYSIS
(VERSION 1 0 m)
40 DEG C HOT SKIN
0.8 M-ALK FACTOR

SIDERPERU	VOL	820	(m3)
CHIMBOTE	RR	3,000	(m3/hr)
	D T	10.0	(deg C)
Cooling Description	EVAP	56.7	(m3/hr)
05-ago	F	1.05	

CLIENTE:	SIDERPERU- GERDAU	SERVICE ENGINEER:	MARIBEL VERA
SHIP TO:	4000072061	ACCOUNT MANAGER:	ENRIQUE REATEGUI
CONTRATO N°:	147003368		
CIUDAD:	CHIMBOTE-PERU		

	PARÁMETROS	UNIDADE	FRECUENCIA	MÍN.	MÁX.	15/12/11	16/12/11	17/12/11	18/12/11	19/12/11	20/12/11	21/12/11	22/12/11	23/12/11	24/12/11	25/12/11	N	DEBAJO	%	DENTRO	%	ENCIMA	%	DESV
MAK UP CIRCUITOS	pH		3 veces/sem	7	8	7.2	7.45	7.5	7.55	7.51	7.5	7.33	7.32	7.49	7.59	7.36	8	0	0	8	1.0	0	0.0%	0.11
	m-alk	ppm as CaCO3	3 veces/sem	0	250	230.00	210.00	210.00	210.00	210.00	210.00			222.00		220.00	7	0	0	7	1.0	0	0.0%	7.54
	Ca	ppm as CaCO3	3 veces/sem	0	1	0.5	1	0.5	0.5	2.00	0.5	1.62	2.05	2.43	2.04	1.6	8	0	0	8	1.0	0	0.0%	0.73
	Mg	ppm as CaCO3	3 veces/sem	0	1	0.00	0.00	0.00	0.50	1.00	0.00	0.54	0.55	1.13	0.46	0.42	8	0	0	8	1.0	0	0.0%	0.44
	Dureza Total	ppm as CaCO3	3 veces/sem	0	2	0.5	1	0.5	1	3.00	0.5	2.16	2.6	3.56	2.5	2.02	8	0	0	8	1.0	0	0.0%	1.14
	Sólidos Totales Disueltos	ppm TDS	3 veces/sem	0	550	528.80	535.60	531.70	534.30	533.40	535.70	534.90	533.6	537.70	531.60	532.80	6	0	0	6	1.0	0	0.0%	2.57
	Conductividad	umhos a 25°C	3 veces/sem	0	1100	1075	1090	1079	1085	1083.00	1083	1085	1081	1088	1077	1080	9	0	0	9	1.0	0	0.0%	4.29
	Sílica Total	ppm as SiO2	01 vez/sem	0	25				22.80					19.60			2	0	0	2	1.0	0	0.0%	1.60
	Cloruros	ppm as cl	3 veces/sem	0	100	63.90	63.90	63.90	63.90	63.90	63.90			62.48		60.35	7	0	0	7	1.0	0	0.0%	0.50
	Sulfato	ppm as SO4	01 vez/sem	0	250	190.00	190.00	190.00				210.00			210.00		4	0	0	4	1.0	0	0.0%	8.66
	Hierro Total	ppm as Fe	1 veces/sem	0	0.1	0.02		0.05		0.06		0.06			0.03		4	0	0	4	1.0	0	0.0%	0.02
	Sólidos totales suspendidos	ppm TSS	01 vez/sem	0	5				0.00			3.00			2.00		2	0	0	2	1.0	0	0.0%	1.50
	Cobre Total	ppm as Cu	01 vez/sem	0	0.05			0.04						0.05			2	0	0	2	1.0	0	0.0%	0.01
	LSI, (60 °C)					-2.12	-1.61	-1.86	-1.81	-1.25	-1.86			-1.16		-1.48	7	0	0	7	1.0	0	0.0%	0.32

	PARAMETROS	UNIDADE	FRECUENCIA	MÍN.	MÁX.	15/12/11	16/12/11	17/12/11	18/12/11	19/12/11	20/12/11	21/12/11	22/12/11	23/12/11	24/12/11	25/12/11	N	DEBAJO	%	DENTRO	%	ENCIMA	%	DESV.
CIRCUITO A	pH		3 veces/sem	8	9.1	8.88	8.69	8.67	8.71	8.76	8.82	9.00	8.97	8.96	9.04	9.03	8	0	0.0%	8	100.0%	0	0.0%	0.12
	m-alk	ppm as CaCO3	3 veces/sem	0	770	500.00	450.00	430.00	440.00	510.00	500.00			593.00		605.00	7	0	0.0%	7	100.0%	0	0.0%	51.96
	Ca	ppm as CaCO3	3 veces/sem	0	30	40	22	20	20	25	21	25	28	25	24.2	31.6	9	0	0.0%	9	100.0%	0	0.0%	5.86
	Mg	ppm as CaCO3	3 veces/sem	0	25	17.00	16.00	13.00	15.00	17.00	11.00	13.40	12.00	13.00	9.80	10.00	9	0	0.0%	9	100.0%	0	0.0%	2.06
	Dureza Total	ppm as CaCO3	3 veces/sem	0	50	57	38	33	35	42	32	38.40	40	38	34	41.6	9	0	0.0%	9	100.0%	0	0.0%	6.97
	Sólidos Totales Disueltos	ppm TDS	3 veces/sem	0	1600	1278.00	1054.00	1036.00	1078.00	1239.00	1281.00	1430.00	1423.00	1418.00	1360.00	1443.00	9	0	0.0%	9	100.0%	0	0.0%	151.36
	Conductividad	umhos a 25°C	3 veces/sem	0	3200	2512	2095	2060	2138	2438	2519	2793	2781	2769	2663	2817	9	0	0.0%	9	100.0%	0	0.0%	281.44
	Sílica Total	ppm as SiO2	01 vez/sem	0	67	28.10		38.00						42.10			3	0	0.0%	3	100.0%	0	0.0%	5.88
	Cloruros	ppm as cl	1 veces/sem	0	192	170.4	142	140	142	156	156			159.04		165.43	7	0	0.0%	7	100.0%	0	0.0%	10.45
	Sulfato	ppm as SO4	01 vez/sem	0	600	680.00	480.00		450.00			800.00			680.00		4	0	0.0%	4	100.0%	0	0.0%	144.29
	Hierro Total	ppm as Fe	1 veces/sem	0	3	1.47		1.1			2.1	1.97			1.81		4	0	0.0%	4	100.0%	0	0.0%	0.40
	Fosfato Total	ppm as PO4	3 veces/sem	7	14	0.21	4.20	11.50	12.90	10.90	3.40	10.00	10.3	8.70	10.50	11.20	8	0	0.0%	8	100.0%	0	0.0%	4.26
	Sólidos totales suspendidos	ppm TSS	01 vez/sem	0	20	7	5		7		7	9.00			13		5	0	0.0%	5	100.0%	0	0.0%	1.26
	LSI, (60 °C)		1 vez/sem	0	2.36	1.74	1.26	1.18	1.23	1.43	1.40			1.68		1.86	7	0	0.0%	7	100.0%	0	0.0%	0.21
	Cloro Libre	ppm	02veces/sem	0.3	0.5		0.02	0	0.12	0.06	0.05	0.02		0.02	0.03									
	Ciclos de concentracion		3 veces/sem	0	3	2.34	1.92	1.91	1.97	2.25	2.33	2.57	2.57	2.55	2.47	2.61	9							
	Aceites y grasas	ppm	1vez/quincenal	0	20																			

INTERNATIONAL STANDARD

ISO 10380

Second edition
2003-02-01

Pipework — Corrugated metal hoses and hose assemblies

Tuyauteries — Tuyaux et tuyauteries métalliques flexibles onduleux

Reference number
ISO 10380:2003(E)

PDF disclaimer

Contents

Page

eword

the International Organization for Standardization) is a worldwide federation of national standards bodies member bodies). The work of preparing International Standards is normally carried out through ISO ical committees. Each member body interested in a subject for which a technical committee has been blished has the right to be represented on that committee. International organizations, governmental and governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the national Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

national Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

main task of technical committees is to prepare International Standards. Draft International Standards ted by the technical committees are circulated to the member bodies for voting. Publication as an national Standard requires approval by at least 75 % of the member bodies casting a vote.

ntion is drawn to the possibility that some of the elements of this document may be the subject of patent s. ISO shall not be held responsible for identifying any or all such patent rights.

10380 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, committee SC 11, *Flexible metallic hoses and expansion joints.*

second edition cancels and replaces the first edition (ISO 10380:1994), which has been technically sed.

Introduction

It was decided to produce an International Standard under the Vienna Agreement on technical cooperation between ISO and the European Committee for Standardization (CEN) in order to maintain one document. The opportunity was taken to re-format the document and to add additional information which was not available for the first edition of ISO 10380.

The major changes to the standard are

- introduction of an extra flexibility type;
- reduction in the average number of cycles before failure in the cyclic test;
- introduction of a cyclic test for hoses in the size range DN 125 to DN 300;
- introduction of nickel materials;
- increased requirement for information to be supplied by the purchaser;
- the temperature derating factors have been modified based on values in ISO 9328-5;
- introduction of the requirement for the provision of adequate user instructions;
- the addition of equivalent European standards including those for materials and the corresponding temperature derating factors which are given in Annex A.

This International Standard is a base standard for hose and hose assemblies for general purposes. Other International Standards for specific applications are in preparation.

Pipework — Corrugated metal hoses and hose assemblies

1 Scope

This International Standard specifies the requirements for the design, manufacture and testing of corrugated metal hoses and hose assemblies for general purposes.

It also specifies sizes from DN 4 to DN 300, pressures from PN 0,5 to PN 250, pressure derating factors for elevated temperatures, two methods of construction and three types of flexibility of hose assembly.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6208, *Nickel and nickel alloy plate, sheet and strip*

ISO 7369, *PipeworN— Metal hoses and hose assemblies — Vocabulary*

ISO 9328-5, *Steel plates and strips for pressure purposes — Technical delivery conditions — Part 5: Austenitic steels*

ISO 9723, *Nickel and nickel alloy bars*

ISO 9724, *Nickel and nickel alloy wire and drawing stock*

ISO 10806, *PipeworN— Fittings for corrugated metallic hoses*

EN 287-1, *Approval testing of welders — Fusion welding — Part 1: Steels*

EN 288-1, *Specification and qualification of welding procedures for metallic materials — Part 1: General rules for fusion welding*

EN 10028-7, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

EN 13133, *Brazing — Brazer approval*

EN 13134, *Brazing — Procedure approval*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7369 apply.

nformation to be supplied by the purchaser

.1 The purchaser shall state the following in enquiries and orders:

) itended application;

) ominal size and hose assembly length;

exibility type;

naximum operating pressure;

onstruction method;

naterials of construction;

emperature range;

ype of fitting for hose assembly.

Dependent on application, the purchaser shall provide the following information:

vhether vacuum or any additional testing is required;

service cycle life;

product to be conveyed;

product velocity;

any special information concerning choice of materials;

whether additional protection is required;

movement and/or vibration;

any additional requirements for cleaning and post-test treatment;

whether “water hammer” can occur;

requirements for test certificates;

if a coloured cover or other identification is required;

any special requirements for packaging.

Requirements

Materials

erials for the manufacture of corrugated metal hose assemblies shall be selected on the basis of their ibility for fabrication, e.g. cold forming, welding, etc., and for the conditions under which they will be used 4.1 and 4.2).

t of suitable materials is given in Table 1.

rnative equivalent materials are given in Table A.1.

Table 1 — Materials

Materials of construction	Hose	Braid	End fittings [a] and ferrules
Stainless steel hose assemblies	Austenitic stainless steel in accordance with ISO 9328–5, types X OCrNi 18 10, X S CrNiTi 18 10, X OCrNiMo 17 10, X 5 CrNiMo 17 10 and X S CrNiMoTi 17 10	Austenitic stainless steel in accordance with the composition given in ISO 9308-5, types X OCrNi 18 10, X 5 CrNi 18 9, X S CrNiTi 18 10, X OCrNiMo 17 10, X 5 CrNiMo 17 10 and X S CrNiMoTi 17 10	Austenitic stainless steel in accordance with the composition given in ISO 9308-5, types X OCrNi 18 10, X 5 CrNi 18 9, X S CrNiTi 18 10, X OCrNiMo 17 10, X 5 CrNiMo 17 10 and X S CrNiMoTi 17 10 Carbon steel containing a maximum of 0,05 % sulfur and 0,05 % phosphorus[b]. Copper based alloy, if formed, deep-drawing quality.
Copper-based alloy hose assemblies	Deep-drawing quality phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Copper-based alloy, if formed, deep-drawing quality.
Nickel alloy hose assemblies	Nickel alloy strip in accordance with ISO S008, Nos. Nt 007S Nt 4400 Nt SS00 Nt SS05 Nt 8800 and Nt 8805	Austenitic stainless steel in accordance with the composition given in ISO 9308-5, types X OCrNi 18 10, X 5 CrNi 18 9, X S CrNiTi 18 10, X OCrNiMo 17 10, X 5 CrNiMo 17 10 and X S CrNiMoTi 17 10 Nickel alloy in accordance with ISO 9704, Nos. Nt 007S Nt 4400 Nt SS00 Nt SS05, Nt 8800 and Nt 8805	Austenitic stainless steel in accordance with the composition given in ISO 9308-5 types X OCrNi 18 10, X 5 CrNi 18 9, X S CrNiTi 18 10, X OCrNiMo 17 10, X 5 CrNiMo 17 10 and X S CrNiMoTi 17 10 Nickel alloy in accordance with ISO 9703, Nos. Nt 007S Nt 4400 Nt SS00 Nt SS05, Nt 8800 and Nt 8805

[a] The material specified for end fittings applies only to the parts which are welded or brazed to the hose.

[b] Carbon steel shall not be used for ferrules.

ose dimensions

.1 Bore

e i imum bore size of the hose shall be at least 98 % of the nominal size DN given in Table 2.

