THE ENCLOSED PROPOSAL SUBMITTED EXCLUSIVELY

To

Therm-Tech of Waukesha
USA

For

THREE CHAMBER VACUUM FURNACE
TYPE CME T12
WITH OIL QUENCHING SYSTEM

SECO/WARWICK Proposal No. **18736-1-0-10-SWC-VAC**

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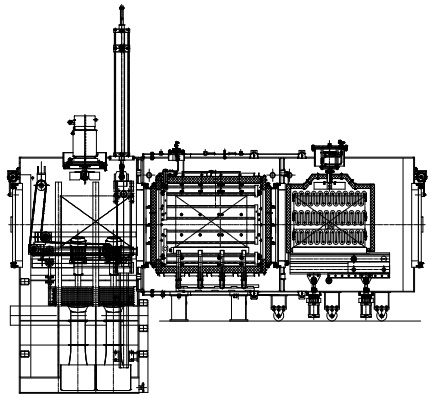
1. SCOPE

In general, this proposal provides that **SECO/WARWICK S.A.** (hereinafter referred as SECO/WARWICK) shall furnish:

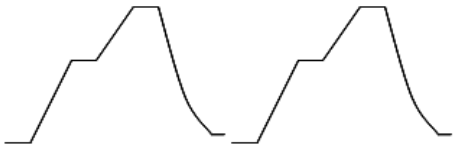
One (1) Three Chamber Vacuum Carburizing Furnace type CME T12 with Oil Quenching System

to **Therm-Tech of Waukesha** facility (hereinafter referred to as PURCHASER).

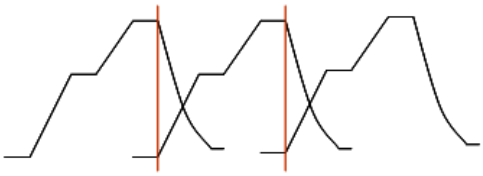
The CME D12 is furnace is a three-chamber furnace with separate loading vestibule with preheating system, heating chamber and oil quenching chamber. Furnace is loaded through the vestibule door. Than the charge is being preheated up to 1400°F [750°C] in the loading vestibule. Up to 660°F [350°C] the load is going to be pre-oxidized. Then the chamber is evacuated, and when the charge obtains 1400°F [750°C] and the heating chamber is empty, the thermal and the pressure door separating both chambers are lifted to the upper position and the load is transferred to the heating chamber. While the heating cycle continues, the loading vestibule is pressurised up to ambient pressure with neutral gas and the second charge is being loaded into the vestibule. Upon completion of heating cycle, the first load is transferred to the quenching chamber where it can be cooled down in neutral gas or oil. Afterwards the second charge is transferred to the heating chamber under adequate pressure. During the heating of the second charge the third one is being loaded into the vestibule. The rest of the operation goes in the same sequence.



Typical **CMe**® furnace type T



Typical Process Flow Chart of 1 and 2 chamber furnaces



Process Flow Chart of the 3 chamber furnace in continuous production.
Increase of productivity with the help of 3 chamber furnace.

Convection heating system ensures rapid and uniform heating of the load also in low temperatures, which allows shortening the heating-up time.

Durable graphite insulation and heaters provide long, reliable service in this heavy-duty furnace designed for the industrial work place. Cooling may be carried out in two ways: in neutral gas or in hardening oil.

High efficient oil agitation system ensures excellent oil penetration through the load which result in uniform and fast charge cooling.

The pumping system, power supply and cooling systems are generously sized to enable, a wide range of industrial heat treatment applications including quench hardening and tempering, degassing, annealing solution heat treatment and low pressure carburizing.

The quenching chamber vessel will be manufactured for operation at the pressure **of 29PSI [2 bar abs]** according to **EC 98/37 Machinery Directive**. The cylindrical vacuum chamber with water jacket cooling system is horizontally oriented for front loading and discharging. The vessel is made of carbon steel, sand blasted and painted with vacuum epoxy paint. The furnace is able to operate between 0-29Psi [-1/+1 bar] of working pressure.

This offer remains valid during thirty (**30**) days from the date of its issue.

1. SCOPE–continued

THE MAIN ADVANTAGES OF SECO/WARWICK VACUUM FURNACE:

- **Cost & Time reduction** of carburizing process (acc. to **FineCarb®**) in comparison to conventional technologies
- **High quality** (**clean and bright**) parts following heat treatment
- **Reliability**
- Very good **Process Repeatability**
- **No** load **Decarburization** and **Oxidation**
- **Minimisation of** quench **Distortion**
- **Environmental friendly – No CO_2 emission**
- **Optimal Processing Gases Consumption**
- **Full Automation** of the **Thermal** and oil **Hardening Processes**
- **Computer Control System** is equipped with a **Visualization System** (In Touch Wonderware)
- **Easy Process Set Up** and visual display of the process parameters
- **Data Archiving** and **Reporting System**
- **Universality of the Furnace** can be used for both hardening and other heat treatment processes
- **Compact Construction** requires a small installation area

2. FURNACE SPECIFICATIONS

There are two main components which form part of the whole furnace, these are:

A.LOADING VESTIBULE – PREHEATING CHAMBER

Cylindrical loading chamber with water jacket is horizontally oriented for front loading. The water jacket of the vessel is equipped with a safety valve protecting the walls from overpressure of the cooling water. The chamber vessel wall contains the vacuum pump port and penetrations for power feedthroughs, system gauging, and instrumentation. The vessel is made of carbon steel, sand blasted and painted with vacuum epoxy paint. Charge loading operation is being done through the vestibule vacuum-tight, insulated door by means of external, mobile loading equipment, to a predetermined position. An automatic, right-side driven front door provides first of all an access for charge loading, periodic cleanup and system maintenance. A special type pneumatic seal, located in the groove of the front door's flange ensures (flange-to-flange) tightness of the furnace vestibule casing and the front cover.

- **Simple door closing mechanism**
- **Prolonged service time of door sealing - no movement against mating flange**

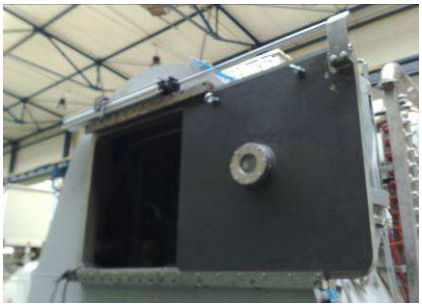


Fig.2 **Manual loading door**

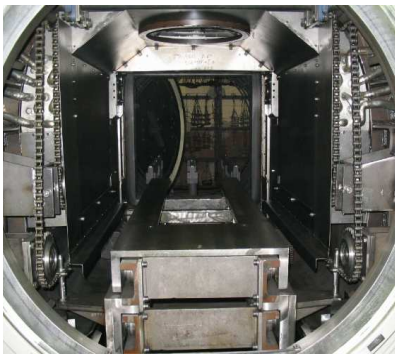


Fig.3 **Vestibule view with an elevator and cooling blower**

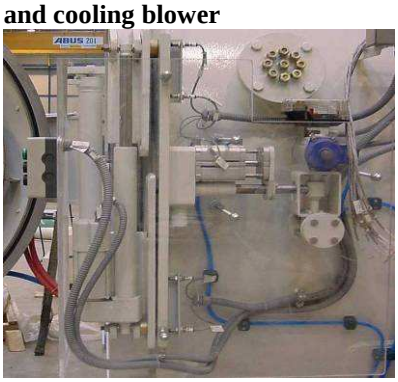


Fig.4 **Manual door closing mechanism**

The front door closing mechanism driven by pneumatic cylinder allows positive pressure operations.

There is a heating system installed in the hot zone, which enables to heat up the charge up to 1400ºF [750°C]. The process takes place under air atmosphere in temperature up to 660ºF [350°C] and

afterwards is being carried out under vacuum up to 1400ºF [750°C].

There is a convection fan fixed to the heating chamber ceiling for the purpose of the rapid heating, and uniformity of the temperature during the convection heating cycle. The fan's blade is fabricated from heat resistant steel for high temperature mechanical strength and is able to operate up to **1450ºF [800°C]** in the convection heating cycle.

The power feedthroughs are manufactured from copper and provide vacuum and pressure-tight connections with the heating element power terminals. The wire type heating elements are placed horizontally on both sides of the furnace along the loading vestibule. They are mounted on the lids as packets, which ensures easy mounting and dismounting.

The vestibule heating system contains one (1) heating zone. The temperature is measured by means of double thermocouple placed in the furnace ceiling. One of them is connected to protecting controllers securing the chamber from excessive temperature increase.

