Tomsk Electronic Company
is certified by NQA-Russia
according to international
Standard BS EN ISP 9001:2011

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Scientific and Manufacturing Enterprise

TOMSK ELECTRONIC COMPANY, Ltd.

Integrated Solutions For Rolling

- Lines and Complexes of Non-Destructive Testing
- Lines and Complexes of Heat Treatment
- Robotic Transport Systems

www.npptec.ru
2013

SME Tomsk Electronic Company

- is an up-to-date engineering and manufacturing enterprise offering samples of process design and production for metallurgical, oil and gas, energy and other domains.

The quality of products and project implementation complies with international standards. SME TEC has a Certificate of Compliance of quality management system with requirements of ISO 9001:2011, appropriate SRO certificates on design, construction, assembly, and commissioning works including acting as general designer and general contractor.

Process solutions offered by our company demonstrate excellent characteristics, high accuracy, reliability, safety, long-term service life, which will allow your enterprise to increase significantly quality and volume of product output, and to improve working conditions and personnel performance efficiency.

All engineering decisions are made by the highly skilled staff of our company with an individual approach to each customer.

Modern technologies, high technical level of the equipment and professionalism of company's specialists - all that enables to produce unique in its characteristics and functionality devices and automation equipment the safety of which withstand the tests of time and is confirmed by our customers and partners.

Integrated Solutions for Rolling

Having many years' experience in development of process design, equipment and process automation for metallurgical industry; qualified technical staff; full range of machine-building, electronic, electric techniques; and effective work management SME TEC offers:

- Lines and complexes of non-destructive testing for various mill products and transport machine building enterprises

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- Lines and complexes of heat treatment of railroad rails, wheels, hubs, bolsters, pipes and other articles of rolled metal

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- Robotic transport systems, complete integrated automation of rolling

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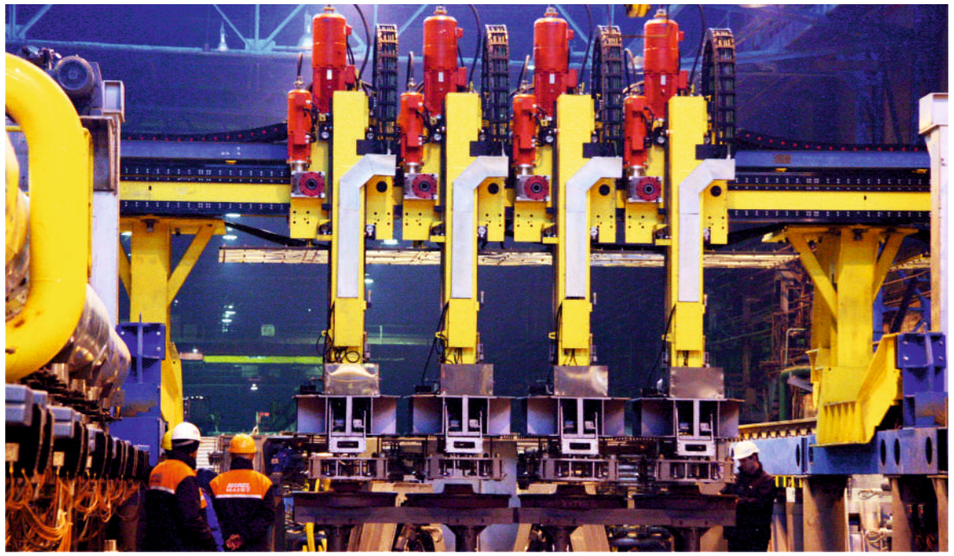


Lines and Complexes of Non-Destructive Inspection

In context of severe market competition one of the factors determining the financial success of any manufacturer is the quality of its products. The quality of rolling products provides reliability and safety of operation of railway transport objects. Since 2005 for the purpose of quality control assurance in view of requirement strengthening of national and international standards applied to the quality of products SME TEC develops activity in field of non-destructive inspection for mill products and transport machine building enterprises.

Automated Final Inspection Line (FIL)
for Wheels and Tires Shop of OAO NTMK

Final inspection lines for railway wheels, FIL-1 and FIL-2, for OAO Nizhniy Tagil Iron and Steel Works became our pilot projects. The next step in our development begun with cooperation with European institutes and companies, and since 2010 our company has participated in creation of the Competent center together with the following enterprises: RESA (Germany), AREVA (France), IntellegeNDT (SIEMENS&AREVA) and Fraunhofer institutes IZFP, IPA, IIS. Within Competent center the enterprises are assumed to participate in developing up-to-date engineering solutions in the field of non-destructive testing for metallurgical, nuclear, and oil and gas domains:

- **For metallurgical industry** - product quality control while providing required output capacity
- **For oil and gas industry** - valve and pipeline state monitoring
- **For nuclear industry** - valve and pipeline state monitoring, as well as defect detection and monitoring of equipment state, where human presence is not possible.

Relations of partnership with European companies and institutes, and proven experience in project implementation in Russia allowed our enterprise in 2010 to approach the Chinese market, and to offer our solutions; and in 2011 the company entered the project on construction of final inspection line for railway wheels of high-speed trains for MaSteel corp. Magan (China). In December 2012 the line was successfully brought into operation.

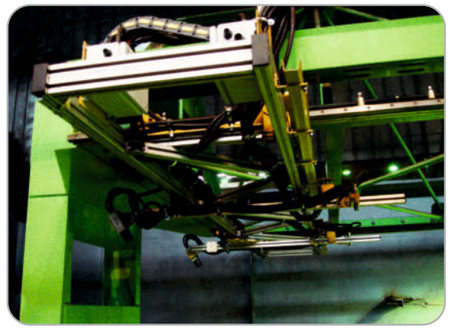
The main requirements to lines and complexes providing high quality of products are the following:

- Compliance with national and international standards
- Performance of full range of process steps using various natural approaches (depending on product type)
- High work output.

All process steps are highly automated, and certain steps are performed in full automatic mode. The lines and complexes are equipped with modern PCS (based on controllers available from world-known manufacturers), having sophisticated hierarchy integratable into currently available systems. In combination with final inspection lines and complexes SME TEC develops and supplies conveying systems for product transportation.

SME TEC is experienced in developing and implementation in collaboration with different manufacturers of equipment responsible for quality of output products:

- Control of internal defects with ultrasonic immersion test units - in collaboration with Fraunhofer Institute for Applied Research IZFP (Germany)
- Control of surface defects with magnetic-luminescent inspection units - in collaboration with NPO INTROTEST
- Geometry control of rolled products with dimensional measurement unit - self-design project.



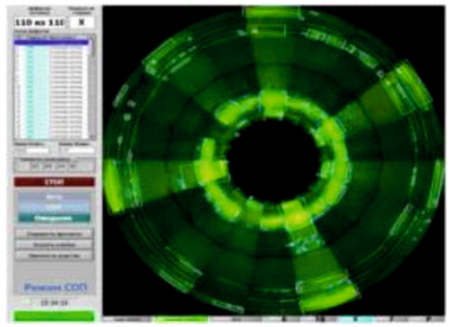
Sheet Dimensional Measurement Systems
for OAO Vyksa Steel Works

Non-Destructive Testing Equipment

SME TEC jointly with partners develops and implements lines and complexes of non-destructive testing for rolled products, which may include following units:

- Inspection units of surface defects (magnetic-luminescent, thermographic, and eddy-current control)
- Inspection units of internal defects
- Dimensional inspection unit.

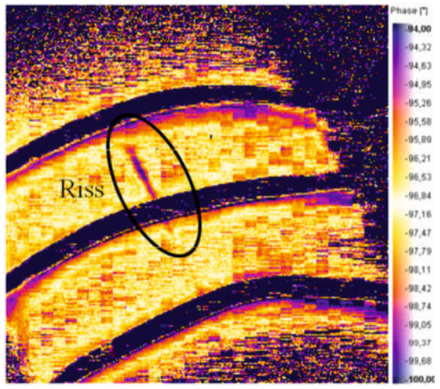
Inspection Lines and Complexes of Surface Defects
are designed and manufactured in collaboration with NPO INTROTEST.

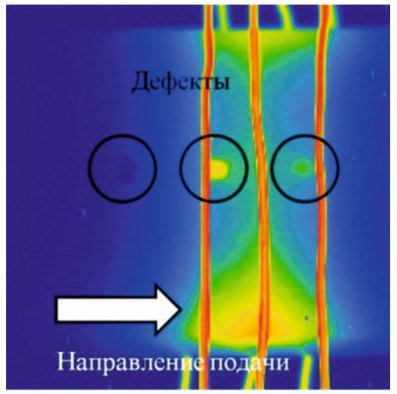


Technical Parameters

General Features	
Inspection method	Fluorescent magnetic
Inspection procedure	Applied field method (AFM)
Minimum length of the nominal defect, mm	2
Minimum depth of the nominal defect, mm	4
Minimum opening width of the nominal defect, μm	25
Power consumption, kW	120 (380 V, 50 Hz)
Accidental outcome of defected wheels from the line is not to exceed % out of discarded wheels	0.01
Inspected Product Parameters	
Dimensions (WxHxD), mm	500 x 500 x 2000
Weight, kg	3000
Capacity	
Unit cycle time, sec	134

Thermographic Inspection Units and Lines
are designed and manufactured in collaboration with Fraunhofer Institute for Manufacturing Engineering and Automation IPA.