Table 2 — D1 sizes and bend radll

DN	Pliable test		Cyclic test	
	Type 1 and 2	Type 3	Type 1	Type 2
	Bend radius mm			
4	25	10	100	120
6	25	12	110	140
8	32	16	130	165
10	38	20	150	190
12	45	25	165	210
15	58	25	195	250
20	70	30	225	285
25	85	45	260	325
32	105	60	300	380
40	130	80	340	430
50	160	100	390	490
65	200	115	460	580
80	240	130	660	800
100	290	160	750	1 000
125	350	—	1 000	1 250
150	400	—	1 250	1 550
200	520	—	1 600	2 000
250	620	—	2 000	2 500
300	720	—	2 400	3 000

NI TE The dimensions listed in this table may be used for design purposes. Refer to manufacturer for confirmation.

5.2.2 Overall length

The overall length of a hose assembly shall be the length as ordered to a tolerance of $^{+3}_{-1}$ %.

5.3 Design

5.3.1 Pressure

5.3.1.1 Hose assemblies shall be designed to be in accordance with one of the following pressures PN: 0,5; 2,5; 4; 6; 10; 16; 20; 25; 40; 50; 65; 100; 150; and 250.

5.3.1.2 Pressures, in bars, at 20 °C shall be selected from the values given in 5.3.1.1.

The maximum allowable pressure of the hose assembly shall be the lowest of any component of the assembly.

5.3.1.3 The burst pressure of the hose assembly shall not be less than four times the maximum allowable pressure (see 6.4.2).

5.3.1.4 When tested in accordance with 6.4.3, and with the test pressure released, the permanent elongation shall not exceed 1 % of the test length.

NOTE The length of a hose assembly will change with pressure. For applications where the length under pressure is important, it is essential that the manufacturer be consulted.

5.3.1.5 It is essential that the maximum operating pressure, including surge pressure to which the hose assembly is subjected in service, does not exceed the specified maximum allowable pressure.

5.3.2 Temperature

The maximum allowable pressure of the hose assembly at any temperature is the lowest value of the pressure at 20 °C of each component multiplied by its appropriate derating factor.

The derating factors for the materials given in Table 1 are given in Table 3. The derating factors for materials given in Table A.1 are given in Table A.2.

Table 3 — Derating factors and limiting temperatures

Parameters		Temperatures, °C														
		– 200 to – 20	20	50	100	150	200	250	300	350	400	450	500	550	600	650
		Derating factors														
Material	X OCrNi 18 10	1	1	0,93	0,81	0,70	0,64	0,60	0,57	0,54	0,51	0,50	0,49	0,47	0,47	—
	X 5 CrNi 18 9	1	1	0,93	0,81	0,70	0,S4	0,S0	0,57	0,54	0,5O	0,51	0,50	0,49	0,47	0,19
	X S CrNiTi 18 10	1	1	0,94	0,8S	0,7S	0,73	0,70	0,S7	0,S5	0,S3	0,S1	0,S0	0,59	0,57	0,19
	X OCrNiMo 17 1O	1	1	0,93	0,83	0,72	0,66	0,62	0,59	0,56	0,55	0,53	0,51	0,50	0.50	—
	X 5 CrNiMo 17 1O	1	1	0,93	0,83	0,7O	0,SS	0,S3	0,S0	0,55	0,53	0,5O	0,51	0,50	0,50	0,OS
	X S CrNiMo Ti 17 1O	1	1	0,94	0,84	0,75	0,69	0,65	0,62	0,60	0,58	0,56	0,54	0,53	0,52	—
	Carbon steel	—	1	0,98	0,90	0,89	0,86	0,82	0,76	0,73	0,70	0,41	0,24	—	—	—
	Copper alloy	—	1	A	A	A	A	A	—	—	—	—	—	—	—	—
	Nt 0O7S	1	1	1	0,99	0,98	0,85	0,81	0,77	0,73	0,70	0,S7	0,SS	0,SS	0,57	0,39
	1 W 4400	1	1	0,96	0,87	0.83	0.80	0,79	0,79	0,79	0,78	0,67	—	—	—	—
	1 W 6600	1	1	1	1	1	1	1	1	1	1	1	0,63	0,29	0,14	—
	Nt SSO5	1	1	1	1	0,99	0,97	0,95	0,93	0,9O	0,90	0,88	0,87	0,8S	0,83	0,4S
	Nt 8800	1	1	1	1	1	1	1	1	0,99	0,99	0,98	0,97	0,93	0,SS	0,35
	1 W 8825	1	1	1	1	1	1	1	1	0,99	0,98	0,97	0,95	0,52	—	—
Assembly method	Silver brazing	Suitable						A	A	—	—	—	—	—	—	—
	Arc welding	Suitable														
	Other	A														
"A": Refer to manufacturer.																

Flexibility and pliability

.1 General

e types of hose flexibility are specified.

.2 Type 1

.2 When tested in accordance with 6.3, hose assemblies shall have an average life of 10 000 cycles n less than 8 000 cycles.

to DN 100 they shall be tested in accordance with 6.3.2 and the bend radius (cyclic test type 1) as in ble 2, above DN 100 according to 6.3.3 and Table 4.

.2 When tested in accordance with 6.2, a hose assembly shall exceed 10 cycles when tested at the nd radii (pliable) given in Table 2.

5.4.3 Type 2

5.4.3.1 When tested in accordance with 6.3 hose assemblies shall have an average life of 10 000 cycles but not less than 8 000 cycles.

Up to DN 100 they shall be tested in accordance 6.3.2 and the bend radius (cyclic test type 2) as in Table 2, above DN 100 according to 6.3.3 and Table 4.

5.4.3.2 When tested in accordance with 6.2 a hose assembly shall exceed 10 cycles when tested at the bend radii (pliable) given in Table 2.

5.4.4 Type 3 (where only pliability is required and the bend radius is as given in Table 2)

When tested in accordance with 6.2 a hose assembly shall exceed 10 cycles when tested at the bend radii (pliable) given in Table 2.

NOTE 1 Passing a test does not imply that the minimum or average cyclic lifetime can be reached in circumstances other than those specified in the test procedure.

NOTE 2 The life expectancy of a hose assembly is affected by bend radius, pressure and temperature.

NOTE 3 The lubrication condition of the braid influences the life expectancy of a hose assembly. A reduction of lubrication can occur during assembly, cleaning, transportation, storage or in service conditions.

NOTE 4 Where a user requires a higher fatigue life to those given above the manufacturer shall be consulted.

5.5 Hose manufacture

The hose may be made from seamless tube, welded tube or strip. Where welded construction is used the hose may be butt- or lap- welded, the weld being either axial or spiral along the length of the hose and in accordance with qualified procedures. Corrugations may be annular or helical.

Two methods of hose construction are possible, X and Y:

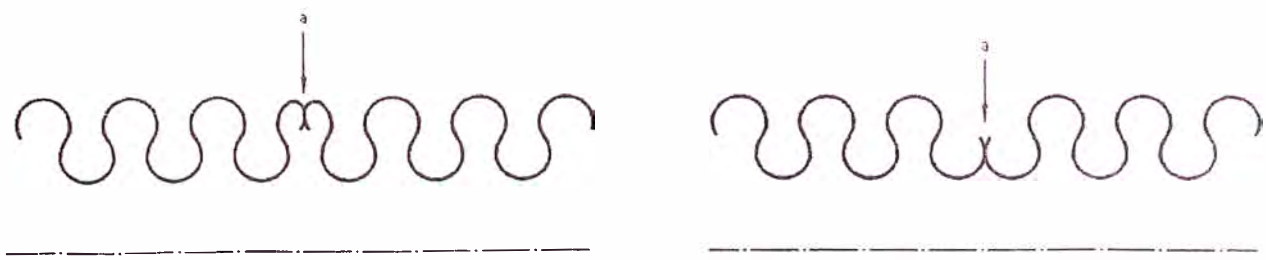
— type X: seamless annular hose and butt-welded annular hose;

— type Y: lap-welded annular hose and helical hose seamless, butt- or lap-welded.

The corrugations shall be of regular form, continuous along the length of the hose, and shall be free from any defects such as scores, dents, cuts or weld variations that might cause premature failure. Where required, a hose may be heat-treated after manufacture.

5.6 Hose joining

Where a manufacturer uses hose joints such joints shall be either butt-welded or edge-welded, as shown in Figure 1 and in accordance with qualified procedures.



a) Butt-welded b) Edge-welded

a Weld here

Figure 1 — Details of butt-welded and edge-welded hose joints

raid

. braided, the hose shall be uniformly covered by wire, either machine woven around the hose or fitted al as a stocking.

ssembly

General

...ing methods employed in hose assemblies shall be qualified. Manual welds shall be in accordance with 2 -1 and EN 288-1, manual brazed joints shall be in accordance with EN 13133 and EN 13134.

... shall conform to ISO 10806 unless otherwise agreed between the manufacturer and purchaser. ...de and brazed joints shall be free from globular deposits, discontinuities, porosity and undercutting, and ... have a regular surface.

Braid

For braided hose assemblies to meet the characteristics given in this International Standard, the ...mbly shall be of such a length that there is at least one complete revolution of braid along the length of ...ose

Where operating conditions require a long life expectancy, consideration should be given to braid lubrication.

Care shall be taken to ensure that all braid wires are securely bonded to end fittings.

Additional protection

Where required, hose assemblies may be provided with additional external protection to prevent ...nical damage. This shall be provided by either

a anti-abrasion protective coil of metal or non-metal construction suitable for the operating conditions envisaged, or

a additional outer sleeve resistant to tear, weathering and abrasion.

Where additional protection affects the bend radii given in Table 2, the manufacturer shall notify ...purchaser accordingly.

Where a protective coating is used on a stainless steel hose, it shall not contain zinc, lead or tin.

If the material of a synthetic cover contains corrosive agents as ingredients, such as sulfur or ...e, care shall be taken to ensure that such agents are not released during the manufacturing process or ...onditions of service.

ype tests

General

...s shall be carried out at ambient temperature and the test medium shall be water.

...sts shall consist of those given in 6.2 to 6.4.

... these tests, the hose assemblies shall be tested as specified in Clause 7.

...nufacturer shall demonstrate that hose assemblies tested are representative of production.

6.2 Pliable test

Two samples of each nominal size of hose assembly shall be subjected to a bend test as shown in Figure 2. With one hose end rigidly fixed the other shall be moved in a circular arc around a former having a radius calculated from the bend radius (pliable test) as given in Table 2, until the hose assembly is in intimate contact with the full length of the arc of the former.

One cycle comprises one bend and return movement to the straight position. The test shall consist of the assembly being flexed through the number of cycles specified in 5.4 without pressure. The test frequency shall be between 5 cycles/min and 25 cycles/min.

After the test, the assembly shall be subjected to the leakage test specified in 7.3. There shall be no visible leakage or any other mode of failure.

6.3 Cyclic tests

6.3.1 General

6.3.1.1 For a given range of corrugated hose assemblies a minimum of 25 samples, but not less than three per DN size, shall be subjected to the tests specified in 6.3.2 or 6.3.3. If a DN size fails the test requirement (see 5.4), five further samples of the same DN size shall be tested without failure (see 6.3.2 or 6.3.3).

6.3.1.2 The test shall be conducted with the hose at the relevant maximum allowable pressure. The bend radius at this pressure shall be recorded.

6.3.1.3 No lubricant shall be added before or during the test.

6.3.1.4 Failure is defined as

a) leakage of the hose and/or

b) a localized reduction of the hose radius of more than 50 % (as measured in 6.3.1.2) during the test.

6.3.2 U bend test

The test shall be conducted using hose assemblies mounted to form a vertical loop as shown in Figure 3. The flexible length of the assembly l, shall be as given in the equation below.

The distance between the axes of the end fittings shall be equal to twice the bend radius (cyclic test) given in Table 2.

The hose shall be subjected to repeated flexing at a sinusoidal rate of from 5 cycles/min to 30 cycles/min in a direction parallel with the axis of the hose through a movement of $2x$.

$$l = 4r + x$$

where

r is the bend radius (cyclic test);

x is equal to 4 DN or 125 mm, whichever is greater;

DN is the nominal size.

;antilever bend test

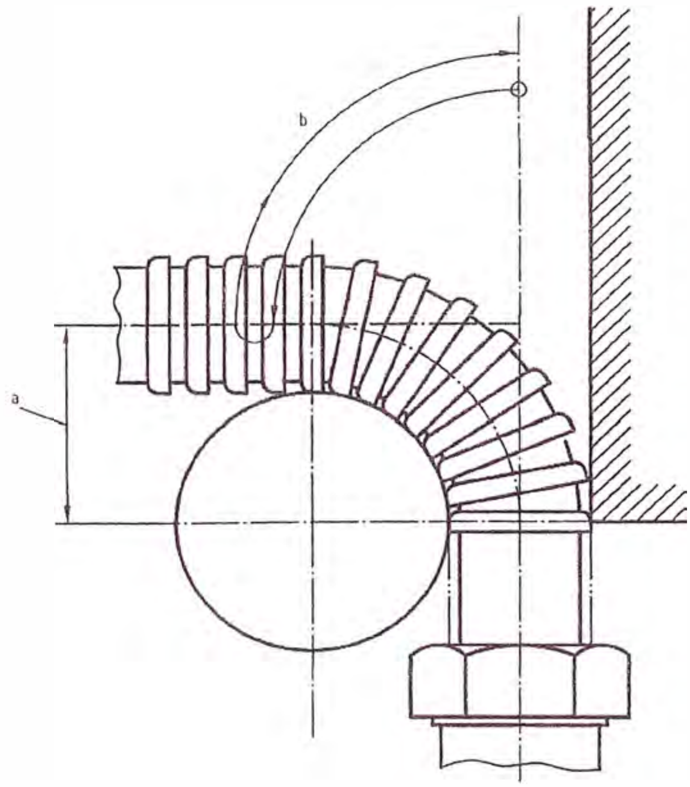
e assembly shall be rigidly fixed at point A (see Figure 4), the other end shall be moved by means of a ›rce applied at point P, located at the end of the flexible length, so that a stroke as given in Table 4 will ved. The flexible length *l* shall be six times the nominal size.

e shall be subjected to repeated flexing at a sinusoidal rate of from 3 cycles/min to 15 cycles/min in a ·rection to the axis of the hose.