The load is supported on the hearth rails running from the front to the back of the hot zone, which are made of heat resistant steel.

The vestibule contains horizontal transfer mechanism for an automatic transfer of the load into the heating chamber.

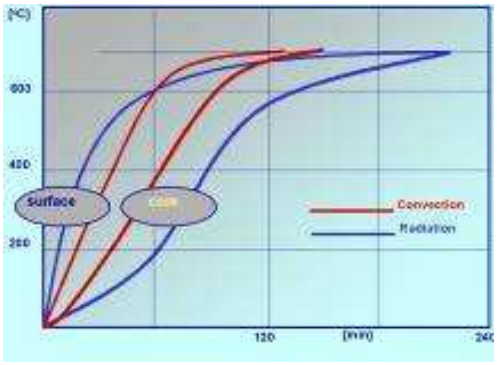


Fig.5 **Comparison of effectiveness of heating up in convection & radiation cycle**.

Fig.6 **Convection fan**.

B. HEATING CHAMBER

The casing of the heating chamber is a cylindrical, double wall construction cooled with the water, made of mild steel. The water jacket of the vessel is equipped with a safety valve protecting the walls from overpressure of the cooling water. The chamber vessel wall contains the vacuum pump port and penetrations for power feedthroughs, system gauging, and instrumentation. Power feedthroughs are manufactured from copper and provide vacuum- and pressure-tight connections with heating

element power terminals. A safety valve protects the vacuum chamber against an unexpected rise in backfill gas pressure during disturbances of gas filling over 29PSI [+1bar]. The vessel is supported from the operating floor by a structural steel weldment and is welded to the quenching chamber. There is a pressure, insulated inner door on the both sides of the heating chamber, which are being moved horizontally into a special shaped door's pocket, located at the right side of the vessel by an pneumatic cylinders, for loading and unloading operations. The vacuum tightness between the loading vestibule and the heating chamber and the quenching chamber during the cycle, is ensured by a pneumatic seal, located in the groove of the heating chamber pressure-door's flanges. When the door is in the closed position the seal is being pressurized to eliminate the gap between mate flanges and to provide leak tight connection. The steady, horizontal run of the door is provided by a guide-bars, which are situated on the top & bottom of the door.

The hot zone is designed for optimum temperature uniformity and rapid heating. Low weight heating elements are assembled from graphite pipes which cover surface around the workload to provide an optimum heat transfer to the charge. The elements and power terminals are supported from water-cooled feedthroughs on the wall of the cubical heating chamber and are accessible from the hot face side of the

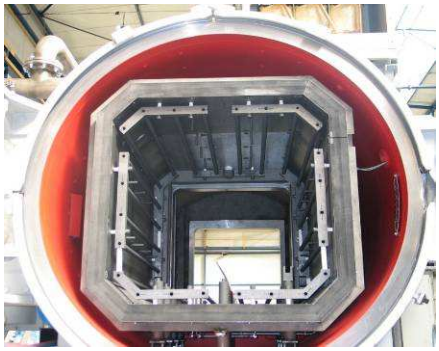


Fig. 7 **Hot zone**.

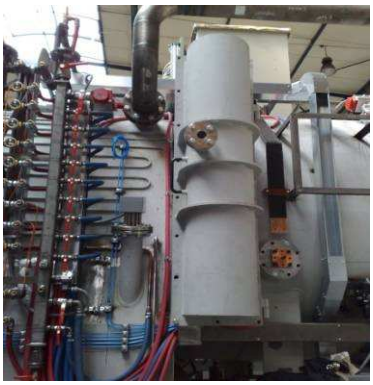


Fig.8 **Thermal door pocket**.

thermal insulation assembly. The hot part of the power terminal is fabricated from graphite and it is electrically isolated by a ceramic sleeve, where it passes through the heat shield. Each graphite terminal is directly coupled to one of the copper power feed throughs in the space between the hot zone and vacuum vessel.

The load is supported on the ceramic inserts by graphite hearth rails running from the front to the back of the hot zone. Graphite piers, mounted on the cold wall chamber, support the hearth rails.

The hot zone insulation assembly comprises an optimum combination of graphite and ceramic materials, which are supported by a rectangular steel structure. The complete

chamber can be easily removed from the vessel through the opening after previous dismantling the loading vessel from the casing of the heating chamber. The insulation pack includes: ceramic fibre, high purity graphite felt with a graphite CFC board lined from the hot side of the heating chamber. Modular design of the hot zone, ensures an easy maintenance and repair operations. It has been designed to obtain an optimal temperature uniformity and speed of heating up. Presented solution ensures the temperature uniformity in the range of **±10ºF [±5°C]**.

C. QUENCHING SYSTEM

The cooling chamber consists of oil tank and vestibule which is a superstructure of the tank. The vestibule contains horizontal transfer mechanism for an automatic transfer of the load to / from the heating chamber. Another, vertical transfer mechanism is applied for lowering the charge into the oil bath after heating cycle. The elevator is driven by a pneumatic cylinder.

The bottom part of the vestibule contains an oil bath with appropriate oil heating elements, oil heat exchanger and agitators with continuously adjustable rotational speed. The bath temperature is being automatically controlled in the range up to **140ºF [60ºC]** before quenching.

The double-wall vacuum vessel of the heating chamber and single-wall furnace vestibule are separated with an vacuum-tight, insulated inner door which are installed in the middle. This allows to run high vacuum processes without any influences from an oil vapours created in the quenching chamber. There is a cooling blower installed at the top of the vestibule which allows for gas cooling operation – **optional (not included in this offer)**.

Upon the completion of the heating cycle the load is transferred to the quenching chamber, where various cooling methods, depending on technological requirements, can be applied. These are:

- Cooling in the neutral gas - ***OPTIONAL***
- Cooling in the forced oil circulation having the neutral gas over the oil bath.

C1. QUENCHING OIL CONDITIONING

There are features available to maintain the proper quenching oil parameters as follows:

- Oil level and temperature monitoring
- Oil heaters enable preliminary to heat the oil up **140ºF [60ºC]**.
- Oil cooling system
- Oil agitators with variable rotational speed
- Flow direction guides ensure uniform flow of the oil through the charge

C2. OIL COOLING & AGITATING SYSTEM

The main goal of the cooling system is to prepare the oil, to the set level of temperature before the hardening stage, as well as to not let the temperature to increase above required level during quenching operations. Cooling system consist of two subsystems, which are provided to remove the heat from oil during and after oil quenching process. The first one include an **OIL(Hardening oil) / OIL (Cooling medium)** heat exchanger, which is located in the oil tank – direct cooling of hardening oil. The second one, the external circuit of an oil circulation includes circulation pump and heat exchanger – which is responsible for cooling the oil – cooling medium.

Depending on the application there may be:

- Air Blast Cooler

OIL/AIR

- Plate Heat Exchange

OIL/WATER

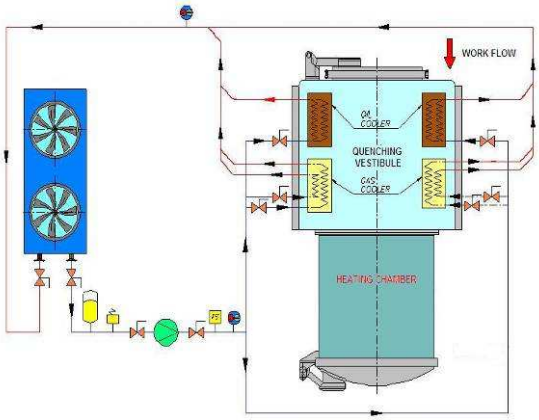


Fig.9 **Oil cooling system with an air blast cooler – pictorial view**.

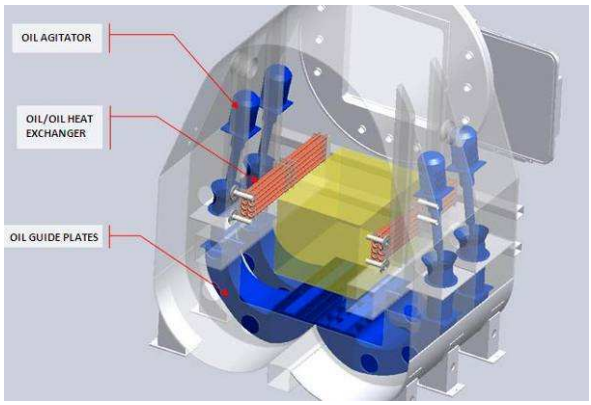


Fig.10 **Cooling vestibule shown with charge and oil agitation system– pictorial view**.