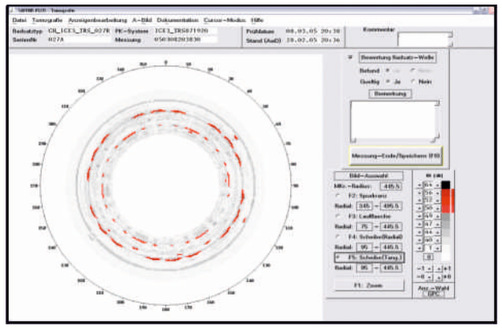
Technical Parameters

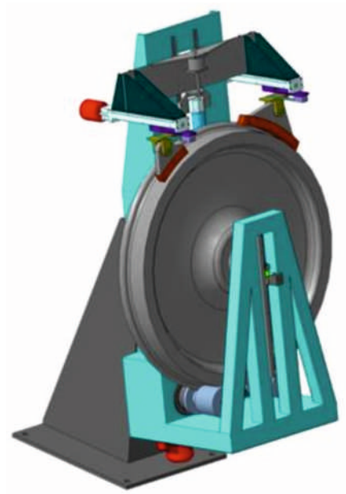
General Features	
Inspection method	Fluorescent magnetic
Inspection procedure	Applied field method (AFM)
Minimum length of the nominal defect, mm	2
Minimum depth of the nominal defect, mm	4
Minimum opening width of the nominal defect, μm	25
Power consumption, kW	120 (380 V, 50 Hz)
Accidental outcome of defected wheels from the line is not to exceed % out of discarded wheels	0.01
Inspected Product Parameters	
Dimensions (WxHxD), mm	500 x 500 x 2000
Weight, kg	3000
Capacity	
Unit cycle time, sec	60

Inspection Lines and Complexes of Internal Defects

are designed and manufactured for internal defect control of rolled metal products (including wheels, tires and rails) and metal constructions of different geometry for particularly hazardous and responsible production facilities developed in cooperation with IntelligeNDT (Siemens & AREVA).

intelligeNDT Systems & Services AREVA



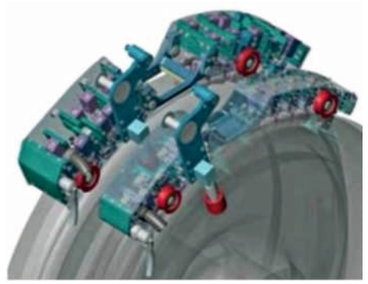


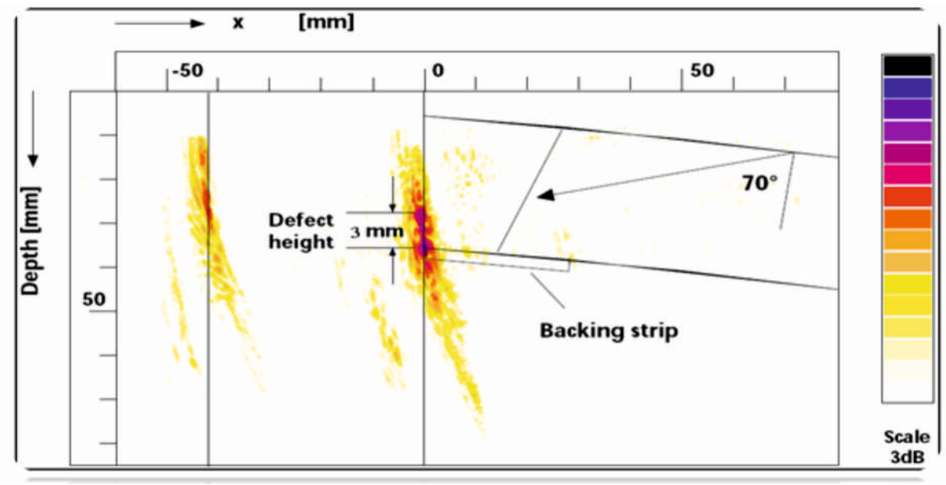
Technical Parameters

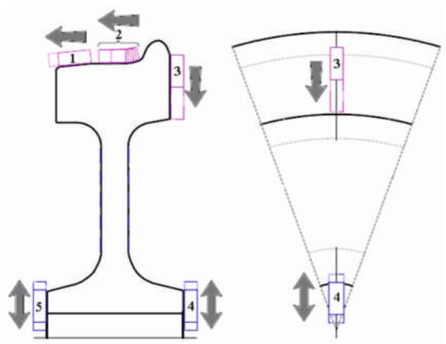
General Features	
Inspection method	Ultrasonic
Inspection procedure	0º P/E phase grating, 3MHz
Minimum length of the nominal defect, mm	1
Width of «silent» zone from surface, mm, at most	3
Power consumption, kW	30 (380 V, 50 Hz)
Inspected Product Parameters	
Dimensions (WxHxD), mm	500 x 500 x 2000
Weight, kg	3000
Capacity	
Unit cycle time, sec/Piece	134

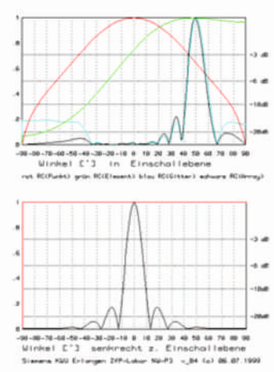
Ultrasonic Inspection for High-Speed Wheels and Tires Defects

During operation following wheel parts are inspected: rim, disk and hub. Inspection is done by means of longitudinal waves from UT probes. Measuring system detects defects from 1 mm. Probes are equipped with local immersion system to provide the required conductivity.









Geometry Control Units and Lines

are designed and manufactured on the basis of geometry control units for rolled metal products developed by SME TEC, internal defect control unit of rolled metal products (including wheels, tires and rails) and metal constructions of different geometry.

Technical Parameters

Inspection method	Measurement of geometrical parameters
Inspection procedure	Laser
Minimum size of the nominal defect is 0.1 mm	0.1

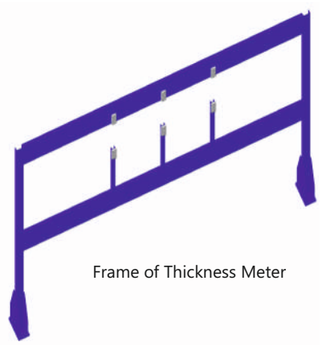
Example of Implemented Solution

Sheet Dimensional Measurement Systems for OAO Vyksa Steel Works (Vyksa)
are designed, manufactured and successfully implemented by SME TEC.

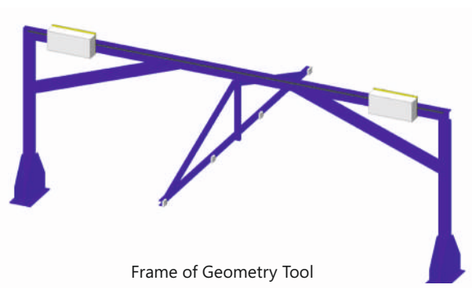
Technical Parameters

Parameter to be measured	Measuring range for physical magnitude	Limits for absolute permissible error
Sheet length, mm	8600...13000	±3.0 mm
Sheet thickness, mm	7...50	±0.1 mm
Sheet width, mm	1000...4500	±1.0 mm
Curvature	Of right/left edge	0...200 mm ±1.0 mm

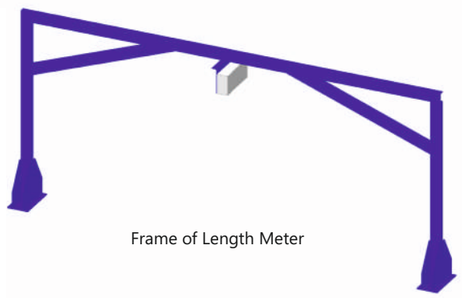
The systems consist of frames for geometry tool, thickness meter and length meter.



Frame of Thickness Meter



Frame of Geometry Tool

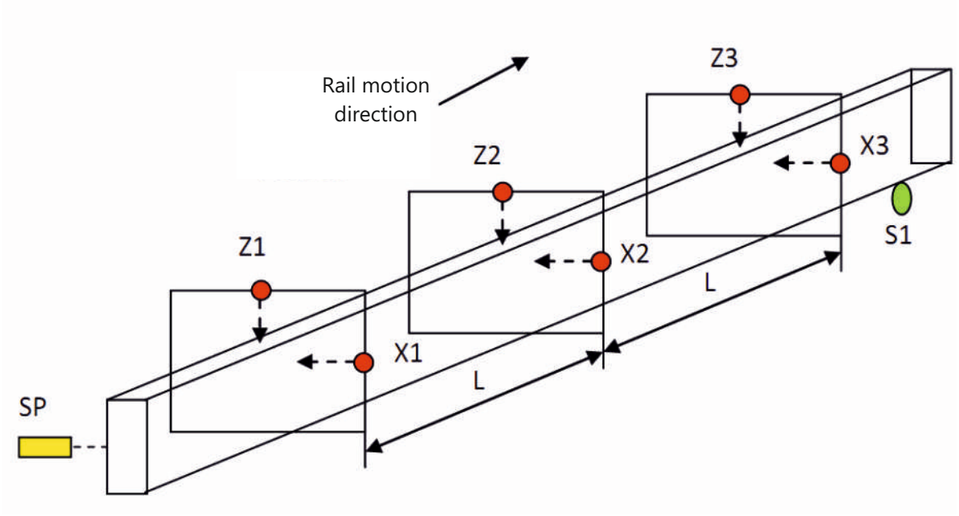


Frame of Length Meter

Rail Dimensional Measurement System

Beside the geometry control unit specialists of SME TEC have developed a rail dimensional measurement system. Operating principle of measurement system is based on continuous rail measurement on specified length with optical proximity sensor of non-contact type.

The structure of the measurement system consists of 3 measuring frames with sensors installed thereon. Measuring frames are to be mounted on vibration absorbing foundation. Measurement sensors are spaced at 1500 m from each other.



Rail dimensional measurement system.
X1, X2, X3 – optical displacement sensors for straightness measurement in horizontal plane.
Z1, Z2, Z3 – optical displacement sensors for straightness measurement in vertical plane.
S1 – rail position sensor at measuring point (incremental encoder).
Distance L = 1.5 m SP - 2D-camera (geometry tool).

Railroad Wheel
Final Inspection Lines FIL-1 and FIL-2

In 2005 SME TEC started implementation of railroad wheel final inspection line FIL No. 2 acting as General Contractor within the upgrade of the railroad wheels and tires shop of OAO Nizhniy Tagil Iron and Steel Works. In December 2007 the line was successfully tested in industrial environment. Work partners within this project became following companies: Wheelabrator Group (Toronto, Canada), NPO INTROTEST (Yekaterinburg), Scientific and Research Institute for Paint Coatings with Pilot Machine-Building Plant Victoria (Khotkovo), Fraunhofer Institute for Applied Research (Germany).

In a parallel way with this project SME TEC Ltd. started works at upgrade of existing wheels final inspection line No. 1 in order to enhance functional capabilities and to unify the equipment of wheels final inspection lines of OAO Nizhniy Tagil Iron and Steel Works. The basic objective was to resupply the existing line with shot-blasting machine for wheel disk treatment and corrosion-resistant coating application unit without a stop of operating line. The upgrade was successfully completed, and FIL No. 1 was brought into operation in full at the end of the year 2007.