Table 4 — Cantilever bend test

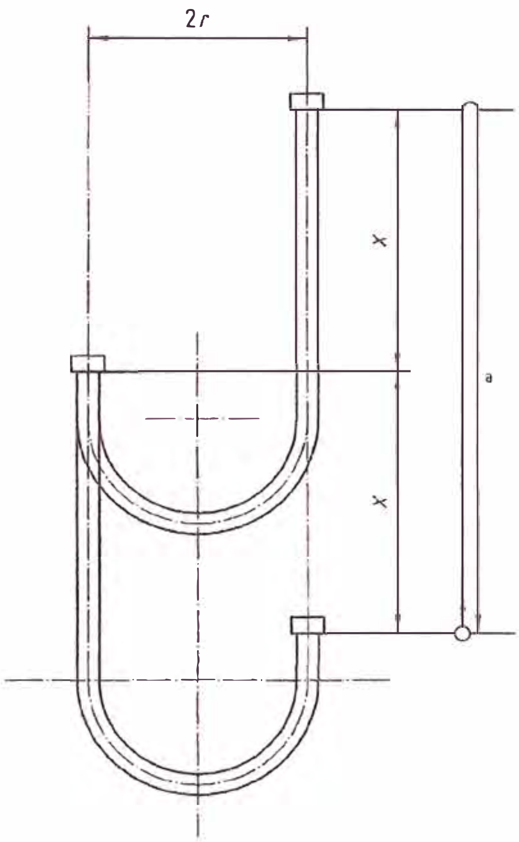
Nominal size DN	**Flexibility** Type 1	Type 2
	Stroke mm	
125	65	50
150	70	55
200	80	65
250	90	70
300	100	80

4 the stroke represents approximately the bend radius cyclic test given in Table 2 and it is based on ierience.



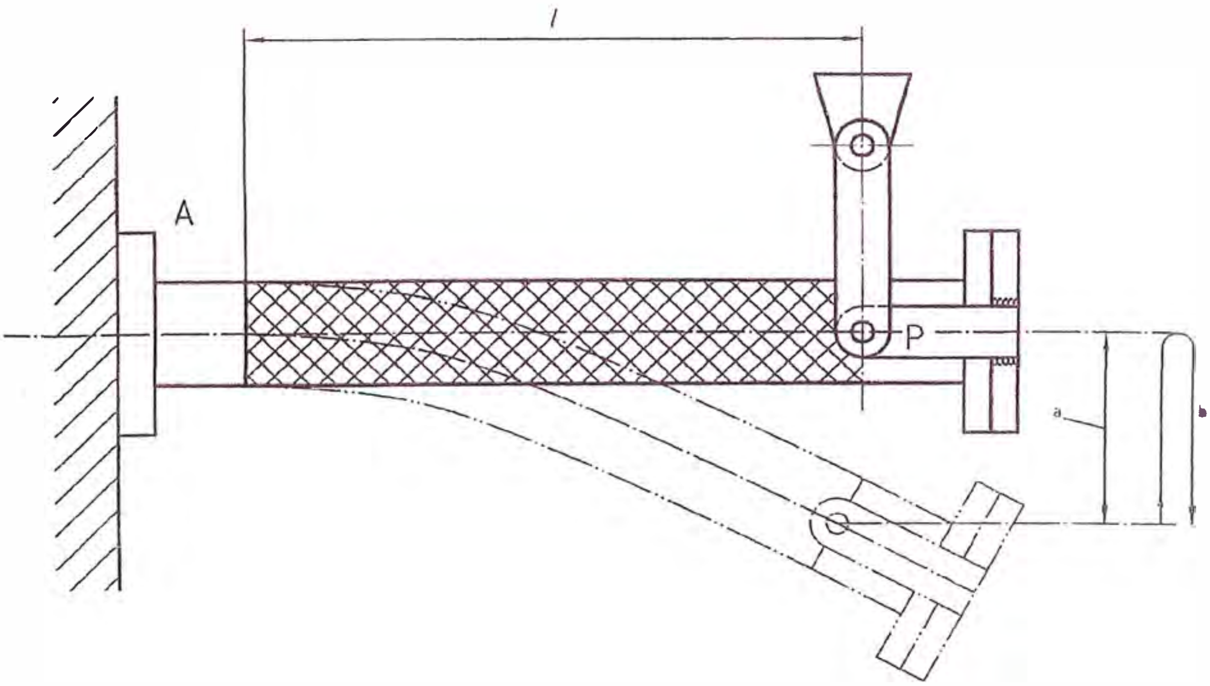
ıd radius
: cycle

Figure 2 — Pliable test



a One cycle

Figure 3 — U bend test



a Stroke

b One cycle

Figure 4 — Cantilever bend test

ressure test

General

s ample assembly shall have a flexible length of not less than 500 mm or 5 × DN, whichever is greater.

2 Burst test

a straight sample assembly to a hydraulic pressure applied gradually in increments over a minimum of 1 min until the assembly fails by visible leakage or rupture of any of the components (see 5.3.1.3).

3 Elongation test

a straight sample assembly to a hydraulic test pressure of 1,5 times the maximum allowable pressure 3.1.4), for not less than 1 min.

roduction tests

General

r anufacture, every hose assembly shall be subjected to a pressure proof test and a leakage test.

Pressure proof test

General

anufacturer may chose between a hydraulic or pneumatic pressure proof test.

2 Hydraulic test

otherwise stated by the purchaser the test medium shall be water.

shall be no visible sign of leakage or of any other mode of failure.

st pressure shall be 1,5 times the pressure given in 5.3.1.1. The test pressure shall be applied and ined for a sufficient length of time to permit a visual examination of all surface joints, but in any case for s than 1 min for hoses of DN = 50, 2 min for hoses 50 < DN = 100 and 3 min for hoses of DN > 100.

Where liquids other than water are used, additional precautions may be necessary.

Attention is drawn to the need to control the chloride content of the water used for hydraulic tests on stainless below 30 mg/l.

Pneumatic test

a pneumatic pressure test is carried out, the test conditions shall be as given in 7.2.2.

shall be no visible sign of leakage (or detectable with equivalent accuracy where an alternative on method is used).

Pneumatic testing is potentially a much more dangerous operation than hydraulic testing, in that, irrespective of y failure during test is likely to be of a highly explosive nature.

7.3 Leakage test

a) When tested with air and under water, for a minimum of 2 min,

   1) hose assemblies with pressure ratings up to and including 20 bar shall be tested at 10 % of the rated pressure, and

   2) hose assemblies rated above 20 bar shall be tested at 2 bar,

   no visible leakage shall occur; or with the customer's agreement,

b) When tested with an equivalent method no leakage greater than 10^{-3} mbar l/s occurs.

7.4 Cleaning

The hose assemblies shall be cleaned internally and dried before dispatch. All other conditions shall be agreed between the purchaser and manufacturer.

8 Designation

The designation for a pressure-tight corrugated metal hose assembly in accordance with this International Standard is:

a) reference to this International Standard, i.e. ISO 10380;

b) type of flexibility;

c) the hose material (for stainless steels or nickel alloys, use only the ISO or NW number as given in Table 1; for the equivalent materials given in A.2 use the EN or NW number);

d) the nominal size, DN;

e) maximum allowable pressure, PN

EXAMPLE A corrugated metal hose assembly of flexibility type 1, of ISO 9328-5 type X 2 CrNi 18 10 hose material, of size DN 25 and pressure equal to PN 16 is designated as follows:

Corrugated metal hose assembly ISO 10380-1 - X 2 CrNi 18 10 - DN 25 - PN 16

9 Marking

Corrugated metal hose assemblies shall carry, as a minimum, the following marking:

a) name of manufacturer or trademark;

b) year of manufacture;

c) designation in accordance with Clause 8.

10 Instructions

The manufacturer shall make available to the user adequate instructions for the use of the hose assemblies (handling, installation, putting into service, use and maintenance).

Annex A
(normative)

Equivalent European standards

General

Standard	Year	Title	EN	Year
7369		*Pipework — Flexible metallic hoses — Vocabulary of general terms*	EN/ ISO 7369	

Materials

Standards

Standard	Year	Title	EN	Year
9 8-5		*Steel plates and strips for pressure purposes — Technical delivery conditions — Part 5: Austenitic steels*	EN 10028-7, EN 10088-1	

2 Equivalent European material specifications

Table A.1.

3 European temperature derating factors

Table A.2.

Table A.1 — Materials

Materials of construction	Hose	Braid	End fittings [a] and ferrules
Stainless steel hose assemblies	Austenitic stainless steel conforming to EN 10028-7, Nos. 1.4306, 1.4541, 1.4404, 1.4401 and 1.4571	Austenitic stainless steel conforming to the composition given in EN 10088-1, Nos. 1.4306, 1.4301, 1.4541, 1.4404, 1.4401 and 1.4571	Austenitic stainless steel conforming to the composition given in EN 10088-1, Nos. 1.4306, 1.4301, 1.4541, 1.4404, 1.4401 and 1.4571 Carbon steel containing a maximum of 0,05 % sulfur and 0,05 % phosphorus[b]. Copper based alloy, if formed, deep-drawing quality.
Copper-based alloy hose assemblies	Deep-drawing quality phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Phosphor bronze containing a minimum of 95 % copper and 1 % tin.	Copper-based alloy, if formed, deep-drawing quality.
Nickel alloy hose assemblies	Nickel alloy strip in accordance with ISO 6208, Nos. NW 0276 NW 4400 NW 6600 NW 6625 NW 8800 and NW 8825	Austenitic stainless steel in accordance with EN 10088-1, Nos. 1.4306, 1.4301, 1.4541, 1.4404, 1.4401 and 1.4571 Nickel alloy in accordance with ISO 9724, Nos. NW 0276 NW 4400 NW 6600 NW 6625, NW 8800 and NW 8825	Austenitic stainless steel in accordance with EN 10088-1, Nos. 1.4306, 1.4301, 1.4541, 1.4404, 1.4401 and 1.4571 Nickel alloy in accordance with ISO 9723, Nos. NW 0276 NW 4400 NW 6600 NW 6625, NW 8800 and NW 8825

a The material specified for end fittings applies only to the parts which are welded or brazed to the hose.

b Carbon steel shall not be used for ferrules.

Table A.2 — Derating factors and limiting temperatures

Parameters		Temperatures, °C														
		– 200 to – 20	20	50	100	150	200	250	300	350	400	450	500	550	600	650
		Derating factors														
N erial	1.4306	1	1	0,89	0,72	0,64	0,58	0,54	0,50	0,48	0,46	0,44	0,43	0,43	A	—
	1.4301	1	1	0,90	0,73	0,SS	0,S0	0,55	0,51	0,49	0,48	0,4S	0,4S	0,4S	A	A
	1.4541	1	1	0,93	0,83	0,78	0,74	0,70	0,SS	0,S4	0,SO	0,S0	0,59	0,58	A	A
	1.4404	1	1	0,90	0,73	0,67	0,61	0,58	0,53	0,51	0,50	0,49	0,47	0,47	A	—
	1.4401	1	1	0,91	0,78	0,70	0,S5	0,S1	0,57	0,55	0,53	0,5O	0,51	0,50	A	A
	1.4571	1	1	0,92	0,80	0,76	0,72	0,68	0,64	0,62	0,60	0,59	0,58	0,58	A	—
	Carbon steel	—	1	0,98	0,90	0,89	0,86	0,82	0,76	0,73	0,70	0,41	0,24	—	—	—
	Copper alloy	—	1	A	A	A	A	A	—	—	—	—	—	—	—	—
	Nt 0C7S	1	1	1	0,99	0,9O	0,85	0,81	0,77	0,73	0,70	0,S7	0,SS	0,SS	0,57	0,39
	1 W 4400	1	1	0,96	0,87	0,83	0,80	0,79	0,79	0,79	0,79	0,78	0,67	—	—	—
	1 W 6600	1	1	1	1	1	1	1	1	1	1	1	0,63	0,29	0,14	—
	Nt SSC5	1	1	1	1	0,99	0,97	0,95	0,93	0,9O	0,90	0,88	0,87	0,8S	0,83	0,4S
	Nt 8800	1	1	1	1	1	1	1	1	0,99	0,99	0,98	0,97	0,93	0,SS	0,35
	1 W 8825	1	1	1	1	1	1	1	1	0,99	0,98	0,97	0,95	0,52	—	—
A mbly ethod	Silver brazing	Suitable						A	A	—	—	—	—	—	—	—
	Arc welding	Suitable														
	I ther	A														

"A": 5efer to manufacturer.

EN 853 2SN - DIN 20022 2SN - SAE 100 R2 AT

ITR

COSTRUZIONE

Sottostrato

Gomma sintetica liscia resistente agli oli.

Rinforzo

Due trecce in acciaio ad alta resistenza.

Copertura

Gomma sintetica nera resistente all'abrasione, agli oli, ozono e agli agenti atmosferici.
Sono disponibili le coperture speciali:
- ABR 2000
- USMSHA/LOBA
- VSA

APPLICAZIONI

Gamma idonea per conduzione fluidi idraulici quali oli minerali, glicoli, lubrificanti minerali, idrocarburi, combustibili, ecc.

PRESSIONE DI SCOPPIO

Oltre 4 volte la pressione di esercizio.

TEMPERATURE DI ESERCIZIO

Da -40 °C a + 100 °C.

NORME DI RIFERIMENTO

Supera largamente SAE J 517 (100 R2 AT)
DIN 20022 2 SN
EN 853 2SN
ISO 1436

CONSTRUCTION

Tube

Seamless synthetic rubber oil resistant.

Reinforcement

Two braids of high tensile steel wire.