The oil agitation system includes **4 variable speed agitators**, which are installed symmetrically on both sides of the hardening tank. Flow direction is being forced by specially shaped guiding-plates, which ended with so-called, diffuser ensure an optimum oil flow through the charge. Speed of the oil flow may be controlled, depending on the technological requirements, by changing the rotational speed of agitators.

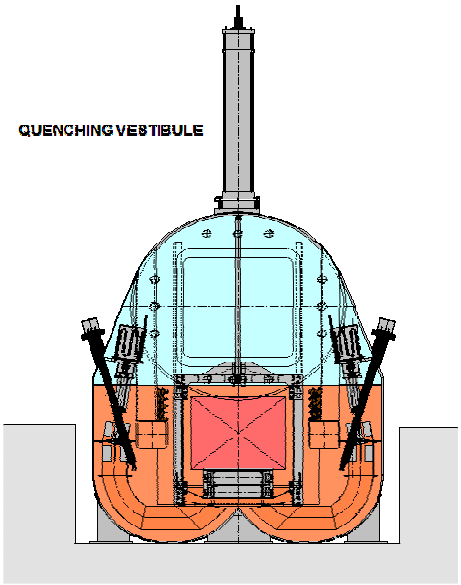


Fig.11 **Oil agitation system – pictorial view**.

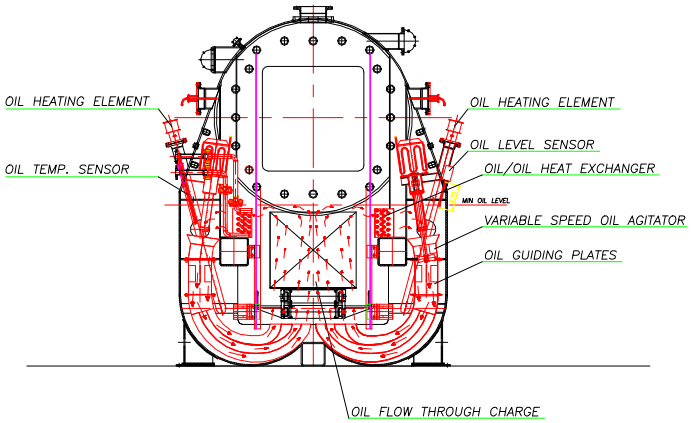


Fig.12 Cooling vestibule shown with charge and oil agitation system– pictorial view**.**

D. PUMPING SYSTEM

The pumping system operates two chambers (quenching and heating). The system contains the rough vacuum pumping system, including a Root's pump supported by a rotary vane pump. The system is configured for an automatically sequenced operation and it is connected through the vacuum valves to the appropriate vessels. A push-button starts the rotary vane pump to begin the vacuum chamber roughing cycle. When the chamber is preliminary evacuated down to **15Torr [20 mbar]** the booster starts for high-speed evacuation. The heating and cooling chambers are evacuated in a sequence.

A control manifold provides all necessary ports for vacuum and pressure gauging. A further valve port is provided for connection to the PURCHASER's helium leak detector.

Operation of the pumping system is controlled by PLC and is fully automatic. An operator 's panel indicates the operating status of all elements of the system e.g. pumps, valves etc.

- ***A flexible bellows isolates the furnace from mechanical pump vibration.***
- ***The mechanical and Root's pumps are shipped with a full charge of pumping fluid.***

Fig.13 **Pumping system**

E. PARTIAL PRESSURE SYSTEM

To prevent evaporation of volatile constituents from load materials during heating under vacuum, the pressure inside the furnace can be regulated via a partial pressure bleed system comprising a needle metering valve and a solenoid cut-off valve. The partial pressure inside the heating chamber is adjustable within the range **10^{-2} to 15Torr [10^{-2} to 10 mbar]**, in line with the characteristics of the furnace load. This system includes Nitrogen supply. It operates in automatic mode.

F. LOW PRESSURE CARBURIZING SYSTEM (FineCarb®)

Low pressure carburizing with a number of advantages is now becoming more widely used. These qualities are both technical and economic. One of the major advantages are the new opportunities in **environmental** and **process automation**. The present technology has been already extensively applied in industry, the scope of which will soon be significantly expanded.

The underpressure carburizing is carried out normally in the range of **1 - 11Torr** [**1 - 15mbar] abs** in an environment of hydrocarbons: acetylene (**C_2H_2**), ethylene (**C_2H_4**). Using the pressure and temperature expansion of the carburizing medium which flows to the heating chamber, we get an **easy and quick exchange of the process atmosphere**, which is a very important feature of the method. In practice, this means that the use of such a flow speeds of carburizing gases causes that the volume exchange in the chamber takes place within seconds.

The **FineCarb®** system employs the original carburizing atmosphere, which is a mixture of gases where the carbon carrier is ethylene with acetylene mixed with hydrogen in a specific and proprietary patented volume ratio. On the one hand it is achieved a significant reduction in the formation of aromatic rings whose presence leads to the generation of tar, troublesome problem in the operation of the furnace - and the **limitations of internal oxidation**, which occurs when applying a pure acetylene. On the other hand, the ultimate effect of treatment as a result of synergy is enhanced in comparison with the atmospheres based on carbon mono-media. **FineCarb®** method allows you to eliminate the entire complex of these negative phenomena, while maintaining all the advantages of the various carbon carriers at the same time. In this way, it is guaranteed to obtain **uniform**, **well-formed carburized layers** of all surfaces of treated workpieces, including the **deep-blind holes**, while maintaining a **bright & clean surface of the charge**. In addition, the process is being run within a **low-gases consumption**.

This method provides a **very good penetration** of the carburizing medium also for **densely packed loads** with large surface of diffusion front, and loads with deep holes, where it is obtained an **excellent uniformity of the layers of external and internal surfaces of holes**.

F1. SIMULATOR SimVac®

One of the major advantages of **FineCarb®** system is the ability to treat each process individually, so it is possible to implement individual, unique orders. Such functionality is achieved by the detailed design for each process using **SimVac** program, which models the all

phenomena occurring during vacuum carburizing. Model of process implemented in SimVac takes into account many factors affecting the final concentration profile of carbon and carburized layer microstructures. It allows programming of the optimal process from: the temperature of carburizing process, the grade or composition of alloy steel, the shape (curvature) of carburized parts point of view. It calculates the way of charge precooling down to hardening temperature.

After entering the necessary input data, such as grade, load parameters, the required hardness of the case, etc., there are determined parameters of thermo-chemical treatment, and you are given all stages of carburizing process with an expected profile of carbon and hardness. Figure 14 presents some dialog window of the program.

Low pressure carburizing is characterized by: a very high ratio of carbon transfer at the interface, which results in very rapid transport of coal to the surface charge. In the initial phase of carburizing, for example at a temperature of 1750ºF [950°C], the flux of carbon directed to the charge surface is up to 250 g/m^{2}h. This means that, for thin carburized layers a significant acceleration of the process is obtained in relation to atmosphere carburizing. Carburizing process can easily run at temperatures up to 1920ºF [1050°C] - the natural range of temperatures for a vacuum furnace. The increase in process temperature to 1740ºF - 1800ºF [950 - 980°C], compared to traditional endo-gas carburizing is usually conducted in the temperature range 1610ºF - 1700ºF 880 - 930°C, will clearly accelerate the carburization caused by a significant increase in diffusion coefficient. This determines the significant acceleration in relation to traditional endo-gas carburizing.

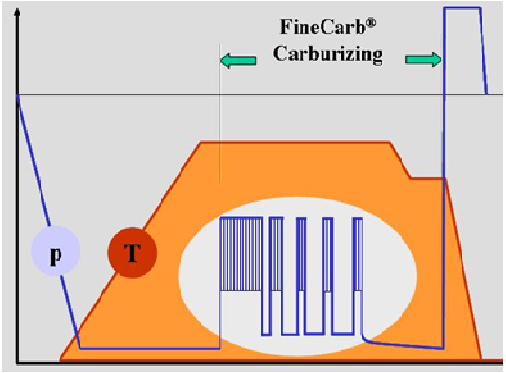


Fig. 14 **Flow chart of carburizing process by LPC®.**

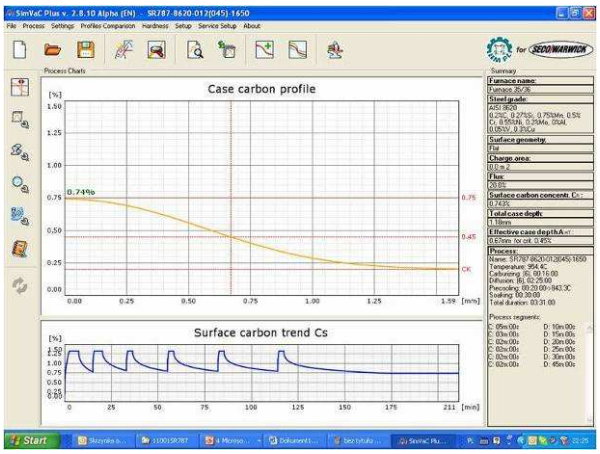


Fig. 15 **Window of the SimVac® simulator**.