Functions of FIL No. 1 Equipment

Equipment of FIL No. 2 allows performing following process steps:

- Transportation of wheels along the wheel final inspection line, i.e.:
  - Movement of wheels
  - Handling of wheels for process operations
  - Preparation of wheels for overhead crane transportation (stack assembly, or stacking into holder)
  - Stack assembly of discarded (unacceptable) wheels depending on defect type.
- Chemical treatment of the wheel surface
- Hardening of wheel disk surface by shot-blasting
- Application of corrosion-resistant coating on railroad wheel disk surface
- Information tracking of process.

Functions of FIL No. 2 Equipment

Equipment of FIL No. 1 allows performing following process steps:

- Transportation of wheels along the wheel final inspection line, i.e.:
  - Un-stacking and handling of individual wheels along the transportation line
  - Movement of wheels
  - Handling of wheels for process operations
  - Preparation of wheels for overhead crane transportation (stack assembly, or stacking into holder)
  - Stack assembly of discarded (unacceptable) wheels depending on defect type.
- Chemical treatment of the wheel surface
- Identification of wheel marking
- Visual inspection for surface defects and wheel geometry
- Ultrasonic inspection for internal flaws
- Magnetic particle inspection of the wheel surface for surface connected flaws
- Hardness testing of the wheel rim butt-end.
- Wheel check by Customer representatives
- Hardening of wheel disk surface by shot-blasting
- Application of corrosion-resistant coating on railroad wheel disk surface
- Information tracking of process.

Resupply of Railroad Wheels Final Inspection Lines FIL-1 and FIL-2

Resupply of railroad wheels final inspection line No. 1 (FIL-1) and No. 2 (FIL-2) of Wheels and Tires Shop OAO EVRAZ NTMK with equipment providing 100% magnetic particle control of railroad wheels on turn-key basis (Nizhniy Tagil, Russia).

January, 2012 - awarding of contract. As a work partner acts NPO INTROTEST (Yekaterinburg). Works are being performed on the operating wheels final inspection lines No. 1 and No. 2.

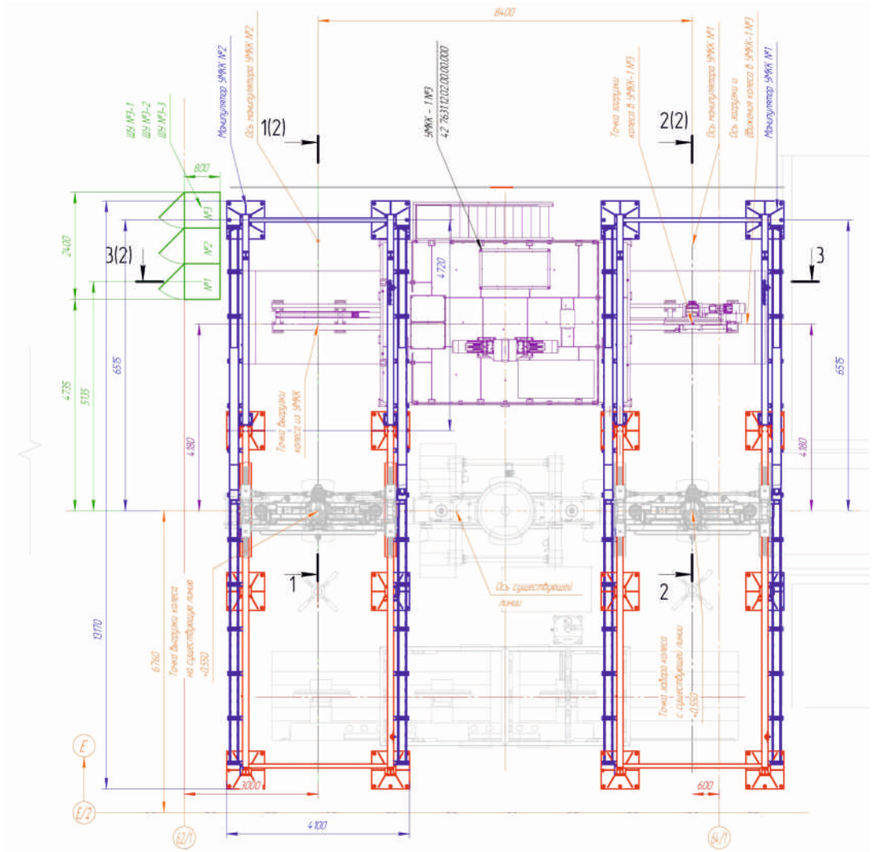
Within the framework of this project, SME TEC performs the following scope of work:

- Development of technical assignment, design and operational documentation
- Equipment manufacturing
- Equipment supply
- Modification of existing software for FIL Nos. 1, 2
- Installation
- Commissioning

Equipment supplied for FIL No. 2 includes the following:

- Magnet fluorescent inspection unit (UMKK-1) No. 3

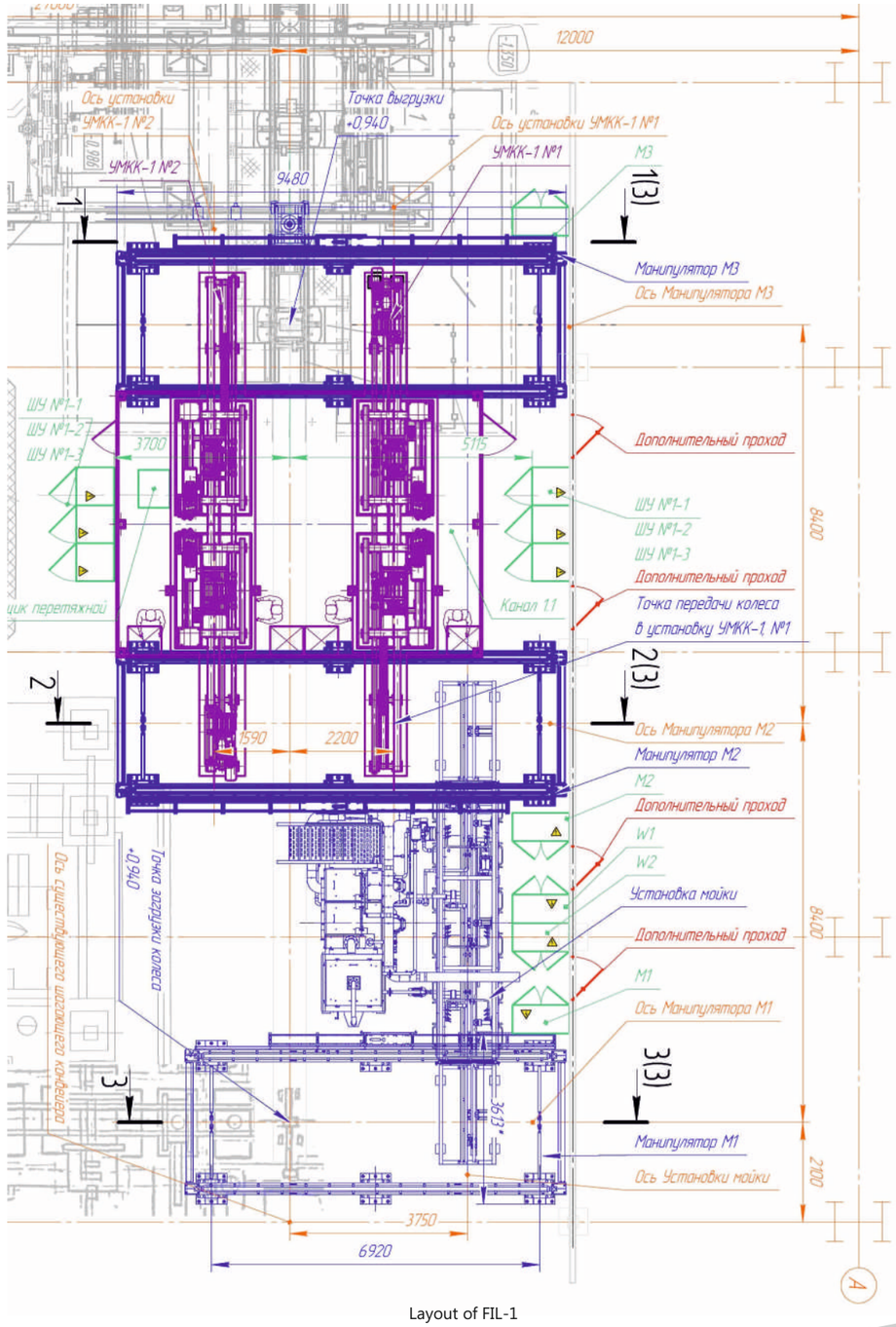
- Equipment under modification for OAO EVRAZ NTMK
- Equipment supplied by SME TEC Ltd.
- Electric Equipment
- Equipment supplied by ZAO NPO INTROTEST
- Existing equipment of OAO EVRAZ NTMK



Layout of FIL-2

Equipment supplied for FIL No. 1 includes the following:

- Manipulator M1
- Manipulator M2
- Manipulator M3
- Washing unit
- Magnet fluorescent inspection unit (UMKK-1) No. 1
- Magnet fluorescent inspection unit (UMKK-1) No. 2



Layout of FIL-1

Railroad Inspection Line for High-Speed Trains for MAANSHAN IRON & STEEL COMPANY LIMITED

During the period from May, 2011 to February, 2012 SME TEC Ltd. took part in implementation of project on production and control of railroad wheels for high-speed trains within the framework of contract with MAANSHAN IRON & STEEL COMPANY LIMITED (Maanshan, China).