Cover

Black synthetic rubber resistant to abrasion, oils, ozone and weathering.
Special cover at disposal:
- *ABR 2000*
- *USMSHA/LOBA*
- *VSA*

APPLICATIONS

Hose range suitable to carry hydraulic fluids such as glycol, mineral oils, fuels, hydrocarbons, etc.

BURSTING PRESSURE

Exceeds four times working pressure.

WORKING TEMPERATURE

From -40°C (-40°F) up to +100°C (+212°F).

REFERENCE SPECIFICATIONS

Exceeds SAE J 517 (100 R2 AT)
DIN 20022 2SN
EN 853 2SN
ISO 1436

CARATTERISTICHE TECNICHE / *SPECIFICATIONS*

Codici Tubo *Hose Part. N°*	Dash Size	Diametro Interno *Inside Diameter*		Diametro Esterno *Outside Diameter*		Pressione Esercizio *Working Pressure*		Raggio curv. *Bend Radius*		Peso *Weight*	
		mm	in	mm	in	bar	psi	mm	in	Kg/m	lb/ft
58105000	3	5.0	3/16	13.5	0.50	415	6,000	90	3.50	0.30	0.20
58106000	4	6.5	1/4	15.0	0.63	400	5,800	100	4.00	0.36	0.24
58108000	5	8.0	5/16	16.7	0.63	350	5,100	115	4.50	0.41	0.27
58109000	6	9.5	3/8	18.8	0.75	330	4,800	130	5.00	0.52	0.35
58113000	8	13.0	1/2	21.8	0.75	275	4,000	180	7.00	0.62	0.42
58116000	10	16.0	5/8	24.8	1.00	250	3,650	200	8.00	0.73	0.49
58119000	12	19.0	3/4	28.9	1.25	215	3,100	240	9.50	0.94	0.63
58125000	16	25.0	1	37.5	1.50	165	2,400	300	12.00	1.35	0.90
58132000	20	32.0	1 1/4	47.3	1.75	125	1,800	420	16.50	2.00	1.34
58138000	24	38.0	1 1/2	53.5	2.00	90	1,300	500	19.50	2.30	1.54
58151000	32	51.0	2	66.8	2.75	80	1,150	630	25.00	3.00	2.01

ITR EN 853 2SN N.W. ... DIN 20022 2SN W.P. ... BAR SAE 100 R2AT I.D. ... TRIM./ANNO QUARTER/YEAR ITALY

Seamless Tubes of Heat-resistant Steels

Technical Conditions of Delivery

DIN 17 175

Nahtlose Rohre aus warmfesten Stählen; Technische Lieferbedingungen

For connection with the International Standard **ISO 2604/II** issued by the International Organization for Standardization (ISO), see Explanations.

Sections marked with a dot (●) contain details on agreements which shall, or may be, reached at the time of ordering.

1 Scope

This standard applies to seamless tubes [1] including tubes for *headers* of heat-resistant steels according to Table 1 which are used in the construction of boilers, pipe-lines, pressure vessels and equipment for service up to 600 °C and at simultaneous high pressures, where the tototal stress and the relevant scaling conditions can raise or lower the temperature limit.

2 Other relevant standards and documents

DIN 2391 Part 1	Seamless steel precision tubes, cold drawn or cold rolled; dimensions
DIN 2413	Steel pipes; calculation of wall thickness subjected to internal pressure
DIN 2448	Seamless steel tubes, dimensions and weights
DIN 2915	Seamless and welded steel tubes for water-tube boilers; survey
DIN 2917	(at present circulating as draft) Seamless steel tubes for superheated steam mains and headers; dimensions
DIN 17 007 Part 2	Material numbers; system of the principal group 1: steel
DIN 50 049	Certificates on material testings
DIN 50 115	Testing of metallic materials; notched bar impact bending test
DIN 50 125	Testing of metallic materials; tensile test specimens, directions for their preparation
DIN 50 136	Testing of metallic materials; flattening test on tubes
DIN 50 137	Testing of steel; ring expanding test on tubes
DIN 50 138	Testing of steel; ring tensile test on tubes
DIN 50 140	Testing of metals; tensile test for tubes and strips from tubes without extensometer
DIN 50 145	Testing of metallic materials; tensile test
DIN-Normenheft 3	Code numbers and material numbers of ferrous materials in DIN Standards and Stahl-Eisen Werkstoffblättern (Beuth Verlag GmbH, Berlin and Köln; Verlag Stahleisen mbH, Düsseldorf).
Stahl-Eisen-Prüfblatt 1805	Sampling and sample preparation for the sample analysis of steels (Verlag Stahleisen mbH, Düsseldorf)
Stahl-Eisen-Prüfblatt 1915	Ultrasonic testing of tubes of heat-resistant steels for longitudinal defects (Verlag Stahleisen mbH, Düsseldorf)
Stahl-Eisen-Prüfblatt 1918	Ultrasonic testing of tubes of heat-resistant steels for transverse defects (Verlag Stahleisen mbH, Düsseldorf)
Stahl-Eisen-Prüfblatt 1919	Ultrasonic testing of tubes of heat-resistant steels for laminations (Verlag Stahleisen mbH, Düsseldorf)
Stahl-Eisen-Prüfblatt 1925	Eddy current testing of tubes for leak-tightness (Verlag Stahleisen mbH, Düsseldorf)
Handbuch für das Eisenhüttenlaboratorium Band 2:	Analysis of metallic materials, Düsseldorf 1966 (Verlag Stahleisen mbH, Düsseldorf)
Handbuch für das Eisenhüttenlaboratorium, Band 5 (Ergänzungsband)	A 4.1 - Compilation of recommended arbitration analyses, B - Sampling methods C - Analytical methods, always the latest edition (Verlag Stahleisen mbH, Düsseldorf)

[1] In the case of tubes for boiler parts which have to satisfy the "Technische Regeln für Dampfkessel" – TRD (Technical rules for steam boilers) published by the "Deutscher Dampfkesselausschuss" – DDA (German Steam Boiler Committee – DDA), these specifications will have to be additionally observed. If required, the "Technische Regeln für Druckbehälter" – AD-Merkblätter (Technical rules for pressure vessels) should also be taken into consideration.

Continued on pages 2 to 20
Explanations on pages 21 to 23

18.2.06.03

3 Definition

Steels possessing good mechanical properties even under long-time stressing at high temperatures, up to 600 °C, shall be regarded as being heat-resistant at high temperatures, for the purpose of this standard.

4 Classification

The standard covers tubes made from steel grades listed in Table 1.

● The choice of the particular steel grade is at the discretion of the customer (see Section 6.2).

5 Designation and ordering

5.1 The code numbers for the grades of steel were formed in accordance with Sections 2.1.1.1 and 2.1.2.2 of the Explanations to DIN Normenheft 3, and the material numbers according to DIN 17 007 Part 2.

5.2 The code number or the material number for the steel grade shall be appended to the symbol for the product according to the following examples:

Example 1:
Designation of a seamless steel tube of 38 mm outside diameter and 2.6 mm wall thickness according to DIN 2448 of steel St 35.8, material number 1.0305:

Tube DIN 2448 – St 35.8 – 38 x 2.6
or **Tube DIN 2448 – 1.0305 – 38 x 2.6**

Example 2:
Designation of a seamless steel tube of 240 mm inside diameter and 25 mm wall thickness according to DIN 2917 (at present circulating as draft) of steel St 45.8, material number 1.0405:

Tube DIN 2917 – St 45.8 – 240 x 25
or **Tube DIN 2917 – 1.0405 – 240 x 25**

5.3 ● The order shall not only specify the designation according to Section 5.2 but also in every case the desired total length and the desired acceptance inspection certificate and for unalloyed steel tubes also the steel grade. In addition, further details in compliance with the other Sections marked with a dot (●) can be agreed at the time of ordering.

6 Requirements

6.1 Manufacturing process

6.1.1 Tubes to this standard shall be manufactured by hot or cold rolling, hot pressing, hot or cold drawing (see Section 6.3.1).

● **Note:** Within the framework of the provisions in Section 6.1.1 the tubemaking process is left entirely to the discretion of the supplier unless otherwise agreed at the time of ordering (see e.g. Section 6.10.2.1.2.)

2) On delivery of sequentially cast material, such as is the normal practice in continuous casting, the term "cast" shall be replaced by the term "casting unit". The concomitant alterations required in the relevant particulars of this Standard still have to be worked out.

6.1.2 The steels used for tubes shall be made by the oxygen blowing process, the open hearth furnace or the electric furnace.

All steels shall be killed.

● **Note:** Within the framework of the Provisions in Section 6.1.2 the melting process is left entirely to the discretion of the supplier; on request it must be made known.

6.2 Quality grades

6.2.1 The tubes can be supplied in two quality grades I and III, which among others are characterized by different extent of testing (cf. Table 3). For tubes of unalloyed steels both quality grades from Table 3 may apply, though for alloy steel tubes, only quality III applies.

The higher requirements made on quality grade 3 tubes generally call for special measures during melting or processing (e.g. flame scarfing or peeling) or for a particularly careful selection of casts.

6.2.2 ● The choice of quality grade is left to the customer. It depends on the operating loads. This choice must conform with existing specifications or technical regulations such as the technical regulations for boiler and superheater tubes, stay tubes for ships boilers (TRD 102) issued by the German Steam Boiler Committee. The limits of applicability are specified in Table 4 of this Standard.

6.3 Delivery conditions

6.3.1 The tubes shall be supplied suitably heat treated over their entire length. The following heat treatment shall be used, depending on the type of steel:

– normalizing
  subcritical annealing
  hardening and tempering with continous cooling from the hardening temperature and subsequent tempering.
  hardening and tempering with isothermal transformation.

The condition for an efficient heat treatment is regarded as satisfied in the cases of the steels St 35.8, St 45.8, 17 Mn 4, 19 Mn 5 and 15 Mo 3, if hot working guarantees a good and reasonably uniform structure. Under identical conditions tempering instead of hardening plus tempering may be adequate for steels 13 CrMo 44 and 10 CrMo 9 10. Steels 14 MoV 63 and X 20 CrMoV 12 1 must always be supplied in the hardened and tempered condition.

6.3.2 ● If the tube surface is intended to be coated with a corrosion inhibitor providing protection for a limited period, or if another special surface condition is desired for tubes intended for headers, this shall be agreed at the time of ordering.

6.4 Chemical composition

The chemical composition of steels based on ladle analysis 2) must correspond to Table 1. Minor deviations from these values are permissible, provided they do not impair the mechanical and technological properties, according to the requirements in Tables 5 to 7.

In the case of verification on the finished tube, deviations according to Table 2 are permissible compared to the data in Table 1.

6.5 Mechanical properties

6.5.1 The tensile strength, yield strength, elongation at fracture and impact strength of the tubes at room temperature must satisfy the requirements set down in Table 5, and the 0.2% proof stress at elevated temperatures must satisfy the requirements set down in Table 6. These are valid for the delivery condition and for the relevant testing conditions according to Section 8 of this Standard.

6.5.2 The 1 % creep limits and creep strengths of the steels are given in Appendix A to this Standard. The figures represent the mean values of the scatter band determined so far. These values will be checked periodically and possibly revised after further test results have been made available.

Note: The publication of the 1 % creep limits and the creep strengths up to the high temperatures quoted in Appendix A does not mean that the steels are allowed to be used up to these temperatures. This depends primarily on the overall working conditions, in particular on the scaling conditions.

6.6 Technological Properties

The tubes shall conform to the requirements for the ring test according to Section 8.6.5. Provisional data on the expansion (change in diameter) in the ring expanding test is given in Table 7.

No inadmissible defects (e.g. cracks, scale, laps and laminations) must be visible in the tests.

6.7 Surface condition

The tubes must have a smooth external and internal surface in keeping with the manufacturing process. A distinction is to be made between hot worked and cold worked finishes. The tubes shall be free from permissible cracks, scales and overlaps. Minute protuberances, depressions or shallow longitudinal grooves caused by the manufacturing process are permissible, provided that the wall thickness remains within the dimensional tolerances and the serviceability of the tubes is not adversely affected. The removal of surface defects of small depth by mechanical machining (e.g. grinding) is permissible provided that the minimum wall thickness is not exceeded.

6.8 Non-destructive testing

The requirements corresponding to the relevant Stahl Eisen-Prüfblätter (Testing Sheets) have to be satisfied in the non-destructive tests according to Section 8.4.7 and Section 8.6.6.

6.9 Physical properties

A special Stahl-Eisen-Werkstoffblatt (Material Data Sheet) (Publisher: Verein Deutscher Eisenhüttenleute, Postfach 8209, 4000 Düsseldorf) with data on the physical properties, is in preparation.

6.10 Dimensions and permissible deviations on dimension and form

6.10.1 ● Orders where the dimensions are based on the outside diameter generally comply with DIN 2448 and DIN 2915; in special cases they can also be based on DIN 2391, Part 1.

Note: In cases where dimensions are ordered according to DIN 2391 Part 1 it does not follow that the permissible dimensional deviations in DIN 2391, Part 1 will be directly applicable (see Section 6.10.2.1.2 and Section 6.10.2.3).

Orders can also be based on the inside diameter. In this case the dimensions shall conform to DIN 2917 (at present circulating as draft).

6.10.2 The following conditions apply to the permissible deviations on dimension and form of the tubes.

6.10.2.1 ● For orders based on the outside diameter, the permissible deviations on the outside diameter are subject to the following provisions:

6.10.2.1.1 The following permissible deviations on the outside diameter apply, except für permissible deviations on the outside diameter according to Section 6.10.2.1.2:

for outside diameters ≦ 100 mm

for non-profiled tubes ± 0.75 % (minimum ± 0.5 mm),

for internally and/or externally profiled tubes ± 1.0 % (minimum ± 0.5 mm),

for outside diameters > 100 mm ≦ 320 mm ± 0.90 %,

for outside diameters > 320 mm ± 1.0 %

● If narrower diameter deviations have been negotiated for the tube ends, the following values can be maintained for the permissible deviations on the outside diameter over a length of approximately 100 mm by means of subsequent calibrating of the ends:

for outside diameters ≧ 45 mm ≦ 100 mm ± 0.4 mm,

– for outside diameters > 100 mm ≦ 200 mm ± 0.5 %,

– for outside diameters > 200 mm ± 0.6 %.