The carburizing cycle is carried out automatically, according to a programmed recipe with the carburizing dosing gases.

The main rule of low pressure carburizing refers to precise dosing of carburizing medium with, so called filler in the desired **Quantity and Time**. Dosing is programmable by using the calculator of carburizing process which is built into the furnace control system. Dosing is done by precision valves to ensure repeatability of the mass and flow settings. Apart from the mass control valves the installation consists of appropriate pressure sensors, cut-off valves mechanical and electromagnetic type.

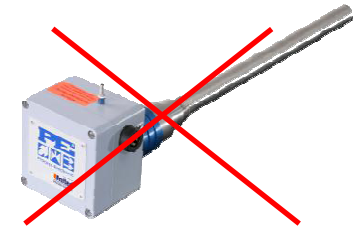
On the next page, there is a comparative table of endo-gas and low pressure carburizing presented.

THE MAIN ADVANTAGES OF SECO/WARWICK's LOW PRESSURE CARBURIZING BY FineCarb® TECHNOLOGY

- **Carburizing costs & time reduction**
- **High quality (clean and bright) parts following heat treatment**
- **High reliability**
- **Very good process repeatability**
- **No load decarburization and oxidation**
- **Environmental friendly – No CO_2 emission**
- **No open fire**
- **Cleanness of workplace**
- **No additional measuring equipment**
- **Full automation of the processes**
- **Visual computer control system (In Touch Wonderware)**

ENVIRONMENTAL FRIENDLY

NO OPEN FIRE



NO ADDITIONAL EQUIPMENT

CLEANNESS OF WORKPLACE

OPTIMAL GAS CONSUMPTION

CRITERION	GAS CARBURIZING	LOW PRESSURE CARBURIZING
Temperature range, °F (°C)	1450-1800 (790-980)	1450-2000 (790-1100)
Case uniformity in (mm)	±0,010 (±0,25)	±0,002 (±0,05)
Carbon transfer control	YES	TIME & FLOW OF GAS
Load density	Medium	High
Carburizing time, min	x minutes	x minutes minus 10-30%
Carbo-nitriding	NH_3 additions	PreNitLPC®
Microstructure	Acceptable (in most cases)	Optimal (in most cases)
Internal oxidation, in	0,0003-0,0005 common	NONE
Carbides	Suppression difficult	Suppression possible
Dealloying	YES	NONE
Decarburization	Possible	NONE
Furnace conditioning	Required (4 h typical)	NONE
Shell temperature, °F (°C)	Warm (>150, or 65)	Cold (<<150, or 65)
Environmental impact	Emission CO_2	No CO_2 emission
Energy consumption	Low	Lower (~20%)
Gas consumption	Measured in m^3/h	Measured in l/min
Integration with multichamber manufacturing	Difficult	Easy
Investment costs - equipment	Medium	Higher (10-30%)

Table 1. **Comparison of gas carburizing (based on ENDO atmosphere) and low pressure carburizing by FineCarb®**

F2. PRE-NITRIDING FOR LOW PRESSURE CARBURIZING SYSTEM (PreNitLPC®)

The carburizing cycle, including pre-nitriding, is carried out automatically, according to a programmed recipe with the carburizing dosing gases (C_2H_2 & C_2H_4) being carried out via programmable mass flow control valves with also supportive hydrogen and programmable oscillation of gas pressures.

Additional **Ammonia** line in the gas system would be installed for the Pre-Nitriding processes.

The nitrogen support for **PreNitLPC®** carburizing allows the expansion of the applications of **FineCarb®** technology toward higher carburizing temperatures and wider range of steel grades. This technology has been elaborated in Institute of Material Science & Engineering and is ready for industrial applications.

Technically, it is based on dosing of gas, which is a carrier of nitrogen in the initial phase of the process - the stage of heating for carburizing (Fig. 15) can lead the process at higher than traditional temperatures (1830ºF [1000°C] and above), and obtained carburized layers do not exhibit the characteristics of grain growth. High temperature of the process increases the value of diffusion coefficient, which leads to significant shortening time of the carburizing process. The layers, which have been produced at higher temperatures using the pre-nitriding phase demonstrate the strength properties like those carburized at lower temperatures.

Economical aspects of this technology is not only shortened carburizing times, but also less use of process gases (C_2H_2, C_2H_4, H_2, NH_3), measured in liters per minute, and not, as in the case of conventional technologies in cubic meters per hour.

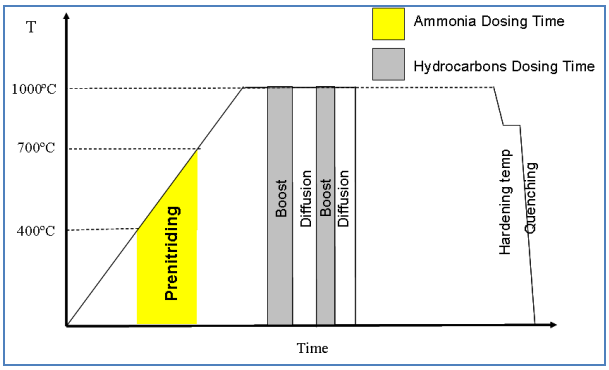


Fig.16 **Flow chart of the pre-nitriding before carburizing process according to PreNitLPC®**

PreNitLPC®, as the final product of merger of operations of pre-nitriding **PreNit** with low-pressure carburizing **LPC** - which is based on **FineCarb®** technology, is a novelty, to which advantages include:

- REDUCTION OF CARBURIZING TIME
- LOWER COSTS OF PROCESSES
- NO INTERNAL OXIDATION
- EXCELLENT UNIFORMITY
- PERFECT PENETRATION
- UNLIMITED CARBON TRANSFER
- GUARANTEED PROCESS REPEATABILITY
- LACK OF CO_2 EMISSION
- ENVIRONMENTALLY-FRIENDLY

Reducing the time will make you able to increase productivity (Fig. 16), and above all to increase the competitiveness of which the previous imagination now becomes real. For every 100 processes (for 0.6 mm ECD), according to traditional technology, you will achieve almost 40% increase in efficiency.

The simplicity of this technology allows for easy implementation into already in use devices, equipped with the application of vacuum carburizing FineCarb®, with options for quenching in oil or gas.

With the PreNit® Technology you can significantly improve the efficiency.

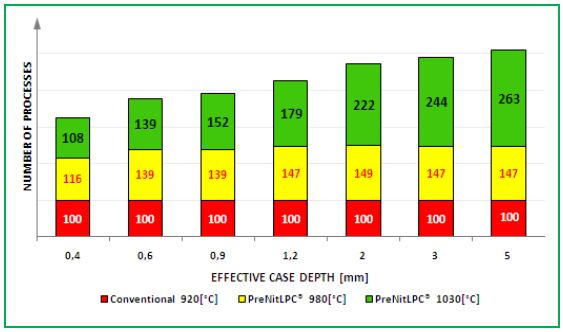


Fig.17 **Efficiency increase depending on Effective Case Depth**.

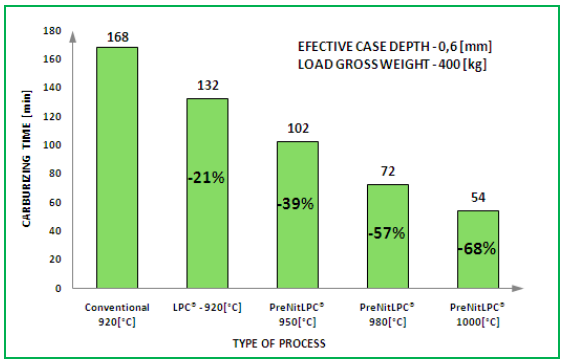


Fig.18 **Time of carburizing depending on process type.**

G. COOLING WATER INSTALLATION

Installation of cooling water is used to remove heat losses from the casing and auxiliary equipment and heat exchanger. Installation is insulated and sealed to minimize corrosion and deposition of scale.