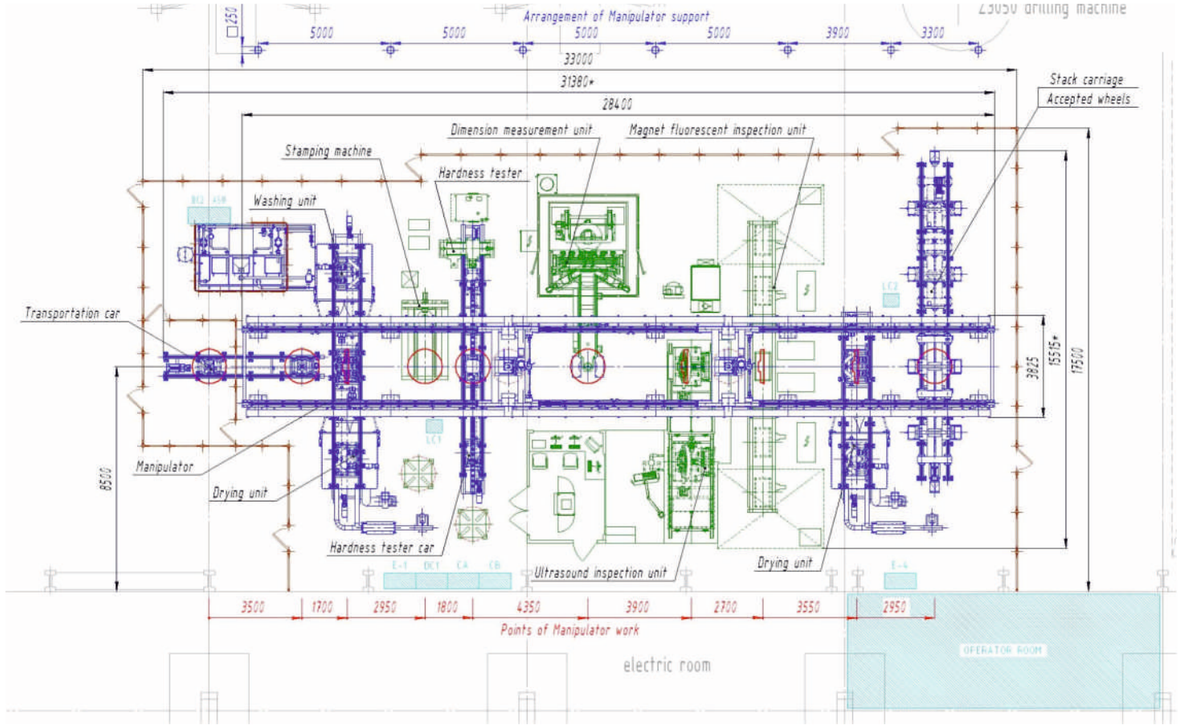
Within the implementation of this project SME TEC executed works on designing, design documentation development, manufacturing and supply of robotic transport system (27400 mm length), equipment loading/unloading of wheels onto/from the line, handling of railroad wheels for process units. There were also process units for surface treatment of railroad wheels for high-speed trains designed and manufactured. Commissioning work was performed during the period of September - November of 2012.

Technical Parameters

Line cycle time, sec/wheels	300
Wheel diameter, mm	From 770 to 1250
Maximum weight of wheel, kg	1000
Performance, wheels per year	100,000
Positioning accuracy along all axes, mm	0.5

The line includes the following equipment:

- Manipulator (TEC, Russia)
- Washing unit (TEC, Russia)
- Hardness control unit (Laizhou Huayin, China)
- Stamping machine (China)
- Dimensional measurement unit (Mermec, Italy)
- Ultrasound testing unit (NDT, Canada)
- Magnet fluorescent inspection unit (China)
- Drying unit (TEC, Russia)
- Painting and drying machine (TEC, Russia)
- Transportation cars (TEC, Russia)



Railroad Treatment and Inspection Line for Tangshan Wenfeng Shanchuan Train Wheel Co., LTD

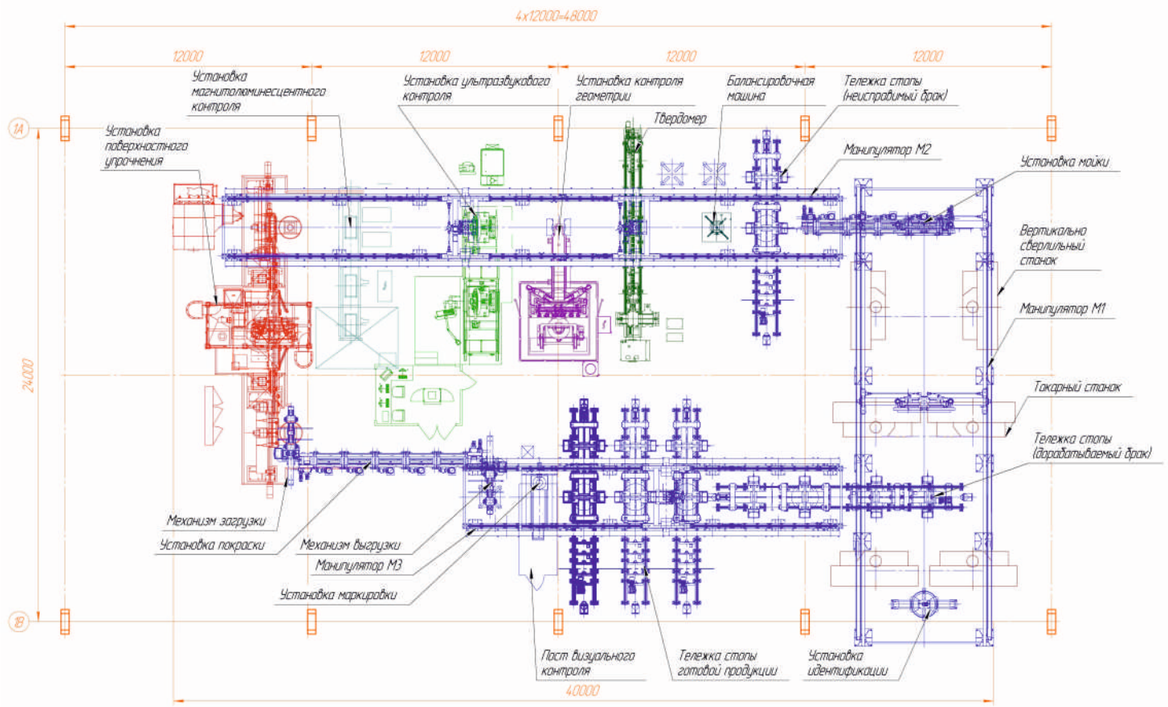
Specialists of SME TEC Ltd., developed a quotation on implementation of process line for treatment and control of railroad wheels for high-speed trains for Tangshan Wenfeng Shanchuan Train Wheel Co., LTD (Tanshan, China). The structure of this line advantageously allows supplying discarded wheels for retreatment.

Technical Parameters

Line cycle time, sec/wheels	300
Wheel diameter, mm	From 770 to 1250
Performance, wheels per year	100,000

The line includes the following equipment:

- Wheel number identification unit (TEC, Russia)
- Manipulators (TEC, Russia)
- Column type drilling machine (PITTLER, Germany)
- Lathes (PITTLER, Germany)
- Washing unit (TEC, Russia)
- Balance machine (Hofmann, Germany)
- Hardness control unit (Laizhou Huayin, China)
- Dimensional measurement unit (Mermec, Italy)
- Ultrasound testing unit (Fraunhofer, Germany)
- Magnet fluorescent inspection unit (Karl Deutsch, Germany)
- Shot-blasting machine (Wheelabrator, Canada)
- Painting and drying machine (TEC, Russia)
- Transportation cars (TEC, Russia)
- Loading and discharge devices (TEC, Russia).



Railroad Wheels Treatment and Final Inspection Line for Taiuan

Final inspection line of railroad wheels is aimed for automated inspection and real time control over acceptance testing operations of completed solid wheels after full profile mechanical treatment of the surface in compliance with the requirements of international standards.

Capacity

Standard railroad wheels, wheels per year	350,000
High-speed railroad wheels CRH3, wheels per year	50,000
Cycle time for standard railroad wheels, sec/wheel	60
Cycle time for high-speed railroad wheels, sec/wheel	300

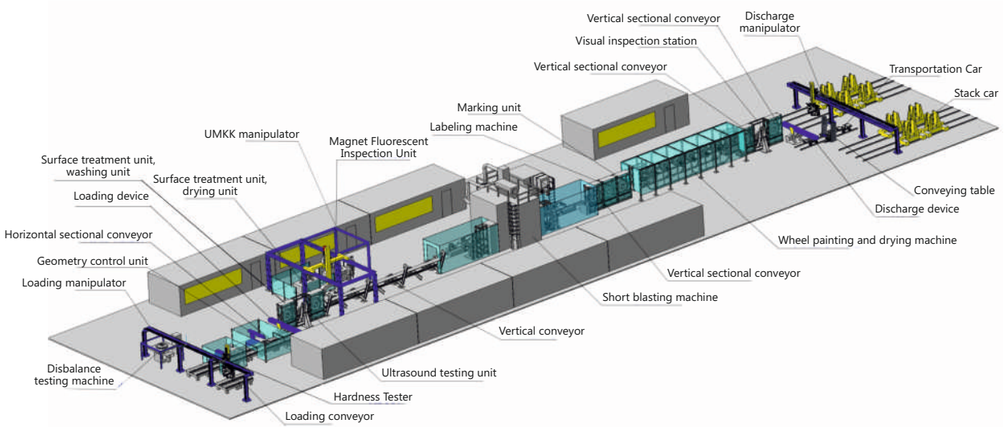
Equipment Configuration

- Disbalance testing machine (UKOD)
- Hardness testing machine (UKT)
- Dimensional measurement unit (UKG)
- Washing unit (UM)
- Surface treatment unit (UPP)
- Ultrasound testing unit (UUZK)
- Magnet fluorescent inspection unit (UMKK)
- Shot-blasting machine (UDO)
- Stamping machine (UNK)
- Painting and drying machine (UPK)
- Labeling machine (UNE)
- Transportation equipment

Goals of FIL Development

The main goal is development, manufacturing and introduction into commercial operation of automated FIL consisting of modern components and providing the following:

- Quality enhancement for manufactured railroad wheels
- Increase of production of railroad wheels with enhanced wear resistance
- Full automation of acceptance testing of railroad wheels:
  - Washing and drying of railroad wheels
  - Transportation of wheels through process area (unstacking, tilting, stacking or putting wheels into cassettes, gathering of discarded wheels into stacks)
  - Checking wheels disbalance
  - Checking dimensional parameters of railroad wheels
  - Checking hardness at of rim edge of the wheel,
  - Visual checking of surface defects
  - Ultrasound inspection of internal defects
  - Magnet fluorescent inspection of wheel surface
  - Shot blasting unit for wheel hardening
  - Applying of anti-corrosion protective painting
  - Applying diameter value on the wheel surface
  - Putting marking on the wheel surface
- Information support with generating full data sheets, recording all parameters and features of the wheel (painting, shot blasting, internal structure etc)
- Automatic control of parameters, providing regular operation mode of FIL
- Routine collection, processing, transfer and storage of data on the state of FIL process equipment
- Displaying of parameters, reflecting the process progress and provision of servicing personnel with actual data about failures in operation of FIL equipment
- Remote automated and automatic control over process equipment.