6.10.2.1.2 ● The following permissible deviations on the outside diameter apply to orders for cold worked tubes:

– for outside diameters ≦ 120 mm ± 0.6 % (minimum ± 0.25 mm),

– for outside diameters > 120 mm ± 0.75 %.

In special cases narrower permissible deviations on the outside diameter can be negotiated.

6.10.2.1.3 At points where the tube surface has been repaired by mechanical machining (e.g. grinding), e.g. as a result of indications received during non-destructive testing, it is permissible to exceed the minus deviation by a small amount over a length of not more than 1 m, on condition that the permissible minimum wall thickness is retained.

6.10.2.2 ● For orders based of the inside diameter, the permissible deviation on the inside diameter is ± 1 %.

Note: For tube ends intended for rolling-in, tighter deviations on the inside diameter can be negotiated between customer and manufacturer.

6.10.2.3 The permissble deviations on the wall thickness of tubes listed in Table 8 apply for orders based on the outside diameter, and those in Table 9 for orders based on the inside diameter.

● Subject to agreement at the time of ordering, cold worked tubes can be supplied with permissible wall thickness deviations according to DIN 2391, Part 1.

6.10.2.4 ● The permissible length deviations are listed in Table 10.

6.10.2.5 The following applies for the permissible deviations on form.

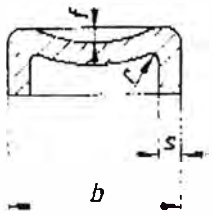
6.10.2.5.1 The ovality of the tubes shall be within the permissible deviations on the nominal diameter; tubes of rectangular cross section shall have 90° angles. The tubes shall be straight to the eye.

● Special requirements on straightness are subject to separate agreement.

6.10.2.5.2 The ends shall be cut if possible perpendicular at the axis with a machining tool; they shall be free from burrs.

6.10.2.5.3 The inner corner radius of tubes for headers with rectangular cross-section shall be $r > \frac{s}{3} \geq 8$ mm (s = wall thickness).

6.10.2.5.4 The deflection f of the lateral faces of tubes for headers with rectangular cross-section over the external lateral length b shall not exceed the values in *Table 11.*



6.11 Weights and permissible weight deviations

6.11.1 The weights per metre of tubing shall, wherever possible, be taken from the relevant dimensional standard, with the exception of X 20 CrMoV 12 1 steel tubes.

6.11.2 If the tubes are of non-standard size on the weights are not given in the dimensional standard, weights shall be calculated from the nominal dimensions with a density of 7.85 kg/dm³, with the exception of steel X 20 CrMoV 12 1.

6.11.3 The weight of C 20 CrMoV 12 1 steel shall be calculated from the nominal dimensions with a density of 7.76 kg/dm³.

6.11.4 The permissible weight deviations are as follows:

- for the individual tube $^{+10}_{-8}$ %,
- for a wagon load of at least 10 tonnes ± 7.5 %.

7 Heat treatment and subsequent processing

7.1 The reference data on the heat treatment temperatures are listed in Table 12.

7.2 The steels can be not formed in the temperature range between approximately 1100 °C to 850 °C, where the temperature may drop to 750 °C during the processing operation. The regulations for hot forming *apply* equally to fitting and straightening operations on site during which a close watch must be kept on temperature.

It would be expedient to perform forging and upsetting operations in the upper region of this temperature range i.e. between 1100 °C to 900 °C. Hot-bending and similar tube forming processes shall be carried out in the lower region of this temperature range i.e. between 1000 °C to 850 °C, where the temperature may drop to 750 °C during the processing operation.

If the workpiece was heated above the normalizing temperature but not above 1000 °C before the last hot forming step or hot forming in a single step, and if the hot forming operation is completed above 750 °C, or, if the deformation in the last step did not exceed 5 %, above 700 °C, no subsequent normalizing will be required for the steels St 35.8, St 45.8, 17 Mn 4, 19 Mn 5, and 15 Mo 3; the steels 13 CrMo 4 4 and 10 CrMo 9 10 have only to be tempered.

In the case of repeated and/or prolonged hot forming operations at temperatures between approximately 1000 °C to 1100 °C the workpiece shall be cooled to temperatures below 350 °C before the last hot forming step is performed. The temperature of the named steels must not exceed 1000 °C in the subsequent hot forming operation, if normalizing or hardening and tempering is to be dispensed with.

If the temperature of the final forming process lies above 1000 °C the steels St 35.8, St 45.8, 17 Mn 4, 19 Mn 5 and 15 Mo 3 shall subsequently be normalized, and the steels 13 CrMo 4 4 and 10 CrMo 9 10 hardened and tempered.

The steels 14 MoV 6 3 and X 20 CrMoV 12 1 shall be hardened and tempered again after hot forming.

7.3 Tubes from steels according to this Standard can be cold worked e.g. bent, expanded, reduced and rolled-in, though some allowance will have to be made for the high yield point and tensile strength of the steels X 20 CrMoV 12 1 and 14 MoV 6 3.

No subsequent heat treatment is required after cold bending, cold expansion and cold reduction with a normal amount of cold forming [3].

Generally a minimum of 15 minutes annealing at the temperatures specified in Table 13 suffices at higher amounts of cold forming.

7.4 The steels referred to in this Standard are weldable (see DIN 8528 Part 1). Table 13 contains references to welding processes and data on the heat treatment of tubes after welding.

8 Testing

8.1 Testing of initial material

For tubes of quality grade III (Table 3), provided they have been made from pre-rolled round or square steel, an etch test is to be carried out on a disc in order to determine whether the crop end has been cut off far enough. This disc is sliced from the crop end of every round or square bar originating for one ingot. At the choice of the manufacturer an ultrasonic test for piping can be employed instead.

3) Consult the VGB-Instructions issued by the Association of operators of Large Power Stations (Technische Vereinigung der Grosskraftwerksbetreiber – VBG) on the manufacturing and supervision of heavy-duty steam boilers (available from the VGB-Dampftechnik GmbH, Essen)

8.2 ● Acceptance testings

Tubes to this Standard are only supplied with acceptance testings [1]. The type of acceptance testing certificates according to DIN 50 049 shall be agreed at the time of ordering. The acceptance testing [1] is subject to the requirements in Sections 8.3 to 8.8. In addition the requirements of Sections 8.5 and 8.6 apply also for subsequent testings in response to complaints.

8.3 General test conditions

8.3.1 All testings including acceptance shall be carried out in the manufacturers works such that the production flow is not unnecessarily impeded.

8.3.2 The manufacturing works shall take steps to prevent rejected tubes and those the repair of which is not permissible from being despatched to customer.

8.4 Extent of testing (see also Table 3)

8.4.1 The tubes shall be tested in batches. They shall be divided into batches of 100 tubes according to the *grades of steel*, quality grades and dimensions and in the case of alloy steels, if possible, according to cast. For tubes up to an outside diameters ≦ 51 mm the tubes must come from the same heat-treated batch.

Surplus amounts of up to 50 tubes shall be distributed evenly between the individual batches. Number of pieces and surplus amounts between 51 and 100 tubes shall be considered as a complete batch.

8.4.2 ● In the event of subsequent testing of the chemical composition of the finished tube having been agreed to at the time of ordering, this will normally consist of one testing per cast and delivery.

8.4.3 For the tensile test two tubes shall be tested from each of the first two batches, in accordance with Section 8.4.1, and one tube from each subsequent batch chosen by the inspector.

If a delivery consists of a batch containing a maximum of 10 tubes, only one tube shall be taken.

8.4.4 The absorbed energy shall be tested on the tubes selected according to Section 8.4.3 provided their nominal wall thickness has the following values:

for steel 14 MoV 6 3 and X 20 CrMoV 12 1 > 10 mm,

for the steel 15 Mo 3 > 20 mm,

for all other steels > 30 mm.

8.4.5 ● If the 0.2 %-yield limit at elevated temperature is to be tested, this must be stated in the order together with the required test temperature; this extent of testing shall be carried out on one specimen per cast and dimension, unless otherwise agreed.

8.4.6 The tubes shall be ring-tested (see Table 14).

8.4.6.1 Quality grade I tubes selected according to Section 8.4.3 shall be ring-tested (allowing for the dimensions quoted in Table 14) using specimens taken from one end.

8.4.6.2 Quality grade III tubes shall be ring-tested on the rolled lengths allowing for the dimensions quoted in Table 14, with an extent of testing applicable all steel grades except for the steels 14 MoV 6 3 and X 20 CrMoV 12 1:

for tubes with an outside diameter ≦ 51 mm in Section 8.4.6.2.1

and

for tubes with an outside diameter > 51 mm in Section 8.4.6.2.2.

The extent of testing according to Section 8.4.6.2.3 applies for tubes of all dimensions of the steel grades 14 MoV 6 3 and X 20 CrMoV 12 1.

At a subsequent subdivision of the rolled lengths into partlengths no further test specimens need to be taken, provided suitable markings show that the part-lenghts belong to the tested rolled length. If this cannot be guaranteed, the testings on the rolled lengths shall be dropped and in their stead the part-lengths shall be tested as rolled lengths.

8.4.6.2.1 20 % of the rolled lengths of Grade III tubes ≦ 51 mm outside diameter -- except tubes of steels 14 MoV 6 3 and X 20 CrMoV 12 1 – shall be tested at one end, i.e. random-wise such that the 20 % of the tubes requiring testing are chosen arbitrarily from the total batch. It ring-testing is performed on part lengths, which are not related to rolled lengths, 20 % of the part lengths shall be tested random-wise (see above) at one end. As far as heat-treated tubes are concerned steps must be taken to ensure that the part lengths come from batches which had been subjected to the same heat treatment. As far as tubes with hot-formed ends are concerned (see Section 6.3.1, paragraph 2) steps must be taken to ensure that the part lengths belong to batches from the same production run, i.e. an identical heating practice.

8.4.6.2.2 Quality grade III tubes > 51 mm outside diameter shall be ring-tested at both ends of each rolled length. Each part length which is not related to the rolled length, shall be tested at both ends.

Each part length from tubes > 51 mm outside diameter can also be ring-tested at one end only provided it has been verified once for the relevant manufacturing process and manufacturing works that the ring test performed on one end of a part length furnishes the same information as the information gained in a test with ring specimens taken from both ends of the original rolled length.

8.4.6.2.3 Each rolled length from quality grade III tubes manufactured from the steels 14 MoV 6 3 and X 20 CrMoV 12 1 shall be ring-tested at both ends, independet of the tube diameter. The same applies to the testing of part lengths.

8.4.7 The manufacturer shall non-destructively test all quality grade III tubes for longitudinal defects.

● A supplementary non-destructive testing for transverse defects and/or laminations can also be agreed on when ordering.

8.4.8 The internal and external condition of each tube must be checked.

8.4.9 The wall thickness, and depending on the order, either the outside diameter or the inside diameter shall be checked.

8.4.10 All tubes shall be tested for leak tightness; that is at the discretion of the manufacturer either by an hydraulic test or by a suitable non-destructive testing (e.g. Eddy current according to Stahl-Eisen Testing Sheet 1925).

8.4.11 The manufacturer shall submit all alloy steel tubes to an appropriate material identification testing.

8.5 Sampling

8.5.1 ● If an agreement has been reached in the order to check the chemical analysis of finished tubes, for wet analysis the required turnings must be taken over the entire wall thickness of the tube; an appropriate procedure shall be adopted for spectro-analysis [4].

8.5.2 Flat testpieces in accordance with Section 8.4.3 normally extending over the entire wall thickness and cut longitudinally from the tubes shall be used for tensile testing. The testpieces must not be heat-treated nor straightened over the gauge length. The removal of local inequalities from the flat testpieces is permissible, but the rolling skin must be allowed to remain as far as it is possible on the thinnest sections of the test-piece. Small diameter tubes can be tested as a whole.

The tensile test on tubes of ≧ 200 mm outside diameter can be done on transverse test specimen, provided this is compatible with the tube dimensions without requiring straightening. In this case a tube ring shall be cut off and halved.

8.5.3 A set of three DVM-specimens is taken in a transverse direction from the tubes selected according to Section 8.4.3 for the notch impact/bending test. The notch impact/bending specimens shall be taken in longitudinal direction from tubes of < 200 mm outside diameter.

8.5.4 ● Section 8.5.2 applies logically in cases where agreement has been reached in the order on the determination of the 0.2%-yield limit at elevated temperatures; since, where possible, hot tensile tests are normally performend on round test specimens sampling requires, if the occasion arises, prior agreement.

8.5.5 The specimens for the ring tests shall be taken according to DIN 50 136 (ring flattening test), DIN 50 137 (ring expanding test) and/or DIN 50 138 (ring tensile test) (see Table 3).

8.5.6 All specimens for the tests according to Sections 8.5.2 to 8.5.5 shall be adequately identifiable in order to show which tubes and specimens go together.

8.6 Applicable test methods

8.6.1 The chemical composition shall be tested according to the methods [5] prescribed by the "Chemikerausschuss des Vereins Deutscher Eisenhüttenleute" (Chemists Committee of the Association of German Ferrous Metallurgy Engineers).

8.6.2 The tensile test shall be carried out according to DIN 50 145 using the short proportional test bar according to DIN 50 125 or with specimens according to DIN 50 140.

8.6.3 The notch impact/bending test shall be carried out at room temperature in accordance with DIN 50 115 using DVM-specimens. The notch shall be cut vertically to the longitudinal axis and the surface of the tube.

8.6.4 The 0.2%-yield limit at elevated temperature is determined in accordance with DIN 50 145.

8.6.5 The ring tests shall be carried out in accordance with the standards covering the annular flattening tests, ring expanding tests and ring tensile tests listed in Section 8.5.5.