The installation is connected to a Buyer's closed loop cooling water through the main manifold equipped with all necessary pressure regulators, valves, pressure switches, flow monitors and terminals. Delivery includes all cables between the collector and the individual power circuits, as well as to connect them with the drain collector. Flow indicators provide visual inspection of water flow through each of the circuits. The rate of flow of water through the various circuits can be adjusted using the manual ball valves. Thermometers on the sinks of each of the circuits are used to optimize the flow of water.

In the event of failure of water supply, the installation provides also an automatic circulation of tap water for a specified period of time, to protect the furnace and process load.

The cooling water system separated into two sub-systems is provided to remove waste heat from the furnace chamber and auxiliary equipment. The loop is isolated and sealed to minimise corrosion and scale build-up.

Fig. 19 **Cooling water installation – main manifold**.

H. CONTROL SYSTEM

The steering system has been assembled in a cabinet hosting the steering and measurement apparatus, with a HMI interface, which gathers data from the detectors and control systems installed in the furnace oven.

The system has been designed in accord with the current directives, standards and rules in Europe (CE) and the US, and it contains the components fit for industrial heat processing. The design offers functionality and high availability of the furnace and warrants safety of the personnel.

The control commands an operation programs are loaded to the steering system with a GUI operating on an industrial IPC machine with a water and dust proof touch screen. The processing unit and the GUI communicate along the internal Ethernet network that also has connectivity available to the external communication system and a phone line by, respectively, a hub, router and modem.

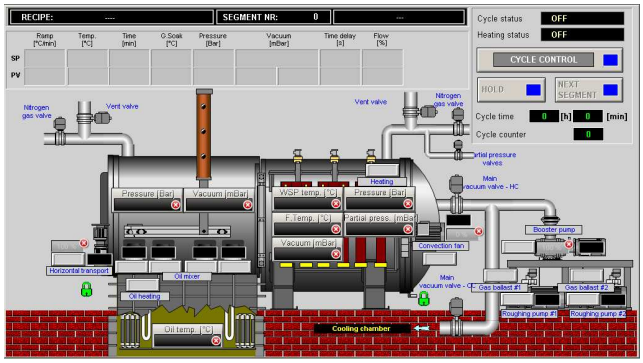
The GUI operates an In-Touch type software. The software is easy and user friendly in operation, offering intuitive set of commands and features the following:

- Each operating or measurement component has been mapped to a visualisation system function
- The visualisation systems provides on line feedback from the active operating components
- SCADA system language version can be switched at any moment
- Specific operating devices can be used in the automated control depending on the relevant selector settings.
- User access privileges are hierarchical The users are able to perform tasks depending on their access privileges
- The root user has access to each operating component in the furnace - manual control effectively
- Input / output of PLC controller is monitored
- Alarms mandatory confirmations can be set up for group or individual confirmation
- The furnace has been divided into subsystems to facilitate easier control. The individual screens reflect the relevant subsystems: water, heating, etc. The GUI is simple and intuitive, and the animation used maps the production system operation, without the superfluous web of installation schemata.
- The hardware and software conform with each other thanks to use of a coherent system of symbolic markings in schemata, the PLC controller and the SCADA system. The markings used in the description, the alarms and schemata

facilitate maintenance and diagnosis of problems that may arise to the personnel and maintenance services.

- The help system - the PDF documentation can be invoked from the individual task operation level - i.e. linked where it is needed
- Electricity system documentation - available form SCADA system, linked to documentation of specific task device or measuring component.
- Remote service access from the Internet (VPN) or phone lines for quick response of the Seco/Warwick service team
- UPS system for the computer availability

H1. THE VISUALIZATION SYSTEM FEATURES A USER FRIENDLY SET OF RECIPES



- Storage capacity for 500 recipes of 40 steps each. The recipes can be edited in various ways: copied under different name, steps can be inserted between the existing ones, or removed from between those that should stay
- On line monitoring of the recipe under operation - the parameters of a foregoing steps and even of this under execution can be altered, given the operator enjoys sufficient access privileges
- Deficient recipes can be verified - the system is considerably fool proof
- Auto launch of the recipe can be set up, a one time launch or weekly launch option. With the GSM messaging system, this minimises human operation and translates to lower expense
- Graphic presentation of the temperature requested by the recipe.
- Apart from recipe operation, individual functionalities can be requested directly, e.g. pumping, cooling.

H2. DATA FILING – DATA COPYING

- Historical data are logged in log files, independently on the database recording. Logged are data concerning the temperature and vacuum, but also events are logged (process suspension, selectors of the operating devices, steps progress etc)
- Historical data can be stored in a CSV file, facilitating in depth analysis with use of an Excel worksheet
- Printouts of the historical trends are easier
- Backup copies of the historical data can be dumped to a CD/DVD or a USB port storage.

- Review of current and historical alarms (all data within a given period)
- Servicing parameters - a set of parameters facilitating SCADA configuration of the furnace. Export/import of the parameters to a file, facilitating furnace operation under varying profiles and configurations

H3. BATCH SAFETY FUNCTIONALITIES, PROCESSING CONTROL

- Process continuation after a break, e.g. power break
- Lookup in the recipe for the highest programmed temperature to check against the batch top capacity The value found can be transferred to the safety controllers.
- The system program features procedures safeguarding against loss or damage resulting from incorrect definition of a recipe or launch of specific steps thereof.

H4. CONTROL SYSTEM – OPTIONS

a) Adjustments to heating control, measurement errors monitoring, NADCAP standard:

- Selection of a temperature controller (for the Allen Bradley adapter) - an IMC or PID controller
- IMC controllers with auto-tuning functionality - examines system response to a given signal to select an optimum temperature parameters The operator does not have to find the controller operating parameters experimentally

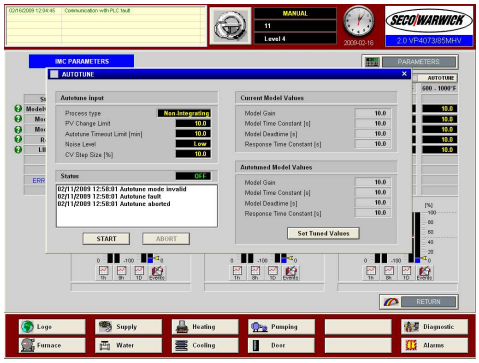


Fig. 20 **Operator's panel window view – PID temperature regulator**.

- Three types of offset for a the thermocouple calibration
- Online compensation of the measurements errors in the measurement paths and the apparatus, makes pirometric and auditing tasks easier
- **AMS2750D** standard control and monitoring system facilitates NADCAP conformance monitoring by the personnel
- PID logging (changes, person, time) enables analysis in case of a failed process
- AMS2750D standard control of the time counters and thermocouple spending: support for SAT testing and reporting (extra option)

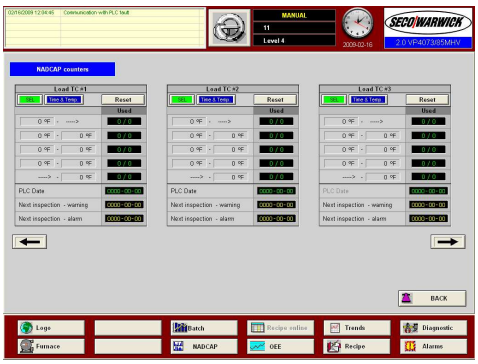


Fig. 21 **Operator's panel window view – Thermocouple offsets**.

b) Functionalities facilitating maintenance and manufacturing control:

- Execution systems activity time counters - maintenance work planning
- Utilities meters: gas, water, power, heating energy (grouping: total, by process, by user) and monitoring of the supply source (tank level, alarms, tank filling) - extra option Current consumption and trend consumption of the materials Cost monitoring of the material/utilities used
- OEE efficiency indicators These functionalities addressing the needs of management overview and the current maintenance teams facilitate optimum use of the furnace, diagnose the shortcomings and monitor maintenance tasks performance, thus eliminating idle time

c) Available reporting

Reporting in basic version – enables generating basic reports concerning batch heat treatment. Following breakdown are possible:

- batch processing list,
- alarms and events list, which appear during process,
- program parameters according to which the process was done,
- historical data of the basic program parameters (temperature, vacuum, etc)
- media consumption (energy, water, gas, etc)
- processing cost

Optionally there exist a possibility to make all reports in graphical form and/or numerical (additional option). All data can be exported to external Excel or HTML files.