Lines and Complexes of Heat Treatment

Robotic Complex for Wheels and Tires Heat Treatment

In November, 2007 within the framework of the third stage of wheel-rolling production revamp at OAO Nizhniy Tagil Iron and Steel Works, under the contract with Andritz MAERZ GmbH Tomsk Electronic Company started developing conveying equipment and manipulators for Wheels and Tires Heat Treatment Line. On December 22, 2008 the first stage of the processing line was put into the operation.

Robotic complex for wheels and tires heat treatment is aimed for conveying the following production during heating, heat hardening and tempering:

- Railroad wheel blanks with D 710-1260 mm as per GOST 9036-88, GOST 10791-2004
- Wheel blanks for export as per standards UIC 812, M107/M208
- Wheel blanks for crane and other equipment with D 710-1260 mm as per TU 14-15-199-89, TU 14-102-170-96
- Carbon-steel wheel tires for broad-gauge railway rolling-stock, underground system and locomotives as per GOST 5000, UIC, ASTM
- Traction motor pinion blanks as per GOST P51220.

Materials for blanks and tires:

- Wheel steel as per GOST 10791
- Steel 20 - Steel 60 as per GOST 1050
- 45ХН as per GOST 4543
- 55Ф as per GOST P51220; ШС812; ВБ; М 107; Св 1804; ТВД2708; Т as per TU 0943-209оп-01124323-2005.

Weight of blanks is

from 280 to 1200 kg.

Within the framework of the project SME Tomsk Electronic Company as a Special Partner of Andritz MAERZ GmbH General Contractor provided the following services:

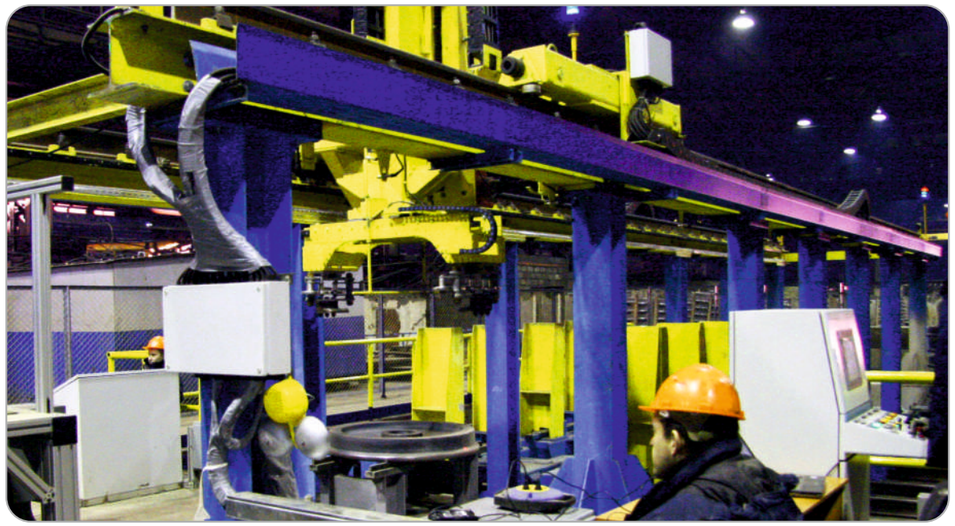
- Development and Customer approval of plan solution for the line including Andritz MAERZ GmbH equipment supply share
- Bringing Andritz MAERZ GmbH construction task in line with the Russian standards and formation of common construction task for the line
- Development of cost estimating documents for installation works including Andritz MAERZ GmbH equipment supply share
- Site equipment installation management and conclusion of contract for erection works with the local installation company
- Generation of report forms for equipment installation (KS-2, KS-3) for Andritz MAERZ GmbH
- Development of construction documentation and manufacture of equipment for Robotic Technology Complex
- Commissioning including connection with the existing rolling line.

Introduction of Complex for Heat Treatment enabled:

- Changing from production of wheels and tires with hardness 320 HB to production of wheels and tires with stable hardness values up to 360 HB.
- Blanks cooling maximum 50 ºC down after leaving a heating furnace and providing 28 seconds for wheel delivery from the heating furnace to the back line of hardening machines (15 meters).
- Integrating the line information space into the shop and rolling line information space that provides information tracking of metal from the moment of heating till the moment of products shipment.

Technical Parameters

Annual running time, hours	7436
Design capacity, pcs/h	100
Normal line cycle, not exceeding, sec.	36
Weight of the supplied equipment, t	500
Power consumption, kW	800
Positioning accuracy, mm	0.5
Lifting capacity, kg	5600
Line capacity, pcs	869



Rail Differential Heat Treatment by Means of Air According to TEC Technology

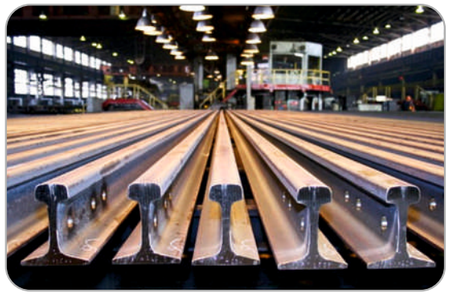
Since 2007 SME TEC has developed the aspects of heat treatment of rolled metal. The main aspect of work is heat treatment of railroad rails in accordance with GOST R 51685 draft requirements, European norm EN13674-1 and AREMA-standard.

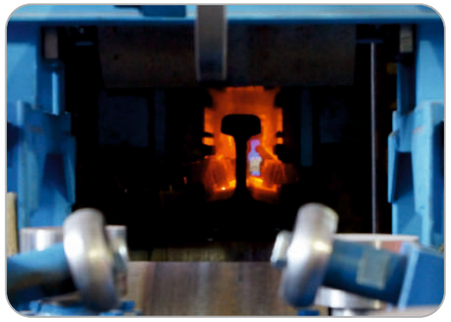
In 2007 the company developed and manufactured the first industrial module for rail heat treatment, enabling to receive the first positive results confirmed by findings of OAO NKMK laboratory. In 2009 SME TEC developed and started up the second industrial module, using which various process parameters were tried out. The positive results were confirmed by the following laboratories: CLK OAO NTMK (Nizhniy Tagil), OAO UIM (Yekaterinburg), VNIIZHT for compliance of heat treated rails with GOST R 51685 draft requirements.

SME TEC has developed and patented the innovation technologies of heat treatment of rails both rolled, TEC-DTP, and separate high-frequency current heating, TEC-DTO. These technologies are tested with the help of pilot-plant equipment produced by SME TEC Ltd.

In 2012 SME TEC conducted an open meeting on «Rail Differential Heat Treatment According to Modern Standards Based on TEC-TD Technology», which was visited by representatives of the following enterprises: OOO EVRAZ Holding, OAO EVRAZ NTMK, OAO EVRAZ SZMK, OAO CHMK, OOO UK Mechel-Stal, OAO UIM, OAO VNIIZHT, FGUP VNIIchermet, OOO RSP-M, OAO RZD, IFPM SO RAN, OOO Magnit-M.

The meeting resulted in signing a protocol, where metallurgical enterprises were suggested to consider the application of TEC-TD technology and machine for rail differential heat treatment as well as to extend technical cooperation with SME TEC.





Method of differential heat treatment based on TEC technology has a wide range of cooling speed regulation (2-14 grades per sec.) due to changing cooling properties of air medium by means of regulated changing air humidity as per desired law (gas medium).

This method allows implementing heat treatment of all rail steel grades with wide range of chemical composition: carbon, hypoeutectoid and hypereutectoid, microalloyed and alloyed steels.

Available permissions allow dispatching heat treated rails with capacity of 20 thous. tons up to 400 thous. tons per year using TEC-DTO technology, and from 20 thous. tons to 1 500 thous. tons per year using TEC-DTP technology.

Application of TEC-DTP and TEC-DTO technologies provides reduction of costs connected with rail production up to 3% due to reducing alloying agent consumption.

Based on TEC-DTP technology there are developed several versions of units with following features:

- Unit version TEC-DTP-S without heating and additional cooling system is the most energy-conserving one (37 kW/ton), it does not require firm surface temperature of rail head which is not below than 850°C at the outlet from the existing cooling bed. In case if rails with temperature which is below 830°C are moved into the unit, it is possible to heat-treat NT rails or to discard them.

- Unit version TEC-DTP-P with heating, without additional cooling system is an energy-conserving one (49 kW/ton), and provides required rail parameter under input temperature of rail surface of extended range, but not less than 750°C. It provides stable output of rails with required quality at significant deviations of rail surface temperature at the inlet of the unit.

- Unit version TEC-DTP-P with heating and additional cooling system is the most preferable one in view of energy consumption per ton (56 kW/ton) and quality of resulting rails. Whereas it provides required rail parameters under input temperature of rail surface of extended range, but not less than 750°C, and minimum deformation on cooling bed, and, accordingly, «soft» rail straightening with rail straightening machine. Herewith cooling bed capacity will be reduced, its structure will be simplified, and in practice it comprises a mechanized storage stand.

Patents:

- RU № 2369646 «Method of differential treatment of profiled mill products, in particular a rail, and appliance for it»

- RU № 2455362 «Method of rails heat treatment and appliance for it»

Applications for an invention:

- RU № 2011131833, patent decision d/d 25.02.13. «Method of rails heat treatment and its installation»

- RU № 2011144110, patent decision d/d 11.01.13. «Method of rails heat treatment and its installation»

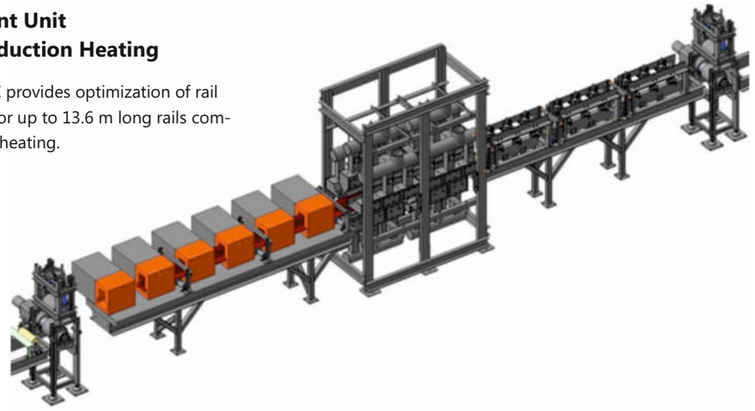
International applications:

- WO 2012/064223, EP 2573194. «Method of rails heat treatment and appliance for it»

- WO 2013/036166. «Method of rails heat treatment and its installation»

Rail Differential Heat Treatment Unit from Separate TEC-DT-13.6 Induction Heating

At the present time SME TEC provides optimization of rail heat treatment technology for up to 13.6 m long rails coming from separate induction heating.