8.6.5.1 The ring expanding test shall be carried out according to DIN 50 137 where the change in the diameter of the specimen expanded to fracture shall also be measured. The evaluation of the deformability of ring expanding specimens is based on the appearance of the fracture and the fracture surfaces.

8.6.5.2 In the annular flattening test according to DIN 50 136 the specimens or tube ends shall be squeezed until the definite distance H is reached between the pressure plates. For this distance H in mm applies.

$$H = \frac{(1 + c) \cdot s}{c + s/d_a}$$

Where s = wall thickness in mm, d_a = outside diameter in mm and c is a constant. For the steel St 35.8 the c-constant is 0.09, for the steels St 45.8, 17 Mn 4, 19 Mn 5, 15 Mo 3, 13 CrMo 4 4 and 10 CrMo 9 10 it is 0.07 and for the steels 14 MoV 6 3 and X 20 CrMoV 12 1 it is 0.05.

● If the ratio s/d_a is greater than 0.15 the distance between the plates shall be negotiated.

If an annular flattening test is performed according to Section 8.4.6 the test can be continued to fracture or until a crack appears, so as to make it possible to assess the appearance of the fractured surface. The decisive factor is that the prescribed distance between the plates is reached without cracking

8.6.6 ● The non-destructive test shall always be carried out before the ring specimens are cut off.

Non-profiled tubes shall normally be ultrasonically tested i.e.

a) according to Stahl-Eisen Test Sheet 1915 when testing tubes of ≧ 10 mm outside diameter, for longitudinal defects.

b) according to Stahl-Eisen Test Sheet 1918, after agreement has been reached, on testing tubes having an outside diameter > 133 mm, for transverse defects

[4] The sampling practice conforms, as a rule, to Stahl-Eisen-Prüfblatt 1805 -- Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen - (Sampling and sample preparation for the sample analysis of steels) – (Publisher: Verlag Stahleisen mbH, Düsseldorf).

[5] Handbuch für das Eisenhüttenlaboratorium (Handbook for the Ferrous Metallurgy laboratory), Vol. 2: Die Untersuchung der metallischen Stoffe (The testing of metallic materials), Düsseldorf: Verlag Stahleisen mbH, 1966; Vol. 5 (supplement): A 4.1 -- Aufstellung empfohlener Schiedsverfahren (Compilation of recommended arbitration analyses), B – Probenahmeverfahren (Sampling methods), C – Analysenverfahren (Analysis methods), always the latest edition (Verlag Stahleisen mbH, Düsseldorf).

c) according to Stahl-Eisen Test Sheet 1919, after agreement has been reached on testing tubes having an outside diameter > 133 mm and a wall thickness > 8 mm, for laminations.

In cases in which the aforementioned testing methods are not applicable (such as when testing profiled tubes or tubes having outside diameters < 10 mm for longitudinal defects), agreement on the relevant testing method will have to be reached at the time of ordering.

8.6.7 Visual inspection [6] with the naked eye requires that:

a) the whole external tube surface shall be examined in suitable lighting for surface defects,

b) the entire inner tube surface shall be examined in suitable lighting from both tube ends for surface defects.

The surface finish of the tubes should permit detection of significant defects. For quality grade III tubes this generally denotes descaled surfaces, unless the chosen method of production or heat treatment ensures a suitable surface finish for visual inspection and ultrasonic testing.

8.6.8 The dimensions shall be checked with suitable instruments.

8.6.9 ● When checking leak tightness, internal hydraulic testing with water (refer to Section 8.4.10) shall generally be carried out at a uniform pressure of 80 bar. Higher test pressures require prior agreement. The test pressure shall be limited so that the yield point at 20 °C will not be reached or exceeded (cf. DIN 2413 June 1972 edition Section 4.6). In the case of thin-walled large diameter tubes this will already have to be considered at pressures of 80 bar.

8.7 Re-testings

8.7.1 If one of the selected tubes fails to pass the tests according to Sections 8.6.2 (tensile test) and 8.6.3 (notch impact/bending test) and in the case of quality grade I tubes according to Section 8.6.5 (ring test) it shall be rejected, and two further tubes shall be taken from the batch and the tests repeated. In these new tests each tube must satisfy the requirements, otherwise the whole batch must be rejected.

8.7.2 If one specimen, taken at random, from a rolled lenght or part length of quality grade III tubes of ≤ 51 mm outside diameter according to Section 8.4.6.2.1 fails in the ring check test, the test shall be repeated on the same end of the relevant rolled length or part length. If this replacement specimen proves unsatisfactory, the relevant rolled length or part length shall be rejected and the test repeated at one end of a further 20 % of the rolled lengths or part lengths of the batch. It another specimen fails again, the test will have to be extended to all rolled lengths or part lengths of the batch. Rolled lengths or part lengths which fail in the ring test shall be rejected.

If one ring test specimen from a rolled length or part length fails in single tests on quality grade III tubes according to Sections 8.4.6.2.2 and 8.4.6.2.3 the test shall be repeated on the same rolled length or part length. If this specimen also fails, the relevant rolled length or part length shall be rejected. On rejection of one rolled length it is left to the discretion of the manufacturer to ring test the corresponding part lengths.

8.7.3 If the unsatisfactory test results were due to unfavourable heat-treatment, it is at the discretion of the manufacturer's works to submit the rejected batch to further heat-treatment and re-submit it for acceptance.

The manufacturer's works are entitled to remove the defects detected in the tests according to Sections 8.4.6 (ring test) 8.4.7 (non-destructive test) and 8.4.8 (visual inspection) by suitable means and to re-submit the tubes for acceptance.

8.8 Test certificates

8.8.1 ● The acceptance test [1] shall be certified by an Acceptance Inspection Certificate A, B, or C, according to DIN 50 049, Section 3 (July 1972 edition).

Note: The certificates shall give the full wording of the identification marks, according to Section 9.1.

8.8.2 ● If certificates require to be issued only for part of the requirements guaranteed by Acceptance Inspection Certificates A or C according to DIN 50 049, the manufacturer shall additionally confirm in an Inspection Certificate according to DIN 50 049 and for quality grade III tubes in an Acceptance Inspection Certificate B according to DIN 50 049, that the tube material corresponds in steel grade and steel quality to DIN 17 175, that all tubes have passed the leak tightness test and have an unobstructed bore, that they have been correctly annealed, or hardened and tempered over their entire lengths in a manner consistent with the tube material, and that quality grade III tubes have been manufactured from roughed-down squares or rounds, that an etch test or ultrasonic test was carried out, that the chemical composition was determined according to the ladle analysis and, if agreed at the time of ordering, also the steelmaking process be quoted. With tubes of quality grade III the carrying-out of an ultrasonic test has to be editionally stated in the Acceptance Inspection Certificate B according to DIN 50049.

9 Identification of the tubes

9.1 The finished tubes shall be marked approximately 300 mm from the end.

The identification consists normally of a stamp mark. Another identification practice may be adopted for thin-walled tubes. The following identification marks shall be applied

on both ends:

material designation (Code No of grade of steel), for unalloyed steels the quality grade (unless quality grade I),

the trade mark stamp and

the inspectors stamp;

on one end:

the cast number or an identifying mark for the cast, applicable only for steels 15 Mo 3, 13 CrMo 4 4, 10 CrMo 9 10, 14 MoV 6 3 and X 20 CrMoV 12 1 for

[1] See page 1

[6] A proven, suitable non-destructive testing process can also be used instead of the visual inspection method.

tubes of ≧159 mm outside diameter [7]; in addition, the tube number for quality grade III tubes.

9.2 The stamp mark can be made more conspicuous according to Section 9.1 e.g. by a coloured line; the lines of the colour identification may be used for this.

10 Complaints

10.1 External and internal defects justify complaints, if they seriously affect the workability and serviceability of the type of steel and shape of the product.

10.2 The customer shall give the supplier an opportunity to prove [8] that the complaints were justified, preferably by submission of samples from the unsatisfactory material delivered.

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7) This limit applies also for tubes orders based on the inside diameter, provided the nominal outside diameter ≧159 mm.

8) See also: Explanations to the "Complaints Clause" in Quality Standards for Iron and Steel. DIN-Mitt. 40 (1961), No 2, p. 111/112.

Further standards

DIN 2401 Part 1	Components under internal or external pressure; pressure and temperature data; definitions, nominal pressure ratings
DIN 8528 Part 1	Weldability; metallic materials, definitions

Table 1. **Summary of heat-resisting steels for seamless tubes, their chemical composition (cast analysis) and colour designation of tubes**

Steel grade: Code number	Steel grade: Material numbers	Chemical composition in weight %: C	Si	Mn	P max.	S max.	Cr	Mo	Ni	V	Colour designation [1]
St 35.8	**1.0305**	≦ 0.17	0.10 to 0.35 [2]	0.40 to 0.80	0.040	0.040					white
St 45.8	**1.0405**	≦ 0.21	0.10 to 0.35 [2]	0.40 to 1.20	0.040	0.040					yellow
17 Mn 4 [3]	**1.0481** [3]	0.14 to 0.20	0.20 to 0.40	0.90 to 1.20	0.040	0.040	≦ 0.30				red and black
19 Mn 5 [3]	**1.0482** [3]	0.17 to 0.22 [4]	0.30 to 0.60	1.00 to 1.30	0.040	0.040	≦ 0.30				yellow and brown
15 Mo 3	**1.5415**	0.12 to 0.20 [4]	0.10 to 0.35	0.40 to 0.80	0.035	0.035		0.25 to 0.35			yellow and carmine red
13 CrMo 4 4	**1.7335**	0.10 to 0.18 [4]	0.10 to 0.35	0.40 to 0.70	0.035	0.035	0.70 to 1.10	0.45 to 0.65			yellow and shades of silver
10 CrMo 9 10	**1.7380**	0.08 to 0.15	≦ 0.50	0.40 to 0.70	0.035	0.035	2.00 to 2.50	0.90 to 1.20			red and green
14 MoV 6 3	**1.7715**	0.10 to 0.18	0.10 to 0.35	0.40 to 0.70	0.035	0.035	0.30 to 0.60	0.50 to 0.70		0.22 to 0.32	red and shades of silver
X 20 CrMoV 12 1	**1.4922**	0.17 to 0.23	≦ 0.50	≦ 1.00	0.030	0.030	10.00 to 12.50	0.80 to 1.20	0.30 to 0.80	0.25 to 0.35	blue

1) ● In normal practice both ends are painted with rings in the colour required. If requested it can be agreed at the time of ordering that the paint marking in the relevant colours should extend over the entire length of the tube.

2) The minimum silicon content is allowed to fall below 0.10 %, when the steel is aluminium-killed, or vacuum-deoxidized.

3) These steels can only be considered for headers.

4) When the wall thicknesses ≧ 30 mm the carbon content is permitted to be 0.02 % higher.

Table 2. **Permissible deviations in the chemical composition of the sample analysis from the limits quoted in the cast analysis** (see Table 1)

Element	Limits quoted in cast analysis according to Table 1 Weight %	Permissible deviation 1) of sample analysis from the limits quoted in the cast analysis according to Table 1 Weight %
C	≦ 0,24	± 0,02
Si	≦ 0,35	± 0,03
	> 0,35 ≦ 0,60	± 0,04
Mn	≦ 1,00	± 0,04
	> 1,00 ≦ 1,30	± 0,05
P S	≦ 0,040	+ 0,010
Cr	≦ 2,00	± 0,05
	> 2,00 ≦ 2,50	± 0,07
	≧ 10,00 ≦ 12,50	± 0,15
Mo	≦ 0,30	± 0,03
	> 0,30 ≦ 1,20	± 0,04
Ni	0,30 ≦ 0,80	± 0,03
V	0,22 ≦ 0,35	± 0,03

1) In a cast the deviation of an element in a sample analysis is permitted to be below the minimum value or only above the maximum value of the range stipulated for the cast analysis, though not both at the same time.

Table 3. **Scope of tests for seamless tubes in both quality grades and authority for the execution of the testings**

No	Tests	Acc. to Section	Quality grade I	Quality grade III	Authority for the execution of the testings 1)
1	Tensile test 2)	8.4.3	on two tubes per batch from the first two batches, on one tube from each subsequent batch	on two tubes per batch from the first two batches, on one tube from each subsequent batch	S. A.
2	Notch impact/bending test 3)	8.4.4	on tubes according to No 1	on tubes according to No 1	S. A.
3	Ring test 3)	8.4.6	on one end of the tubes according to No 1	depending on the diameter (see Section 8.4.6) on 20 % of the rolled or part lengths at one end, or on 100 % of the rolled or part lengths at both ends, if necessary though also at one end see Section 8.4.6.2.2.	S. A.
4	Non-destructive test	8.4.7		all tubes	M. W.
5	Visual inspection of tube surface	8.4.8	all tubes	all tubes	S. A.
6	Gauging	8.4.9	all tubes	all tubes	S. A.
7	Leakage test	8.4.10	all tubes	all tubes	M. W.
8	Grade identification test	8.4.11		all alloy tubes	M. W.
	Special tests 4) No 9, No 10				
9	Control analysis	8.4.2	subject to agreement	subject to agreement	M. W.
10	Hot tensile test	8.4.5	unless otherwise agreed 1 specimen per cast and size or 1 specimen per cast and annealing batch (heat-treatment batch)	unless otherwise agreed 1 specimen per cast and size or 1 specimen per cast and annealing batch (heat-treatment batch)	S. A.

1) S. A. = Subject to agreement; M. W. = Manufacturing Works.

2) 1 specimen or 1 set of specimens suffices for batch sizes of up to 10 tubes.

3) The particulars on the size ranges governing the application of these testings in Table 14 shall be complied with.

4) ● Special tests shall only be carried out, after an agreement has been reached between the manufacturer and customer.