- Advanced history analyzer (additional option) – reporting based on Wonderware Historian software and industrial database ensure maximum safety in storing the data. Characteristic of this solution is more flexibility and possibility of reports and prints making from Excel and Word level or optionally from Internet Explorer without complicated SQL query knowledge, which are made with creator use in automatically way

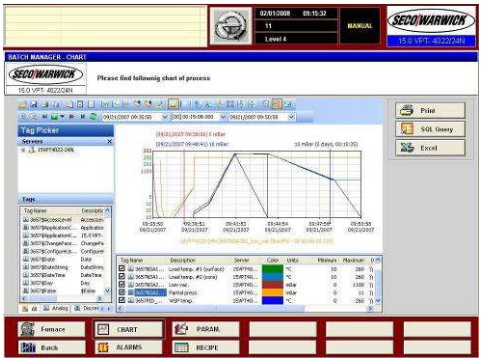


Fig. 22 **Operator's panel window view – historical flow chart**.

d) EXTRA FUNCTIONALITIES

The following functionalities supporting current operation of the furnace can be implemented:

- Auto logging to the visualisation system with proximity transponder
- Support of carbonising processing with a third party software like SimVac - this controls the parameters for the purpose of

building the required carbon layer on the batch surface

- Support for quenching control with a third party software like HardVac - selection of cooling parameters to get the requested toughness of the batch
- Remote access to the SCADA system for the customer (e.g. from another room)
- Free choice of the temperature scale [ºF/ºC] and vacuum [mBar / Torr]
- Decrease the temperature measurement variation to 1 ºC with the National Instruments modules
- In the case of multi chamber ovens, a third party software is available for queuing control optimising manufacturing process
- Tips system - displays the check list for the launch of the specific operating devices:

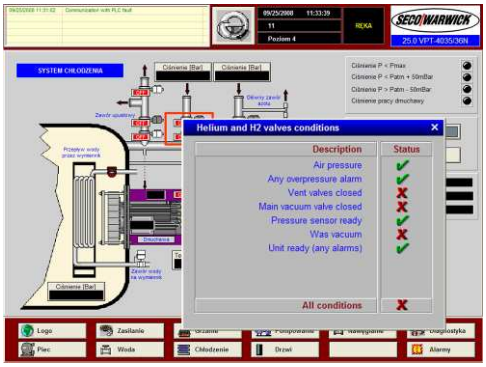


Fig. 23 **Operator's panel window view – manual mode assistant**.

- GSM alarms - each system alarm can be sent as a mobile phone text message to the defined recipient Alarm can also be confirmed with an adequate response text message

H5. CONTROL CABINET

The control cabinet is built on the basis of electrical enclosures supplied by the **Rittal** Company and have an **IP54** environmental rating and meets electromagnetic compatibility requirements. It constitutes a single unit (standing alone or built into the furnace) but, functional, it is divided into several sections. The main isolator is located in the **power supply section**, being equipped with the appropriate short-circuit and overload protection and electric bus bar, distribution system.

The power **distribution section** covers the power safety system, contactors, automatic control devices and connection strips for the power outputs, e.g. pump motors, heating components, gas blower motor, etc.

In the **control section** there are located power supply units, electrical/electronic measuring & control components, electrical protections and connection strips for the control circuits, the programmable logical controller (PLC) and the operator's interface.

Fig 24 **Control cabinet**.

The equipment located inside the cabinet is driven by the either 230 VAC or 110 VAC, and 24 VDC. The cabinet is provided with the cooling fans and internal illumination. The user has to only ensure the connection of the main electric power supply of the TN type, directly to the main isolator terminals; The connections cover the line wires L1, L2, L3 and the protective conductor PE. **The neutral conductor N is not used and it is not needed to be connected**.

The control cabinet is provided with a separated circuit for the service outlet and illumination, this is fed via connections from the main input side of the main isolator; therefore, no additional supply except the main supply is needed. The main isolator mechanism is mechanically interlocked to protect against opening the control cabinet door when the power supply is on.

The programmable logical controller (PLC) monitors the furnace operation, where all input (analogue and digital) signals from the equipment and sensors are connected and which operate the actuating elements of the furnace with use of digital and analog signals.

The PLC controller monitors and controls the analogue process characteristics of the furnace, such as the temperature value in accordance with the PID control algorithm, the vacuum value and the pressure value.

Fig 25 **Control cabinet**.

Absolutely, all-actuating systems are provided with an individual protection and acknowledging components or components analysing operation. This results in the systems being completely diagnosable. The location of any possible failures may be done accurately, effectively and quickly.

H6. SENSORS & ACTUATORS

The sensors and actuators are installed on the furnace to allow correct operation and to avoid any possibilities of their damages in the normal use. They are protected against influence of the environmental conditions and driven with the safe direct current voltage 24 VDC. The electrical wiring on the furnace is installed in ducts and pipes that make it very durable and resistant to mechanical damage; the installation is distributed from a single point to the connection cabinet. The delivery scope covers the complete set of the conductors which connect the furnace with the control cabinet within the specified dimensions.

H7. PROTECTIONS & SAFETY INTERLOCKS

- The vacuum chamber is manufactured according to applicable norms and standards acceptable in the end- user country (UDT, CE, TUV, ASME).
- A relief valve protects the vacuum chamber from excessive gas pressure increases.
- A relief valve protects the vacuum chamber water jacket from excessive water pressure increases.
- The furnace door can be safely opened only after the furnace and ambient pressures are equalized.
- Electrical actuators have built in short circuit protection, and all the motors have protection against overload.
- In the event of power supply failure all valves go to a failsafe condition, and the furnace safely waits for the power to be restored. When the power supply is restored, the furnace can continue the interrupted cycle.
- In the event of a compressed air pressure drop, the cycle is immediately stopped and all valves go to a failsafe condition. When the pressure is restored the furnace can continue the interrupted cycle.
- An emergency stop button is provided which, when actuated by the operator cuts off the power supply to all actuators and stops the cycle. When the situation is cleared the furnace can continue the interrupted cycle.
- In the event of a cooling water supply failure the heating system and cooling blower are shutdown.
- Temperature sensors installed in the water jackets of the furnace door and the furnace body shut down the heating system when the water temperature rises above a pre-set over-temperature value.
- A failure of the water flow through the furnace heat exchanger cooling circuit shuts down the blower motor.
- The heat treatment cycle is fully automated and does not require any operator intervention. The cycle is completed, once the charge is cooled down and ready for removal from the furnace. The furnace door can be opened safely when the load temperature is adequately low and pressures inside the furnace is equalized with an ambient conditions.
- In order to start the heat treatment cycle, the operator has to select the required recipe from within stored recipe cycle programs.
- A negative furnace leak test prevents the work process cycle before starting or allow its continuation.
- When the pressure inside the vacuum vessel exceeds a pre-set value, the heating

system is shutdown to protect the heating chamber from oxidation.

- The furnace is equipped with an independent temperature control system with a separate thermocouple and temperature controller. When the temperature rises over the pre-set value the over temperature controller will immediately shutdown the furnace heating system.
- All abnormal situations activate the audible and visible alarms and the fault information is displayed on the operator panel.
- All vital furnace parameters, alarms and events are recorded in real time on the furnace industrial computer hard drive disc.

I. AXUILIARY EQUIPMENT

I.1 Electric fork lift loader – OPTION

Electric fork lift with max. **2600lbs [1200kg]** carrying capacity is equipped with guides and stops to prevent damage to the furnace during charge transport. Automatic, hydraulic lift, and powered by two (2) fixed and two (2) swivel wheels provide fast, easy, setting the charger. Compact design. Quick and smooth vertical movement of forks with adjustable speed.

Built-in jack for connection into any power socket to charge the batteries.

Manual fork lift loader is available on request.


Fig. 26 **Electric fork lift loader**. **2600lbs (1200kg)**

I.2 Loading tray– OPTION

One (1) a standard set of cast three-level tray, made of heat-resistant material (**2.4879**) - consists of: two (2) basic trays sized 600 x 900 and four (8) trays with dimensions of 600 x 450 with the required columns and dividers. Dedicated to **2100 ºF [1150°C]**.

Fig. 27 **Typical loading tray**.