Main Technical Parameters

Type of rails heat-treated	R65, 3 - 13.6 m long
Rail motion speed, m/min	regulated from 0.2 to 0.72
Reheat temperature,°C	regulated up to 1000
Cooling rate, °C	regulated from 2 to 14
Cooling medium	air with regulated humidity

The technology and modes for differential heat treatment of carbon and microalloy steel rails were optimized. This technology ensures rail quality according to GOST R 51685 draft requirements, provided the following:

- Fine-grained perlitic structure with colony dispersion within the range of 20 μm
- High level of physical and mechanical properties including impact strength of up to 0.4 MJ/m2
- Residual compression stress in all rail components.

The design and operating modes of industrial modules for heat treatment units for rails from rolling and separate induction heating were optimized.

DTO-TEC-13.6 Unit, constructed by SME TEC, allows to perform trial runs for optimization of rail heat treatment technology and modes to Customer's requirements including the following:

- Extending the range of components used for steel chemical composition in order to improve rail quality and optimize the operating costs
- Preparing test lots of rail samples for testing.

Guaranteed Rates of TEC-DTO-106 Unit

Advantages

This technology enables heat treatment of rails made not only from Eh76F steel but also from different other steel grades including hypereutectoid ones. This method allows setting the guaranteed heat treatment mode with required cooling rates at different stages providing optimization of overall cycle time of rail heat treatment.

Mechanical Properties of Rails After Heat Treatment

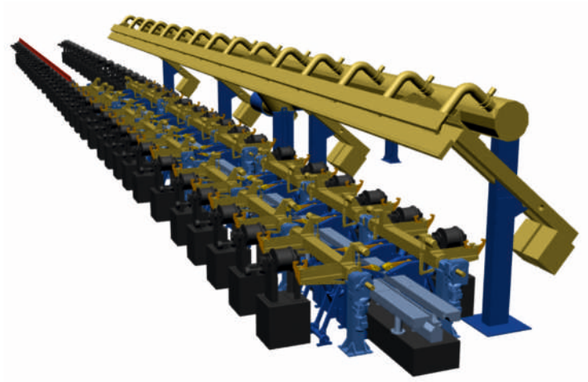
Strength grade	Ultimate tensile strength, N/mm^2	Yield stress, N/mm^2	Percent elongation, %	Percent reduction, %	Impact strength KCU, J/cm^2	Rail category
	nor less than					
DTO370	1290	900	12,0	35,0	15	ИК
DTO350	1180	800	9,0	25,0	25*	НН, СС, ВС

* - HH rail impact strength is determined at a temperature of -60°C

Hardness of Heat Treated Rails According to GOST R 51685-2000 Draft

Hardness measurement point	Hardness of DT350, DTO350HH, DTO350CC, DT350BC rails
On head tread surface	352 - 401
At a depth of 10 mm from the head tread surface along the vertical axis of rail	Not less than 341
At a depth of 22 mm from the head tread surface along the vertical axis of rail	Not less than 321
At web	Not less than 341
At base	Not less than 363

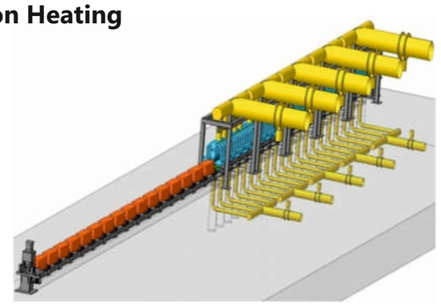
Differential Heat Treatment Unit for Rails Coming from Rolling Heat TEC-DTP



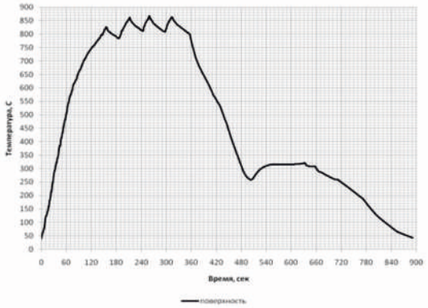
Main Parameters

Capacity, t/y	750 000
Nominal capacity of heat treatment unit for 26.5 m long rails, pcs/h	72
Length of rolled rails, m	26,5
Amount of rails to be treated simultaneously, m	4 x 26.5
Compliance of R65 rails with standard requirements	GOST 51685 draft
Specific power, kW/t	31

Differential Heat Treatment Unit for Rails Coming from Separate Induction Heating



Heat treatment line for rails up to 106 m of HFC-heating

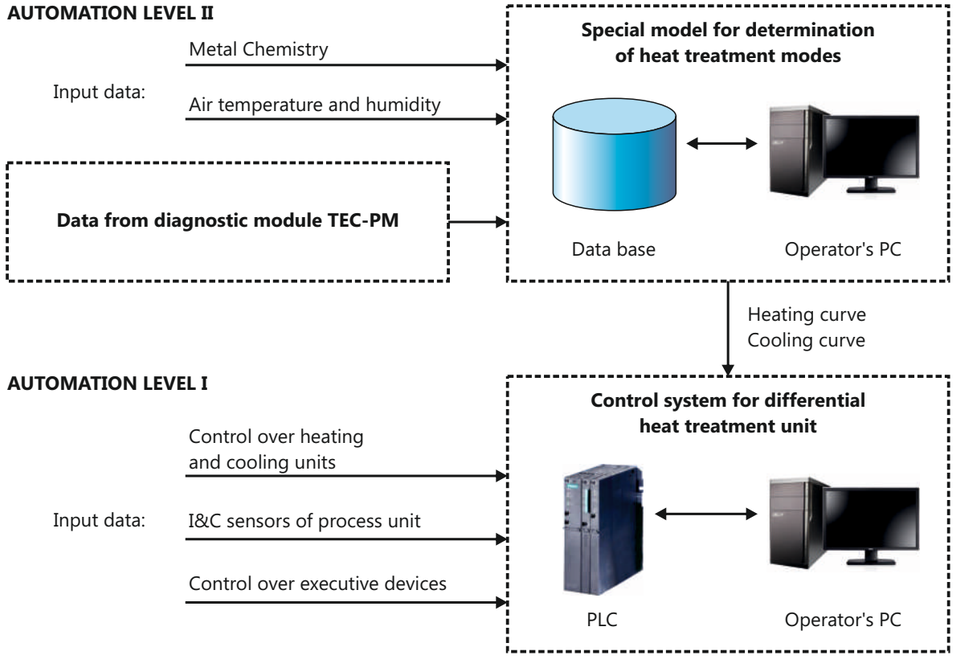


Surface temperature curve for rail made of 76F steel under heat treatment from induction heating

Control Structure of TEC-DT Units

1st level
Control System for Unit and Executive Mechanisms.

2nd level
Special model for determination of heat treatment mode depending on metal chemistry and rail type.

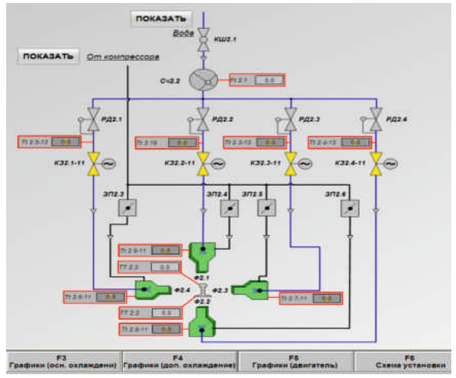


1. In order to provide fine adjustment of heat treatment modes there is developed a diagnostic module checking heating and cooling parameters. It is a measuring rail with host module checking temperature during the heating and cooling processes at different points of rail top and base («black box»).

2. Accuracy of heating and cooling modes during the heat treatment process is controlled by checking following parameters:

- Rail inlet temperature and rail temperature after each heating zone and after main cooling zone, as well as ambient air temperature and humidity
- Rail position, speed and travel force for TEC-DT
- Air pressure and flow rate in air blowers, top and base cooling casings water pressure and flow rate (g/sec) for each injection valve
- Operational parameters of heating equipment and mechanical systems.

3. Data logging, indication of limit values of controlled parameters, generation of a report on heat treatment mode mismatch in case of significant parameter overriding.

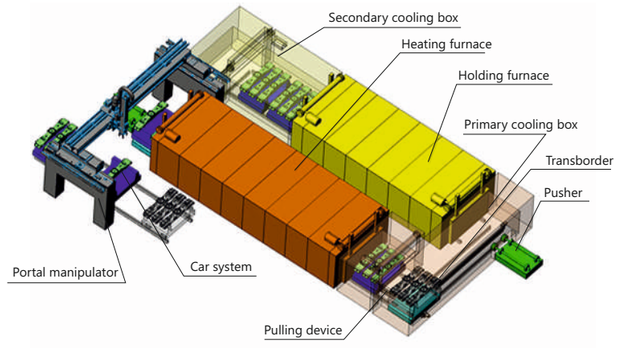


Videogram of the 1st level control system

Heat Treatment Line for Railroad Casting

Heat treatment line for railroad casting enables heat treatment of cast bars - side frame and bolster - for equalizing chemical inhomogeneity and grain size and obtaining mechanical properties specified by OST-32-183-2001.

When using this heat treatment technology a full phase recrystallization of 20GFL and 20GL steels occurs. By grain refining, relieving internal stresses and reducing structure inhomogeneity heat treatment facilitates an increase in plasticity and viscosity of products compared to mechanical properties received after casting.



Process Equipment

- Heating furnace
- Original cooling box
- Holding furnace
- Secondary cooling box
- Transportation system: cars, transborders, pushers, pulling head, rail tracks; car fixing devices.