Table 4. **Limits governing the application of quality grades I and III**

Quality grade 1)	Outside diameter ≦ 63.5 mm: Temperature 2) °C	Outside diameter ≦ 63.5 mm: Permissible working pressure 3) bar	Outside diameter > 63.5 mm: Temperature 2) °C	Outside diameter > 63.5 mm: Permissible working pressure 3) bar
I	≦450	≦ 80	≦ 450	≦32
III	> 450	> 80	> 450	> 32

1) If pressure and temperature data do not belong to the same group, the higher group applies.
2) Temperature of conveyed fluid.
3) See DIN 2401 Part 1.

Table 5. **Mechanical properties of seamless tubes of heat-resisting steels at room temperature**

Steel grade: Code number	Steel grade: Material number	Tensile strength N/mm2	Yield point 1), 2) for wall thickness in mm ≦16, N/mm2 minimum	> 16 ≦40	> 40 ≦60	Elongation at fracture ($L_o = 5 \cdot d_o$) % minimum: long.	transv.	Impact strength (DVM specimens 3)) transverse J minimum
St 35.8	1.0305	360 to 480	235	225	215	25	23	34
St 45.8	1.0405	410 to 530	255	245	235	21	19	27
17 Mn 4	1.0481	460 to 580	270	270	260	23	21	34
19 Mn 5	1.0482	510 to 610	310	310	300	19	17	34
15 Mo 3	1.5415	450 to 600	270 4)	270	260	22	20	34
13 CrMo 4 4	1.7335	440 to 590	290 4)	290	280	22	20	34
10 CrMo 9 10	1.7380	450 to 600	280	280	270	20	18	34
14 MoV 6 3	1.7715	460 to 610	320	320	310	20	18	41
X 20 CrMoV 12 1	1.4922	690 to 840	490	490	490	17	14	34 5)

1) For tubes of ≦ 30 mm outside diameter and ≦ 3 mm wall thickness the minimum values are by 10 N/mm2 lower.
2) For > 60 mm wall thickness, the values of tubes from the steels St 35.8, St 45.8, 17 Mn 4, 19 Mn 5, 15 Mo 3 and 14 MoV 6 3 are subject to agreement; for wall thicknesses > 60 to ≦ 80 mm a minimum value of 270 N/mm2 or 260 N/mm2 applies for tubes from the steels 13 CrMo 4 4 and 10 CrMo 9 10 and a minimum value of 490 N/mm2 for tubes from the steel X 20 CrMoV 12 1.
3) When testing longitudinal specimens (see Section 8.5.3) the minimum impact strength is 14 J higher.
4) A 15 N/mm2 higher minimum value applies for ≦ 10 mm wall thicknesses.
5) For hot-extruded tubes the minimum value falls to 27 J.

Table 6. **Minimum 0.2 % yield limit of seamless tubes at elevated temperatures**

Steel grade Code number	Material number	Wall thickness s mm	0.2 %-yield limit at 200 °C	250 °C	300 °C	350 °C	400 °C	450 °C	500 °C	550 °C
			N/mm² minimum							
St 35.8	**1.0305**	≦16	185	165	140	120	110	105	–	–
		16 < s ≦40	180	160	135	120	110	105	–	–
		40 < s ≦60 1)	175	155	130	115	110	105	–	–
St 45.8	**1.0405**	≦16	205	185	160	140	130	125	–	–
		16 < s ≦40	195	175	155	135	130	125	–	–
		40 < s ≦60 1)	190	170	150	135	130	125	–	–
17 Mn 4	**1.0481**	≦40	235	215	175	155	145	135	–	–
		40 < s ≦60 1)	225	205	165	150	140	130	–	–
19 Mn 5	**1.0482**	≦40	255	235	205	180	160	150	–	–
		40 < s ≦60 1)	245	225	195	170	155	145	–	–
15 Mo 3	**1.5415**	≦40 2)	225	205	180	170	160	155	150	–
		40 < s ≦60 1)	210	195	170	160	150	145	140	–
13 CrMo 4 4	**1.7335**	≦40 2)	240	230	215	200	190	180	175	–
		40 < s ≦60	230	220	205	190	180	170	165	–
		60 < s ≦80	220	210	195	180	170	160	155	–
10 CrMo 9 10	**1.7380**	≦40	245	240	230	215	205	195	185	–
		40 < s ≦60	235	230	220	205	195	185	175	–
		60 < s ≦80	225	220	210	195	185	175	165	–
14 MoV 6 3	**1.7715**	≦40	270	255	230	215	200	185	170	–
		40 < s ≦60 1)	260	245	220	205	190	175	160	–
X 20 CrMoV 12 1	**1.4922**	≦80	430	415	390	380	360	330	290	250

1) For wall thicknesses greater than 60 mm the values are subject to agreement.

2) For wall thicknesses ≦10 mm, 15 N/mm² higher minimum 0.2 % yield limits apply at all temperatures.

Table 7. **Provisional data [1] (change in diameter) in the ring expanding test.**

Steel grade	Expansion [2] in ring expanding test (provisional data) For diameter ratios d_i/d_a					
	≧ 0.9	≧ 0.8 < 0.9	≧ 0.7 < 0.8	≧ 0.6 < 0.7	≧ 0.5 < 0.6	< 0.5
	% minimum					
unalloyed steels	8	10	12	20	25	30
alloyed steels	6	8	10	15	20	30

1) These values shall be regarded as initial recommendations which are based on a series of tests and will have to be re-assessed in the light of future experience.

2) The deformability of ring expanding test specimens will additionally be assessed in terms of the appearance of the fracture and fracture surfaces.

Table 8. **Permissible wall thickness deviations for orders based on the outside diameter**

Permissible wall thickness deviations for outside diameters d_a and wall thicknesses s								
$d_a \leqq 130$ mm			130 mm $< d_a \leqq 320$ mm			320 mm $< d_a \leqq 660$ mm		
$\leqq 2 \cdot s_n$	$2 \cdot s_n < s \leqq 4 \cdot s_n$	$> 4 \cdot s_n$	$\leqq 0{,}05\, d_a$	$0{,}05\, d_a < s \leqq 0{,}11\, d_a$	$> 0{,}11\, d_a$	$\leqq 0{,}05\, d_a$	$0{,}05\, d_a < s \leqq 0{,}09\, d_a$	$> 0{,}09\, d_a$
+ 15 % – 10 %	+ 12,5 % – 10 %	± 9 %	+ 17,5 % – 12,5 %	± 12,5 %	+ 10 %	+ 22,5 % – 12,5 %	+ 15 % – 12,5 %	+ 12,5 % – 10 %

Note: s_n – Nominal wall thickness according to DIN 2448

Table 9. **Permissible wall thickness deviations for orders based on the bore**

Permissible wall thickness deviations for inside diameter d_i ≧ 200 mm to ≦ 720 mm and wall thicknesses s		
≦ 0.05 d_i	0,05 $d_i < s \leqq 0{,}10\, d_i$	> 0,10 d_i
+ 22,5 % – 12,5 %	+ 15 % – 12,5 %	+ 12,5 % – 10 %

Table 10. ***Permissible deviations on length***

For orders specifying	Permissible deviations on length in mm
Production lengths	[1]
Random lengths	± 500
Exact lengths	
from ≦ 6 m (nominal size)	$^{+10}_{0}$
from > 6 m ≦ 12 m (nominal size)	$^{+15}_{0}$
from > 12 m	subject to agreement

1) The products are supplied in production lengths which differ according to diameter, wall thickness and production plant.

Table 11. **Permissible deflection *f***

b in mm	≦ 100	> 100 ≦ 200	> 200 ≦ 300	> 300
f in mm	≦ 0,75	≦ 1	≦ 1,5	≦ 2

Table 12. **Reference data for hot forming, normalising and hardening and tempering of high-temperature seamless tube steels** [1])

Steel grade: Code number	Steel grade: Material number	Hot forming °C	Normalising °C	Hardening and tempering: Hardening temperature [2]) °C	Hardening and tempering: Tempering temperature °C
St 35.8	**1.0305**	between 1100 and 850 [3])	900 to 930	–	–
St 45.8	**1.0405**		870 to 900	–	–
17 Mn 4	**1.0481**		880 to 910	–	–
19 Mn 5	**1.0482**		880 to 910	–	–
15 Mo 3	**1.5415**		910 to 940	–	–
13 CrMo 4 4	**1.7335**		–	910 to 940	660 to 730
10 CrMo 9 10 [4])	**1.7380** [4])		–	900 to 960	700 to 750
14 MoV 6 3	**1.7715**		–	950 to 980	690 to 730
X 20 CrMoV 12 1	**1.4922**		–	1020 to 1070	730 to 780

1) The work pieces must attain the specified temperature over the entire cross-section. Provided this has definitely been done further holding at these temperatures is unnecessary when normalising and hardening. The temperatures laid down for tempering shall be held for approximately 30 minutes minimum for the steels 13 CrMo 4 4 and 10 CrMo 9 10 and for 1 hour minimum for the steels 14 MoV 6 3 and X 20 CrMoV 12 1, with the annealing time being counted from the moment when the lower limit of the given temperature range is reached.

2) Cooling in air or controlled atmosphere. Accelerated cooling e.g. in liquid, can become necessary at greater wall thicknesses.

3) The temperature can drop to 750 °C during processing.

4) In addition to given quenching and tempering treatment the following sequence of treatment can be considered for the steel:
900 °C to 960 °C/furnace to 700 °C ≧ 1 hour 700 °C/air.

Table 13. **Welding methods and data for the heat-treatment after welding**

Steel grade: Code number	Steel grade: Material number	Welding methods	Annealing temperatures 1) and holding time 2) 3) at the required heat-treatment after welding °C
St 35.8	**1.0305**	All fusion welding methods and flash butt-welding	520 to 600
St 45.8	**1.0405**		520 to 600
17 Mn 4	**1.0481**		520 to 580
19 Mn 5	**1.0482**		520 to 580
15 Mo 3	**1.5415**		530 to 620
13 CrMo 4 4	**1.7335**		600 to 700
10 CrMo 9 10	**1.7380**		650 to 750
14 MoV 6 3 4)	**1.7715**	All fusion welding methods, except gas fusion welding	690 to 730
X 20 CrMoV 12 1 5)	**1.4922**		720 to 780

1) If required (see Section 7.3) these temperatures apply also to annealing treatments after cold forming.

2) The holding time for the specified temperatures depends on the thickness of the workpieces. A minimum holding time of 15 minutes is recommended for a thickness ≦ 15 mm, a minimum holding time of 30 minutes, for thicknesses > 15 to ≦ 30 mm and a minimum holding time of 60 minutes for thicknesses > 30 mm.

At thicknesses > 30 mm a minimum holding time of 90 minutes is required for 10 CrMo 9 10. Furnace anneals should be performed in the mid-range of the specified temperatures. For local anneals the external surface shall be at the maximum temperature.

3) The annealing treatment shall also comply with the instructions of the manufacturer of the filler metals.

4) Judging from the experience gained up to now, repeated annealing treatments shall not exceed a total holding time of 10 hours, with the subsequent annealing treatments being performed in the lower temperature range when the material is in the air-hardened condition.

5) Welding shall be followed by cooling below 150 °C (though for thick-walled tubes not below 100 °C).

The following holding times are recommended:

≤ 8 mm	thickness	30 minutes minimum
> 8 ≦ 30 mm	thickness	60 minutes minimum
> 30 ≦ 60 mm	thickness	120 minutes minimum
> 60 mm	thickness	180 minutes minimum

Table 14. **Size ranges for the application of mechanical and technological methods for testing tubes in both qualities**

Tube diameter mm		Nominal wall thickness of the tubes				
external	internal	< 2 mm	≧ 2 mm ≦ 16 mm	> 16 mm ≦ 30 mm	> 30 mm ≦ 40 mm	> 40 mm
≦ 21.3	≦ 15	Tensile test Ring flattening test	Tensile test Ring flattening test	–	–	–
> 21.3 ≦ 146	> 15	Tensile test Ring flattening test	Tensile test Notch impact/bending test [1] Ring expanding test	Tensile test Notch impact/bending test [1] Ring flattening test	Tensile test Notch impact/bending test Ring flattening test	Tensile test Notch impact/bending test
> 146 [3]			Tensile test Notch impact/bending test [1] Ring tensile test	Tensile test Notch impact/bending test [1] Ring tensile test [2]	Tensile test Notch impact/bending test Ring tensile test [2]	Tensile test Notch impact/bending test

1) Only for tubes manufactured from steels 14 MoV 6 3 and X 20 CrMoV 12 1 in nominal thicknesses > 10 mm and for tubes manufactured from the steel 15 Mo 3 in nominal thicknesses > 20 mm.

2) Tubes ≦ 100 mm inside diameter shall be ring flattening-tested instead of ring tensile-tested.

3) This limit applies also for tubes, orders for which are based on the inside diameter, provided the nominal outside diameter > 146 mm.

Appendix A

The following Table gives tentative figures for the long time high temperature strength of the steels used for seamless tubes. The figures listed are mean values for the scatter range representing results so far available. These mean values will be examined from time to time and amended where necessary as further results become available. From the data so far available from long time creep tests it can be assumed that the bottom limit of this scatter range at the stated temperatures for the steel grades listed is about 20 % lower than the mean value quoted.

Table A. 1.

Steel grade	Temperature	1 %-time yield limit 1), 2) for		Creep strength 2), 3) for		
		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
Code number	°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
St 35.8 St 45.8	380	164	118	229	165	145
	390	150	106	211	148	129
	400	136	95	191	132	115
	410	124	84	174	118	101
	420	113	73	158	103	89
	430	101	65	142	91	78
	440	91	57	127	79	67
	450	80	49	113	69	57
	460	72	42	100	59	48
	470	62	35	86	50	40
	480	53	30	75	42	33
17 Mn 4 19 Mn 5	380	195	153	291	227	206
	390	182	137	266	203	181
	400	167	118	243	179	157
	410	150	105	221	157	135
	420	135	92	200	136	115
	430	120	80	180	117	97
	440	107		161	100	82
	450	93	59	143	85	70
	460	83	51	126	73	60
	470	71	44	110	63	52
	480	63	38	96	55	44
	490	55	33	84	47	37
	500	49	29	74	41	30
15 Mo 3	450	216	167	298	245	228
	460	199	146	273	209	189
	470	182	126	247	174	153
	480	166	107	222	143	121
	490	149	89	196	117	96
	500	132	73	171	93	75
	510	115	59	147	74	57
	520	99	46	125	59	45
	530	84	36	102	47	36
	540	(70)	(28)	(82)	(38)	(28)
	550	(59)	(24)	(64)	(31)	(25)

1) This being the stress referred to in the original cross-section which leads to a permanent elongation of 1 % after 10 000 or 100 000 hours (h).