3. EQUIPMENT LIST

FURNACE TECHNICAL DATA:

- Useful dimensions (W x H x L)
  900 x 800 x 1200 [mm]
- Maximum load gross weight
  2600 lbs **[1200** kg**]**
- Total weight
  ca. **50000** lbs [**20** tons**]**

TEMPERATURE

- Maximum temperature
  2300 ºF [**1250** °C]
- Operating temperature
  2200 ºF [**1200** °C]
- Temperature uniformity of dry & empty furnace[1]
  * vacuum heating (1100-2200°F)**±10** [°F]
  * convection heating (300-1340°F) **±10** [°F]

GAS WORKING PRESSURE

- Max. gas pressure during oil cooling cycle (in the quenching vestibule)
  29 PSI [**2** bar abs]

CONVECTION HEATING

- Max. gas pressure during convection heating (in the heating chamber)
  29 PSI [**2** bar abs]

[1] for max operating range available with an additional charge

CONVECTION FAN

- motor power
  2,2 [kW]

VACUUM

- Max. vacuum in heating chamber (clean, dry, cold, empty furnace)
  10^{-2} [Torr] - range
- Operating vacuum (mechanical pumps)
  $\leq 5 \cdot 10^{-2}$ [Torr]
- Max. leak rate in heating chamber
  (clean, cold and empty furnace from $5x10^{-2}$ mbar)
  $3x10^{-3}$ [mbar*l/s]
- Max. leak rate in quenching vestibule
  $5x10^{-2}$ [mbar*l/s]

PRE - HEATING CHAMBER CASING

- Material – mild steel
- Volume – **250** ft³ [**7** m³]

HEATING CHAMBER CASING

- Material – mild steel
- Volume – **282** ft³ [**8** m³]

QUENCHING VESTIBULE CASING

- Material – mild steel
- Volume – 635 ft³ [**18** m^3]
  (including 300 ft³ [**8,5** m^3]of oil tank)

DOOR DRIVE

- Front door – automatic / pneumatic cylinder
  DN 100
- Inner door – automatic / pneumatic cylinder
  DN 100
- Rear door – automatic / pneumatic cylinder

DOOR LOCKING MECHANISM

- Front & inner door – pneumatically driven break
- Rear door – Third Clamping Flange operated by linear actuator powered by motor 2 x 0,25 [kW] (**0,5** kW)

HOT ZONE

Materials:

- Structure – mild steel
- Thermal insulation CFC plate / Hard felt graphite boards / Ceramic fibre
- Heating elements – graphite

HOT ZONE - PRE-HEATIN

Materials:

- Structure – mild steel
- Thermal insulation Ceramic fibre
- Heating elements – resistance wire

HEATING POWER – 240 [kW]

- No. of heating power control zones - **One**
- Heating element distribution – **all around workload**
- Type of heating elements – **low-voltage graphite pipes**

PRE-HEATING POWER – 70 [kW]

- No. of heating power control zones - **One**
- Heating element distribution – **at the two sides**

Type of heating elements – **resistance wire KANTHAL**

COOLING SYSTEM AT QUENCHING CHAMBER

OIL QUENCHING:

- Oil volume (**8,5**) m^3 (quenching oil is not included in the scope of supply)
- Oil agitator: location both sides of the quenching chamber
  motor power 4 x 5,5 [kW] (**22** kW)
- Oil Heaters – **48** [kW]
- Maximum oil temperature (before quenching)
  140 ºF **60** [°C]
- Maximum oil temperature (after quenching)
  250 ºF **120** [°C]
- Oil temperature sensor **J-type** thermocouple
- Oil level sensor **vibrating** level switch

OIL COOLING SYSTEM

- Oil pump
  * motor power – **4** [kW]
- OIL / WATER – heat exchanger **50** [kW]

CHARGE TRANSPORT MECHANISM AT VESTIBULE

- Horizontal load transfer – electrical driven telescopic forks
  * gearbox motor power – **1,5** [kW]
- Vertical load transfer (for quenching) – pneumatic cylinder – **DN 250**

PUMPING SYSTEM – HEATING CHAMBER

- Rotary vane pump – **200** ft³/min [**340** m^3/h]
  * type SV 300 Leybold
  * motor power **6,3** [kW]

- Root's pump – **1000** ft³/min [**1700** m^3/h]
  * type GMa 12,6 HV Aerzen
  * motor power **6,3** [kW]

PUMPING SYSTEM – PRE-HEATING AND COOLIG CHAMBER,

- Rotary vane pump – **200** ft³/min [**340** m^3/h]
  * type SV 300 Leybold
  * motor power **6,3** [kW]

- Root's pump – **1400** ft³/min [**2400** m^3/h]
  * type GMa 13,7 HV Aerzen
  * motor power **8,8** [kW]

INSTRUMENTATION

- Thermocouples – **type S**
- Temperature controller/programmer – **PLC**
- Over-temperature controller
  UDC Honeywell/Eurotherm
- Vacuum transmitters:
  rough vacuum:
  TTR91S Leybold-Vacuum
  * measuring range
  $1x10^{-3}$ - $1x\ 10^{3}$ [mbar]
- Partial pressure control range
  10^{-1} to 10 [mbar]

CONTROL SYSTEM SPECIFICATION

- Control cabinet – **Rittal**
- Main circuit breaker
  Schneider/Siemens/AB
- Industrial switchgear
  Meller / Schneider
- Programmable Logic Controller
  Compact Logicx, Allen Bradley/Siemens
- Heating power controller
  AEG/Eurotherm
- Operator's interface
  Industrial IPC, Wonderware
- Hardware
  IPC TPCC-15A-2CMXU TPC(Touch Panel computer) 15", Windows XP Pro Eng, CPU Pentium M 1,1GHz, 512MBRAM, DVDRW- DVD, 40GB HDD10GB + 30GB. 1xRS232, 1xLPT, 3xUSB, 2xEthernet, Internal modem PCI, card5xUSB
- Screen - **15" PPC color touch screen**
- Operating system – **Windows XP Microsoft**
- Software tool – **InTouch, Wonderware**
- Seco/Warwick software – **SecoVaC**
- Printer – **HP**

4. UTILITIES REQUIRED

The system will be ready for operation upon connection to the PURCHASER's utilities. The PURCHASER is required to furnish all utility connections, including electric power, air and water, and to supply such other services and facilities as are required for installation and/or operation of the equipment.

The following approximate utilities will be required:

	CME T12
A. Electricity	**480V, 3 phase, 60Hz**
* Motors power	46 kW
* Max. power consumption	350 kW
B. Water	
* Inlet temperature	min. 60°F; max. 90°F
* Inlet pressure at the f'ce	min 37PSI, max 60PSI
* Consumption – Average	12 ft³/min [20m^3/h]
* pH	7,5 ÷ 9
* Hardness	<6 dH (German Grades)
C. Cooling / Backfill Gas	**Nitrogen (99,999% N_2) at 175PSI**
* Consumption per cycle	~700 ft^3 per 14,5 PSI
D. Compressed Air	**90÷145 PSI**
E. Carburizing	**According to FineCarb™**
* Acetylene	1,6 ft³/min at 14,5 PSI
* Ethylene	1,6 ft³/min at 14,5 PSI
* Hydrogen	0,8 ft³/min at 14,5 PSI
* Ammonia	1,3 ft³/min at 14,5 PSI

5. ACCEPTANCE

Prior to shipment the furnace undergoes a comprehensive test program under the supervision of SECO/WARWICK personnel. Furnace acceptance will take place at PURCHASER'S plant. All acceptance tests will be performed in order to show proper furnace parameters at given local conditions in the PURCHASER's plant.

The following tests and inspections will be performed by the SELLER's representative with the help of the PURCHASER's competent personnel.

The scope of the control and tests performed by Seco/Warwick's representatives:

1. Inspection of delivery completion.
2. Heating chamber inspection.
3. Inspection of the assembly and utilities connections.
4. Qualitative and quantitative monitoring of the utilities.
5. Inspection of operating medium (oils, greasers, etc.)
6. Leak test of the systems (water, pneumatic, gas, hydraulics, etc.).
7. Inspection of mechanisms and functions (bungs, door, etc).
8. Inspection of the control cabinet and electrical circuits.
9. Test of the safety devices and interlock mechanisms (simulation of fault conditions).
10. Test of nominal temperature.
11. Test of leak rate.
12. Test of ultimate vacuum.
13. Test of convection fan.
14. Test of typical operation cycle of the empty furnace or with a ballast load in the furnace.
15. Test of transport mechanisms

After successfully completing the agreed acceptance tests, the Acceptance Protocol will be completed and signed by both parties. Lesser defects having no influence on furnace operation will not be the basis to refuse furnace acceptance. If acceptance tests are delayed through no fault of SELLER, the furnace will be automatically accepted within three (3) months from the date of advice of shipment or delivery.