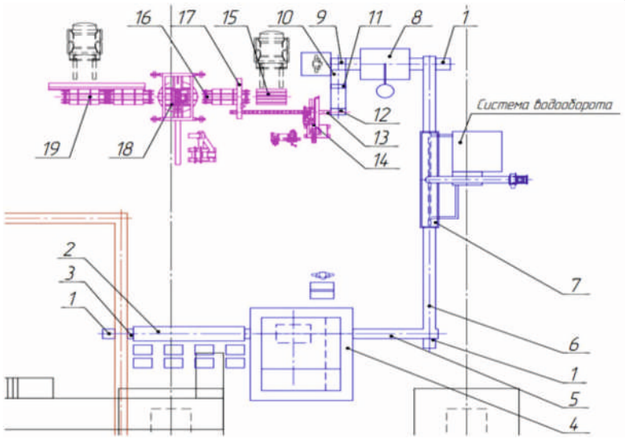
Technical Parameters

Capacity, pcs/h	10
Furnace heating	Electric
Operation mode	Three-shift
Annual working time fund, h/y	6000
Technical features of blanks to be heat treated	
Overall dimensions, mm	
Side frame	2413x671x580
Bolster	2590x480x486
Maximum wall thickness, mm	35
Weight, kg	
Side frame	399
Bolster	520
Material	20G1FL, 20GL steel as per GOST 977-88
Chemical composition, %	C - 0.14...0.21; Si - 0.5...0.8; Mn - 0.9...1.3; V - 0.07...0.13; S - up to 0.03; P - up to 0.035
Utilities	
Voltage, V/Hz	~380/50
Water, kgf/cm^2	5
Temperature, °C	12 - 25
Compressed air, kgf/cm^2	6

Rail Chair Production Line

Technical Parameters

Capacity, t/y	90 (can be extended up to 180 t/d)
Method of blank heating for stamping	Induction HFC heating
Heating temperature,°C	700±10
Equipment weight, t	90 (transportation equipment - 25 t)
Total power demand, kW	750
Air consumption, m^3/min	5 (P=0.5 MPa)
Service water consumption, m^3/h	6



Layout of Rail Chair Production Line

1 - Pusher
2 - HFC Heating Unit
3 - HFC Heating Unit Conveyor
4 - K1739 Press
5 - Roller Table
6 - Mechanical Cooling Bed
7 - Cooling Unit (spray irrigation and aspiration)
8 - Scarfing Machine with Conveyor
9 - Sampling Test Station
10 - Conveyor
11 - Turnover Device
12 - Package Store
13 - Package Table
14 - Packing
15 - Pallet Store
16 - Pallet Table
17 - Manipulator
18 - Packager
19 - Discharge Area Conveyor.

After cutting chair blanks off on the K04.119.240 single-point press they enter the existing transportation line. The rail chairs move on and upon reaching Pusher 1 (Pos.1) are pushed into induction heating area onto the Conveyor in the HFC area (Pos.3), where the chairs are heated by the HFC Heating unit (Pos.2) to the required temperature not exceeding 700°C.

The total installed capacity of HFC heating area is min. 900 kW. Supply voltage - 220/380 V. Heating current frequency is from 5 to 12 kHz.

The heating area consists of four induction heating elements having the installed capacity of at least 225 kW each. The induction heating element includes Frequency converter, water-cooled Transformer-matching device and inductor of at least 1 m length.

Between the induction heating elements there are intermediate zones of temperature equalization along the whole rail chair section.

Upon reaching the heating temperature chair blanks are handled onto the K1739 press (Pos. 4) piece by piece for piercing, and then in the chair discharge area Pusher 1 moves them onto the roller table (Pos. 5). By the roller table (Pos. 5) chairs are fed into the cooling area consisting of mechanical cooling bed of at least 5 m length (Pos. 6) and cooling unit (Pos.7), where blanks are cooled down to the temperature not exceeding 60°C. The cooling unit includes water-air nozzle system, which provides differential supply of cooling medium to various components of rail chair profile, and auxiliary systems (receivers, filters, pumps). Water consumption does not exceed 4 m^3/h.

After the cooling unit the pusher forwards blanks to the scarfing machine (Pos. 8), where burrs are removed and chair edges are machined. Then blanks are transported to the sampling test station (Pos. 9) and moved by the conveyor (Pos.10) to the turnover device (Pos. 11) and package store (Pos. 12). Package table (Pos. 13) brings a package into the packager (Pos. 14) and moves along the line till the manipulator (Pos. 17). The manipulator puts the packages onto pallets, each pallet is brought into the packager (Pos. 18) and then onto the discharge area conveyor (Pos. 19).

Transportation Equipment for Railroad Casting Normalizing

Transportation equipment is aimed for mechanization and automation of loading and discharge processes of normalizing furnace, blank transportation after the furnace through the cooling bed and handing over to the branch conveyor.

Transportation equipment for railroad casting normalizing provides blanks conveying between process units.

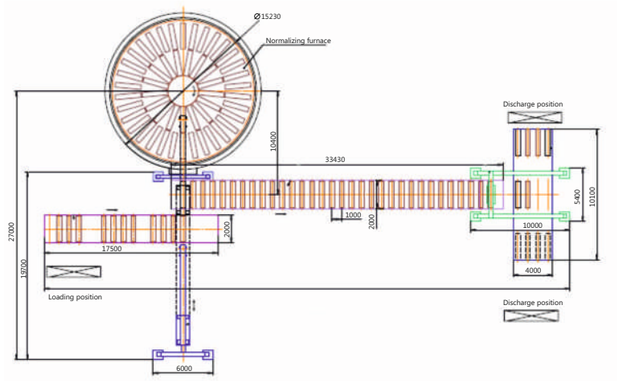
Transported Blanks

Bolster 100.00.001-5	
Overall dimensions, mm	2590 x 480 x 403
Weight, kg	520

Side frame 100.00.002-4	
Overall dimensions, mm	2413 x 554 x 651
Weight, kg	399

Technical Parameters

Performance, max, pcs/hour	15
Temperature of blank heating in the furnace, °C	950
Blank temperature as leaving the mechanical cooling bed, °C	60
Blank cooling period, h	2
Wattage (without furnace), kW	80
Weight of equipment (without furnace), tons	90
Operation mode	24-hour, three-shift



Transportation equipment consists of the following:

- Stack car
- Transfer table
- Transportation cars
- Manipulators
- Mechanical cooling bed.

Blanks being transported to normalizing area using the shop handling equipment are put by operating personnel onto base elements of a stack car. The stack car is designed for placing four blanks. Once the loading is complete the car moves to a transfer table. The transfer table lifts the blanks and the stack car returns to the loading position.

Then a transportation car comes to the transfer table and the table puts the blanks down onto its base elements. The loaded car is transported to manipulator and moving in single-step mode it places the blanks under manipulator gripper. When four blanks are loaded into the furnace, the transportation car moves to the transfer table for a new lot of blanks.

The manipulator moves the blanks into the normalizing furnace and puts them onto furnace hearth guides. Upon completion of heating and normalizing cycle the blank is picked up by the manipulator and discharged from the furnace onto the mechanical cooling bed. Then the manipulator puts the next blank onto free place.

Moving through the mechanical cooling bed in single-step mode the blanks are cooled down to 60°C.

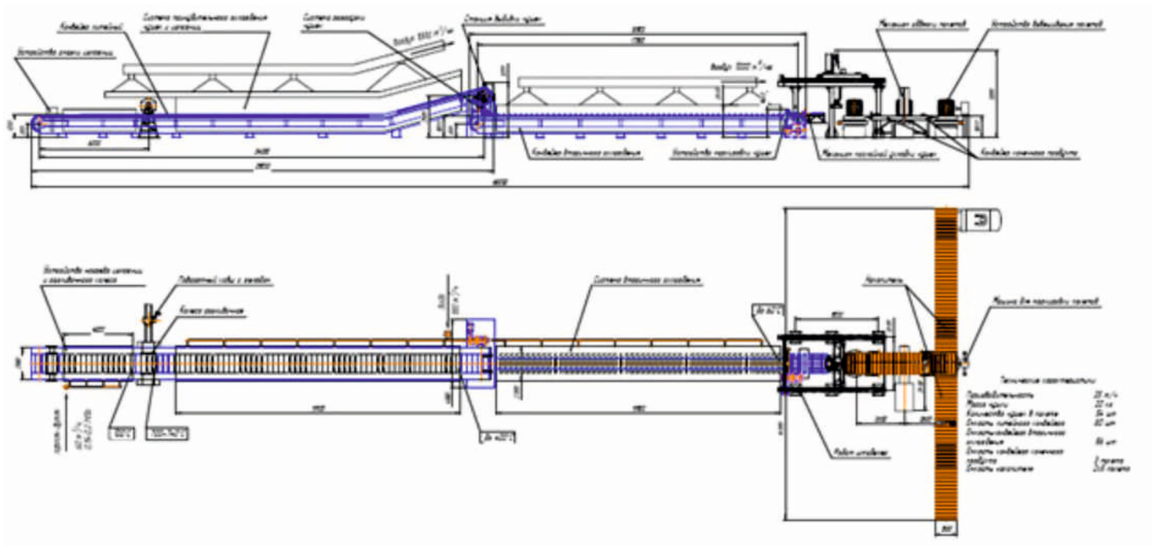
After cooling the manipulator transfers the blanks from the mechanical cooling bed to the transportation cars. Two transportation cars are brought to transfer position by turn. The car loaded with four blanks is transported to the discharge position.

Ingot Molding and Packaging Line

Ingot molding and packaging line is aimed for aluminum ingots production of 20 kg and enables to provide the following automated process: metal molding, cooling and marking of ingots, layer-by-layer packaging, strapping and marking of packages.

Technical Parameters

Capacity, t/h	25
Ingot weight, kg	20±3%
Package weight, kg	Up to 1100 (54 ingots in package)
Product	Pure aluminum
Ambient temperature, °C	From 10 to 41
Liquid metal temperature at molding station, °C	From 700 to 740
Ingot temperature, °C	After primary cooling <400 After secondary cooling <60
Capacity of ingot stacker, ingots/hour	1250 (nominal)
Noise level, dB (A)	Average value of 80 at working stations
Number of operators, persons	2 (for line) 1 (for forklift loader)



Molten primary aluminum extracted from electrolytic cells by means of vacuum ladle is fed into cast house for removing nonmetallic and gaseous impurities and further treatment into marketable products (ingots). Before casting liquid aluminum is held in molten state in mixers.

Casting aluminum from the mixer into ingots of casting conveyor is performed by molding station. The molding station includes a chute with metal level control system, casting wheel and tilting ladle for aluminum dump in emergency case.

The casting wheel provides batch wise filling of molds with aluminum. Before filling the molds are prelubed and preheated. By moving through the casting conveyor ingots are forced cooled down to 400°C. At the end of the casting conveyor ingots are released from the molds and automatically put onto a secondary cooling conveyor.

During transportation through the secondary cooling conveyor ingots are forced cooled down to 60°C and marked.