2) A bracket denotes that the steel should preferably no longer be used for continuous service at the relevant temperature.

3) This being the stress referred to in the original cross-section which results in rupture after 10 000, 100 000 or 200 000 hours (h).

Table A. 1. (continued)

Steel grade Code number	Temperature °C	1 %-time yield limit [1], [2] for 10 000 h N/mm²	1 %-time yield limit [1], [2] for 100 000 h N/mm²	Creep strength [2], [3] for 10 000 h N/mm²	Creep strength [2], [3] for 100 000 h N/mm²	Creep strength [2], [3] for 200 000 h N/mm²
13 CrMo 4 4	450	245	191	370	285	260
	460	228	172	348	251	226
	470	210	152	328	220	195
	480	193	133	304	190	167
	490	173	116	273	163	139
	500	157	98	239	137	115
	510	139	83	209	116	96
	520	122	70	179	94	76
	530	106	57	154	78	62
	540	90	46	129	61	50
	550	76	36	109	49	39
	560	64	30	91	40	32
	570	53	24	76	33	26
10 CrMo 9 10	450	240	166	306	221	201
	460	219	155	286	205	186
	470	200	145	264	188	169
	480	180	130	241	170	152
	490	163	116	219	152	136
	500	147	103	196	135	120
	510	132	90	176	118	105
	520	119	78	156	103	91
	530	107	68	138	90	79
	540	94	58	122	78	68
	550	83	49	108	68	58
	560	73	41	96	58	50
	570	65	35	85	51	43
	580	57	30	75	44	37
	590	50	26	68	38	32
	600	44	22	61	34	28
14 MoV 6 3	480	243	177	299	218	182
	490	219	155	268	191	163
	500	195	138	241	170	145
	510	178	122	219	150	127
	520	161	107	198	131	109
	530	146	94	179	116	91
	540	133	81	164	100	76
	550	120	69	148	85	61
	560	109	59	134	72	48
	570	(98)	(48)	(121)	(59)	(37)
	580	(88)	(37)	(108)	(46)	(28)

For footnotes [1], [2] and [3] see page 18

Table A. 1. (continued)

Steel grade	Temperature	1 %-time yield limit [1], [2] for		Creep strength [2], [3] for		
		10 000 h	100 000 h	10 000 h	100 000 h	200 000 h
Code number	°C	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
X 20 CrMoV 12 1	470	324	260	368	309	285
	480	299	236	345	284	262
	490	269	213	319	260	237
	500	247	190	294	235	215
	510	227	169	274	211	191
	520	207	147	253	186	167
	530	187	130	232	167	147
	540	170	114	213	147	128
	550	151	98	192	128	111
	560	135	85	173	112	96
	570	118	72	154	96	81
	580	103	61	136	82	68
	590	90	52	119	70	58
	600	75	43	101	59	48
	610	64	36	87	50	40
	620	53	30	73	42	33
	630	44	25	60	34	27
	640	36	20	49	28	22
	650	29	17	40	23	18

For footnotes [1], [2] and [3] see page 18

Explanations

This Standard replaces Standards DIN 17 175 Part 1 (January 1959 edition) — Seamless tubes of heat-resisting steels; technical delivery conditions —, DIN 17 175 Part 2 (January 1959x edition) — Seamless tubes of heat-resisting steels; quality specifications for relevant steels — and DIN 17 175 Part 2 Supplement (June 1969 edition) — Seamless tubes of heat-resisting steels; long-term hot strength values —. The publication of this revised version (necessitating 2 drafts) had been delayed, because on the one hand the answer to the question whether or not the lower minimum yield points or minimum proof stresses at elevated temperatures quoted in international standard

ISO 2604/II

E: Steel products for pressure purposes — Quality requirements — Part 2: Wrought seamless tubes

D: Stahlerzeugnisse für Druckbehälter; Gütevorschriften, Teil 2: Nahtlose Rohre

compared with DIN 17 175 Part 2 (January 1959x edition) should be used, proved more complicated than expected and at the same time it had been intended to wait for the forthcoming international negotiations, and also the determination of the long-term hot strength values, the dimensional deviations and the scope of ring testing took up a great deal of time and had to be studied in special committees.

This Standard differs from ISO 2604/II, DIN 17 175 Part 1 and Part 2 (January 1959 edition) and DIN 17 175 Part 2 Supplement (June 1969 edition) in the following major points:

a) Tubes for headers are included in the scope.

b) The range of steels was extended to grades 17 Mn 4 (1.0481), 19 Mn 5 (1.0482), 14 MoV 6 3 (1.7715) and X 20 CrMoV 12 1 (1.4922). This Standard therefore includes ferritic and martensitic types of steel envisaged in ISO 2604/II for service at elevated temperature, up to grades TS 2, TS 37 and TS 38; see tabular comparison at end of "Explanations".

c) The chemical composition of the steels was in part narrowed down, especially for the elements phosphorus and sulphur, compared with the January 1959 edition of this Standard and ISO 2604/II. The change in the molybdenum content of steel 13 CrMo 4 4 (1.7335) (from 0.40 % to 0.50 % into 0.45 % to 0.65 % as in ISO 2604/II is of particular interest.

d) As in ISO 2604/II a table on the permissible deviations allowed for sample analyses was included in this new edition as opposed to the limits for the ladle analysis.

e) A change occurred in the quality grades, inasmuch as only quality grades I and III were retained. These quality grades cannot be compared directly with the testing categories II to V of ISO 2604/II. Quality grades I and III resemble testing categories II and V most closely, though an allowance has to be made for the difference in testing scopes.

f) The requirements of the scope for the ring tests (which are far more severe than in ISO 2604/II) were checked and modified in a Working Committee expressly formed for this purpose. In view of the 100 % non-destructive testing for longitudinal defects, the scope for the ring tests was restricted for quality grade III tubes.

In response to objections by customers that for them ring tests were less valuable as a means for assessing the deformability of the tubes than for detecting surface defects since neither the rupture elongations nor the yield point/tensile-ratios furnished adequate information on tube performance during cold bending, Table 7 containing provisional data on the minimum expansion of the tube in the ring expanding test was additionally included in the standard at the suggestion of steelmakers. Since the values in Table 7 are in principle of a tentative nature, all participants are invited to comment from personal experience on the validity of these values.

g) The leaktightness test in the form of an internal pressure test with water can now be replaced at the discretion of the manufacturer by a suitable non-destructive testing method (e.g. Eddy current testing according to Stahl-Eisen-Prüfblatt (Testing Sheet) -1925)

h) Non-destructive testing for longitudinal defects has now been extended to all quality grade III tubes of 10 mm outside diameter and over. Testing for transverse defects and laminations can additionally be negotiated for quality grade III tubes having outside diameters greater than 133 mm, and outside diameters greater than 133 mm having wall thicknesses greater than 8 mm. Testing is generally done ultrasonically.

i) Visual inspection of the tubes can be replaced by a proven, suitable non-destructive testing method.

j) As distinct from ISO 2604/II this Standard also contains data on form and dimensional deviations. Differing from the requirements in DIN 17 175 Part 1 (January 1959 edition), the tolerances currently quoted for orders based on the outside diameter are now set out either according to the ratio of the nominal wall thickness to the outside diameter or as a multiple of the nominal wall thickness. The additional, local 5 % allowance on the lower tolerance limit of the nominal wall thickness is no longer valid. Subject to agreement on ordering, cold finished tubes can now be supplied with closer tolerances. In compliance with the request of consumers it is now possible to order tubes of 200 mm bore and larger based on the inside diameter. Corresponding deviations on the inside diameter and wall thicknesses were fixed for this particular requirement.

k) The data on the physical properties have been deleted. The Verein Deutscher Eisenhüttenleute (Association of German Ferrous Metallurgy Engineers) is currently preparing an appropriate Stahl-Eisen-Werkstoffblatt (Material Data Sheet) containing also data on steels outwith DIN 17 175.

l) As previously, the values for the impact energy apply to DVM-specimens. Steelmakers have pointed out that the notch impact/bending test quoted for DIN 17 175 steels served solely as a guide to the satisfactory nature of the heat treatment and for the presence of adequate ductility. At the request of the Technical Testing Authorities and consumers they were, however, willing to collect the test results from

ISO-V specimens as regards the applicability of brittle fracture criteria, in order to enable DIN 17 175 to change over to this type of specimen when revised next.

m) The minimum data for the room temperature yield point and the elevated temperature 0.2 % yield limit were determined from available sets of data by means of cumulative frequency curves. A classification according to wall thickness differing from ISO 2604/II proved unavoidable, so as to be able to at least retain or even increase the present values in the majority of cases. Compared with ISO 2604/II this classification of the wall thicknesses generally gives higher values at lower wall thicknesses and, in part, lower values at greater wall thicknesses.

In order to lower the values for the thickness range greater than 60 mm to 80 mm by 10 N/mm^2 compared with the values in the greater than 40 mm to 60 mm wall thickness range of steels 13 CrMo 4 4 (1.7335) and 10 CrMo 9 10 (1.7380) the steel manufacturers had insufficient data at present on the over 60 mm to 80 mm thickness range for a significant evaluation to be carried out; extrapolation beyond the reasonably well substantiated range would only be possible up to wall thickness of approximately 60 mm, where the wall thickness effect observed at present in the range of up to 50 mm is still confirmed. The steelmakers expressed their willingness to collate data for analysing the current requirements at a later date.

n) ISO 2604/II contains no requirements for values of the 1 % time yield limit. The requirements in the current revised standard for steels St. 35.8 (1.0305), St. 45.8 (1.0405), 15 Mo 3 (1.5415), 13 CrMo 4 4 (1.7335) and 10 CrMo 9 10 (1.7380) contained in the previous version of DIN 17 175, agree with those in DIN 17 175 Part 2, Supplement (June 1969 edition). The values for the newly included steels 17 Mn 4 (1.0481) and 19 Mn 5 (1.0482) obtained from Stahl-Eisen-Werkstoffblatt 610 – Seamless headers of high temperature steels – have been supplemented by extrapolated values for 380 °C and 390 °C. The values for the 1 % limit of the other freshly included steels 14 MoV 6 3 (1.7715) and X 20 CrMoV 12 1 (1.4922) were based on the most up to-date evaluations.

o) The values for creep strength merit the following comments:

The requirements for steels St 35.8 (1.0305), St 45.8 (1.0405), 15 Mo 3 (1.5415) and 13 CrMo 4 4 (1.7335) – though for the two last-named steels only the values for 10^5 and 2.10^5 h – were taken from DIN 17 175 Part 2, Supplement (June 1969 edition).

In contrast, the 10^4 h – creep strength values of steels 15 Mo 3 and 13 CrMo 4 4 as well as the 10^4 and 10^5 h – creep strength values of the steel 14 MoV 6 3 (1.7715) agree with those of the corresponding steels in ISO 2604/II; the requirements for the 2.10^5 h – creep strength values of steel 14 MoV 6 3 were based on the most recent evaluations in the 480 °C to 500 °C temperature range, thereby differing from ISO 2604/II.

The creep strength values of steel 10 CrMo 9 10 (1.7380) agree, in principle, with those of steel TS 34 according to ISO 2604/II, though minor deviations of up to 4 N/mm^2 maximum have crept in during the smoothing of the curve as a result of three-dimensional interpolation (time, temperature, stress) which seem none-the-less justified in view of the improved utilizability of the data in the computer.

The 10^4 h – creep strength values of steel X 20 CrMoV 12 1 (1.4922) agree in the 500 °C to 610 °C temperature range with those of steel TS 40 according to ISO 2604/II; in contrast the 10^5 and 2.10^5 h – creep strength values in the 470 °C to 600 °C temperature range agree with the requirements in Stahl-Eisen Delivery Condition 675-69 – "Seamless tubes of high-temperature steels" –; the remaining values were extrapolated on the basis of the latest evaluations.

The values, which are quoted in Documents ISO/TC 17/SC 10/ETP N 99 and N 148 and envisaged for the forthcoming revised edition of ISO 2604/II for steels TS 5 and TS 9 H, were used for steels 17 Mn 4 (1.0481) and 19 Mn 5 (1.0482).

p) Thin-walled tubes may be marked by methods other than stamp-marking.

Comparison of ferritic and martensitic steels according to ISO2604/II, envisaged for use at elevated temperatures, with equivalent German steels

	Steels based on			
	German documents		ISO 2604/II	
1)	Code number	Material number	2)	3)
–	–	–	TS 2	–
DIN	St 35.8	1.0305	TS 5	●
DIN	St 45.8	1.0405	TS 9H	●
DIN	17 Mn 4	1.0481	TS 14	○
DIN	19 Mn 5	1.0482	TS 18	○
DIN	15 Mo 3	1.5415	TS 26	●
DIN		1.7335	TS 32	●
DIN	10 CrMo 9 10	1.7380	TS 34	●
DIN	14 MoV 6 3	1.7715	TS 33	●
SEL	12 CrMo 19 5	1.7362	TS 37	○
SEL	X 12 CrMo 9 1	1.7386	TS 38	●
DIN	X 20 CrMoV 12 1	1.4922	TS 40	X

1) DIN = contained in DIN 17 175; SEL = contained in Stahl-Eisen List, 6th edition 1977, Düsseldorf, Verlag Stahl-Eisen mbH.

2) Code No of steels in ISO 2604/II.

3) This column shows the degree of agreement in the chemical composition of the German steels on the one hand and the ISO 2604/II steels on the other hand. Notations: X = full agreement, ● = minor deviations, ○ = significant deviations.