Then the layer-by-layer stacker places individual ingots onto the storage table and turns them over for 180°, if required. A layer of ingots is formed on the storage table. The robot transfers the ingot layer onto a finished product conveyor.

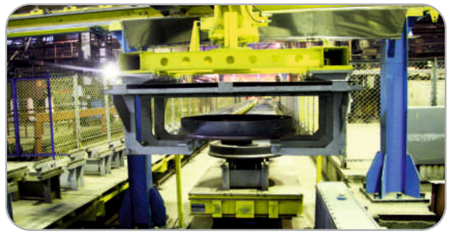
A package of ingots in required quantity is formed on the conveyor. The conveyor moves the finished package to a package storage facility. During package transportation through the conveyor it is strapped, weighed and marked. The storage facility is provided for temporary storage of up to 10 ingot packages. From the storage facility packages are transported to the finished products warehouse.

Ingot molding and packaging line consists of the following:

- Molding station (chute, metal level control system, tilting ladle, casting wheel)
- Casting conveyor
- Mold lubricator
- Mold and casting wheel heater
- Mold and ingot forced cooling system
- Ingots release station
- Ingot discharge system (placing onto the secondary cooling conveyor)
- Secondary cooling conveyor
- Secondary cooling device
- Marking device
- Layer-by-layer stacker
- Robot
- Finished product conveyor
- Strapping machine
- Weighing machine
- Package marking machine
- Storage facility for packages.

Robotic Transport Systems and PCS

In any industry, in addition to the main production machinery and devices, that are «vital organs» of the company, it is not possible to manage without «blood circulatory system» - transferring equipment and systems. Accurate and continuous operation of transport systems, that makes a connection between various operations and processing, directly affects on amount and quality of products.



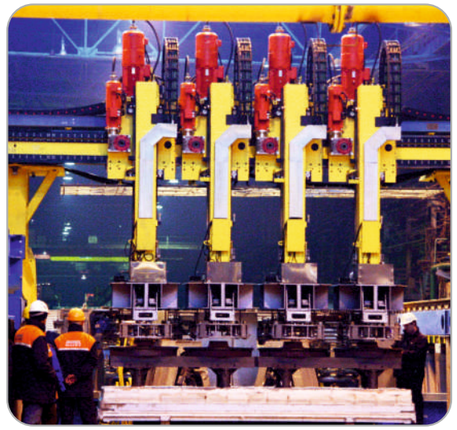
Tomsk Electronic Company has all the necessary potential that allows developing and manufacturing various types of conveying equipment for metallurgical, oil and gas, nuclear and energy industries, including those working in aggressive operation conditions.

Over the years Tomsk Electronic Company developed and put into production the following types of conveying equipment:

- Manipulators, including the high positioning accuracy and complex motion pattern and motion dynamics
- Tilt mechanisms
- Pick and place mechanism.

SME Tomsk Electronic Company offers a full range of services in assessment, designing, manufacturing, supply and commissioning of the conveying equipment of both cold and hot metal, selection, delivery and integration of the major process equipment, integrated production automation, including providing metal information support.

Availability of highly qualified specialists, full range of technologies of electronic, electrotechnical, machinery productions and experience of effective organizational management as a General contractor allows SME TEC realization of the projects of integrated enterprise automation and integration of equipment from different manufacturers and suppliers in single technological complex with single information space.

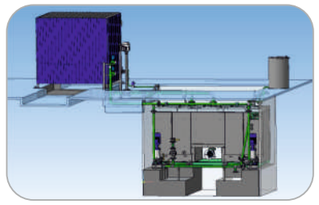


Process Equipment

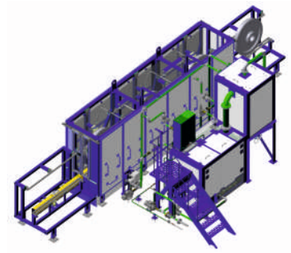
Surface Treatment Unit

The unit is designed for operation as part of processing lines and removal from products surface of metal-working oils and dust. Given unit is used for product surface preparation before conducting control operations. SME TEC produces units with transport systems of two types:

- Product is transported in the unit horizontally. This type unit was implemented for MAANSHAN IRON & STEEL COMPANY LIMITED (Maanshan, China)
- Product is transported in the unit vertically. This type unit was implemented for OAO EVRAZ NTMK (Nizhniy Tagil, Russia).



Unit of Surface Preparation with Horizontal Load



Unit of Surface Preparation with Vertical Load

Units are made of two types: face-to-face and on-go.

Description	Surface treatment unit of on-go type	Surface treatment unit of face-to-face type
Product	Railroad wheel	Railroad wheel
Weight, kg	Not exceeding 1000	Not exceeding 1000
Overall dimensions, mm	Ø770 - 1250	Ø720 - 1270
Overall dimensions, mm	2122 x 2055 x 2040	1500 x 2550 x 10200
Weight, g	6.02	8.3

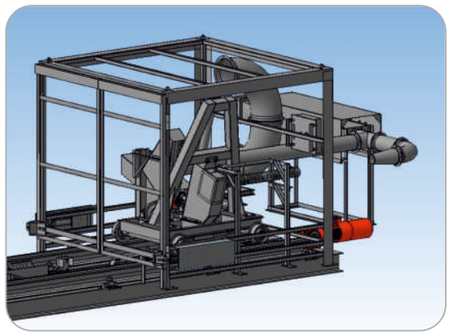
Surface Corrosive-resistant Treatment Unit

Unit is designed for operation as part of processing lines and surfacing of paint coating on the product with its following drying.

Drying Unit

Unit is designed for operation as part of processing lines and removing of moisture from product surface.

Description	Drying unit of no-go type
Product	Railroad wheel
Weight, kg	Not exceeding 1000
Overall dimensions, mm	Ø770 - 1250
Overall dimensions, mm	2122 x 2055 x 2040
Weight, g	6.02

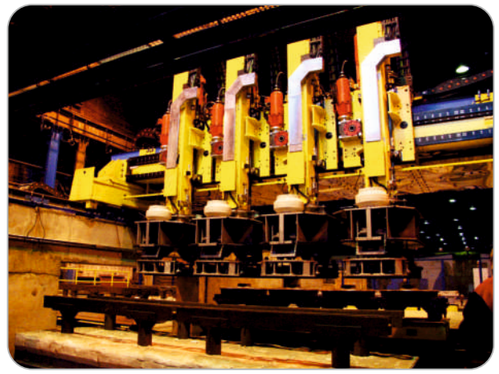


Manipulator Type 1

Technical Parameters

Dimensions (WxDxH), mm	23450x29100x4760
Minimum diameter of blank to be loaded, mm	710
Maximum diameter of blank to be loaded, mm	1270
Elevation (along Axe Z), mm	1200
Maximum lateral travel for grips, mm	450
Manipulator travel along the rail track (along the X axis), mm	20,600
Manipulator weight, kg, not exceeding	90,000
Maximum weight of blank to be loaded, kg	1200
Number of grips, ea.	4
Total nominal power demand of actuators, kW	168.4
Voltage of three phase power line for motor supply with frequency of 50 Hz, V	380-10%...480+10%
Maximum velocity of vertical displacement, m/s	0.53
Maximum velocity of horizontal dis-placement of trains (along Axe Y), m/sec	0.33
Maximum conveying speed along the railway track (along Axe X), m/s	2
Climatic version as per GOST 15150-69	UHL 4
Specified service life of manipulator, years	10

Manipulator Type 2



Technical Parameters

Dimensions without wheel to be loaded (WxDxH), mm	9320x15420x4950
Minimum diameter of wheel to be loaded (dimensional), mm	710
Maximum diameter of wheel to be loaded (dimensional), mm	1260
Elevation (along Axe Z) , mm	300
Maximum lateral travel for grips (along Axe X), mm	10,500
Manipulator weight, kg, not exceeding	38,500
Maximum weight of blank to be loaded, kg	1200
Number of grips, ea.	4
Total nominal power demand of actuators, kW	91
Voltage of three phase feeding circuit, V	380±10%
Ferquency of feeding circuit, Hz	50±1
Maximum velocity of vertical displacement (along Axe Z), m/s	0.53
Maximum velocity of horizontal displacement (along Axe X), m/s	0.77
Climatic version as per GOST 15150-69	UHL 4

Manipulator Type 3

Technical Parameters

Dimensions without wheel to be loaded (WxDxH) without beacon lights, mm	3240x10820x5700
Minimum diameter of wheel to be loaded (dimensional), mm	710
Maximum diameter of wheel to be loaded (dimensional), mm	1260
Elevation (along Axe Z), mm	1636
Maximum lateral travel for grips (along Axe X), mm	6800
Manipulator weight, kg, not exceeding	12,500
Maximum weight of blank to be loaded, kg	1200
Total nominal power demand of actuators, kW	23.1
Voltage of three phase feeding circuit, V	380-10%...480+10%
Maximum speed for horizontal grip moving, mm per sec	1.81
Travel time towards working operation value, s	6
Climatic version as per GOST 15150-69	UHL 4

Manipulator Type 4

Technical Parameters

Dimensions without wheel to be loaded (WxDxH) without beacon lights, mm	3862x28400x7374
Minimum diameter of wheel to be loaded (dimensional), mm	770
Maximum diameter of wheel to be loaded (dimensional), mm	1250
Elevation (along Axe Z), mm	1600
Maximum lateral travel for grips (along Axe X), mm	6800
Manipulator weight, kg, not exceeding	26,154
Maximum weight of wheel to be loaded, kg	1000
Total nominal power demand of actuators, kW	48
Voltage of three phase feeding circuit, V	380-10%...480+10%
Car movement rate, m/s	1.29
Velocity of Axe Z lifting, mm/sec	0.46
Climatic version as per GOST 15150-69	UHL 4

Manipulator Type 5

Technical Parameters

Dimensions without wheel to be loaded (WxDxH) without beacon lights, mm	4205x8110x5792
Minimum diameter of wheel to be loaded (dimensional), mm	920
Maximum diameter of wheel to be loaded (dimensional), mm	1070
Elevation (along Axe Z), mm	567
Maximum lateral travel for grips (along Axe X), mm	3750
Manipulator weight, kg, not exceeding	10,500
Maximum weight of wheel to be loaded, kg	750
Total nominal power demand of actuators, kW	16
Voltage of three phase feeding circuit, V	380
Car movement rate, m/s	0.55
Velocity of Axe Z lifting, mm/sec	0.14
Climatic version as per GOST 15150-69	UHL 4