If temperature uniformity test is required, it can be performed in the presence of the Seller's representative, provided it does not delay or interrupt the standard acceptance tests. In such a case the PURCHASER is obliged to provide qualified personnel as well as all materials, tools and equipment to perform temperature uniformity test (thermocouples, assembly basket, devices for measurement and recording data, etc.).

6. AVAILABLE SPARE PARTS LIST

For your information and planning, the following is a recommended list of first line repair and consumable spares. This is a minimum holding to obviate unnecessary downtime:

- One (1) set of O-rings and gaskets
- One (1) set of thermocouples
- One (1) set of power feedthroughs
- One (1) set of pressure sensors, tubes and switches
- One (1) tube of vacuum grease and sealant
- One (1) set of fuses
- One (1) partial set of heating elements and supports
- One (1) partial set of hearth components
- Two (2) pump oil changes

A more comprehensive spare and consumable parts list with spare part identification numbers will be supplied when the equipment design has been finalised. Pump oils, greases and lubricants will be identified so that PURCHASER may procure from a local supplier.

7. GENERAL SPECIFICATIONS FOR ALL EQUIPMENT

STEEL CLEANING

All steelwork is cleaned thoroughly to remove rust and surface impurities; this is standard SECO/WARWICK practice prior to painting.

PAINTING

All steelwork receives one (1) coat of prime paint and one (1) coat of finish:

- **RAL5019** Capri blue or
- **RAL7032** grey-white paint.

PIPING AND WIRING

The equipment described in this proposal is completely factory assembled, piped and wired prior to shipment. It will only be necessary to make the interconnections between the sections

and components furnished by SECO/WARWICK. All wiring and piping between sections will terminate in terminal boxes or suitable connecting points to minimise all field connections required.

INSTALLATION INSPECTION AND START UP SUPERVISION

SECO/WARWICK provides the services of a field engineer, to install and start up of the equipment for a period not exceeding fifteen (15) working days in accordance with Chapter 9 – "Installation And Start-up Service".

INSURANCE REQUIREMENTS, STATE AND LOCAL CODES

The equipment outline in this proposal will carry CE or UL markings, and will comply with requirements of Machinery Regulations 1992 and any other relevant legislation including safety standard EN 746-7: "Industrial Thermo processing Equipment - Part 7: Special Safety Requirements for Vacuum Thermo processing Equipment".

Any additional equipment or services required to meet insurance, state, or local codes not specifically detailed herein, are to be furnished by the PURCHASER, or where feasible, will be furnished by SECO/WARWICK on an adjusted price basis.

DRAWINGS

SECO/WARWICK will provide complete drawings needed for installation, maintenance, and equipment operation. Typical drawings include piping schematics, wiring schematics, interconnecting diagrams, foundation outlines, and equipment assembly drawings.

Equipment arrangement drawing will be supplied three (3) months after the date of order.

MANUALS

SECO/WARWICK will provide three (3) sets of operating manuals.

TERMS OF PAYMENT

For the items listed in point 10.1

a) **$^1/_3$ payable before the shipment.**

b) **$^2/_3$ payable with quarterly installments within two years after commissioning.**

For the Item 10.2, within 30 days upon completion of the service.
For the Item 10.3, within 30 days upon delivery of the equipment to the customer site.

FREIGHT – EXW, Świebodzin, Poland

DELIVERY

Normal shipment of this equipment is **28-30 weeks** from the date of order. Actual delivery will be dependent on engineering and shop backlog at the time of order placement. SECO/WARWICK will make every effort to

meet specific requirements of the PURCHASER.

WARRANTY

Excluding any further claim SECO/WARWICK warrants that the goods sold hereunder will be free from defects in material and workmanship including failure to reach the performance figures quoted.

SECO/WARWICK undertakes at its discretion to repair or to replace free of charge all parts which are proven to SECO/WARWICK satisfaction to have failed or their working condition is proven to be seriously impaired provided the defects have appeared within 12 months after start-up, but not later than 15 month after dispatch, as a result of faulty design, defects in materials or bad workmanship. PURCHASER shall immediately notify SECO/WARWICK of such defects in writing. Parts replaced shall become the property of SECO/WARWICK.

Excluded from this warranty are the expendable items such as gauge tubes, diffusion and mechanical pump fluids, thermocouples, refractory Metals heating elements and shield assemblies and services and material required for correcting and/or reconditioning malfunctioning equipment resulting from misuse or failure, on the part of the PURCHASER, to perform periodical inspection and maintenance services in accordance with accepted good equipment operation practice.

Excluded from the above standard SECO/WARWICK warranty are those item incorporated in the system of other than SECO/WARWICK manufacture, i.e. temperature instrumentation, vacuum mechanical pumps, etc., in which instance the manufacturer's standard warranty will apply in lieu of all other warranties.

8. ITEMS TO BE FURNISHED BY PURCHASER

1. Unloading and delivery of equipment to final site in factory and assurance during all installation process all necessary hosting cranes, lifts, fork -lifts etc. with service.
2. Labor to install equipment, including reassembly of any components that were removed for shipping purposes and all utility connections necessary (unless turn-key installation is selected)
3. Any stacks, hoods, exhaust ducts, etc. if required.
4. Any additional equipment, for example, which may be required by law, and its installation.
5. Gas at required pressure with all pipe work and necessary valves upstream of the buffer tank to bulk storage system.
6. Sufficient cooling water as required for operation of the equipment.
7. **480 Volt, 3 phase, 60 Hertz** current as required for operation of the equipment.
8. Compressed air in sufficient quantities at a minimum 6 bar (87 psi) as required for operation of equipment.

9. Foundation and pit as required in accordance with information to be supplied by SECO/WARWICK, if necessary.
10. Skilled operators during start up operation.
11. Test load, if necessary.
12. Helium leak detector
13. Quenching oil
14. Equipment to perform TUS and SAT (if tests are required)

9. INSTALLATION AND START-UP SERVICE

SECO/WARWICK provides a competent field representative on a standard ten-hour day basis, Monday through Friday inclusive, to supervise the installation, start-up and commission the equipment. If work is to be performed on other than a standard workday basis, the price for the field representative is subject to adjustment.

The PURCHASER shall advise SECO/WARWICK two (2) weeks before the representatives are required that the plant is prepared to start the installation and start-up proceed on an uninterrupted basis.

This service includes training of the operating and maintenance personnel. This training will take place during start-up of the furnace and will include explanation of the furnace operation, maintenance works and intervals, interlocking and safety function of the equipment, as well as programming of the heat treatment cycles.

It is also understood that this service, if completed in a shorter time period than specified, does not constitute a change in contract and SECO/WARWICK obligation in reference to this service is terminated on the day of completion. Should delays or interruptions be caused by SECO/WARWICK, additional time will be provided at no charge to the PURCHASER.

If operations are delayed or interrupted through no fault of SECO/WARWICK, and additional time is required beyond that stated in the proposal, the PURCHASER will be billed at a rate of USD 800.00 per day plus travel and accommodation expenses for SECO/WARWICK field representative.

10.EQUIPMENT PRICE

10.1 One (1) Three Chamber Vacuum Carburizing Furnace type CME T12 with Oil Quenching System Including:

- Graphite Hot Zone - Rectangular Heating Chamber,
- Rotary vane and Mechanical Roots Vacuum Pumping System,
- Heating System – 240 kW,
- Pre-Heating System – 70 kW, with convection heating system
- Oil agitation allowing forward, reverse and variable speed,
- Oil cooling system (OIL/OIL >> OIL/WATER).
- Nitrogen Partial Pressure System,
- Furnace Water Cooling System including Flow, Pressure and Temperature Sensors,
- Pneumatic, side – driven Front Door, Inner-Pressure Door and Rear Door,
- Control Cabinet, Main Disconnect on Control Panel,
- Cable connections between furnace and control cabinet,
- System available to vacuum tempering and oil hardening,
- Operation and Maintenance Manual,
- PLC/IPC Furnace Control and Management System with Communication Modem,
- 24 hours software and service support,
- Remote troubleshooting,
- Low pressure carburizing system by FineCarb®, as per point E.
  with the pre-nitriding (PreNit) technology

FURNACE PRICE..... 870.000,00 USD

Less discount for:

a) Exchange of the information in regards to process details (times, material, costs).
b) Running the carburizing process in the extent of not lower that 70% of available time.
c) Enabling the reference visit with other Seco/Warwick customers.
d) Support in promotion of the furnace and PreNit technology.
e) Running the tests for other Seco/Warwick customers, based on the agreed rate.

DISCOUNTED PRICE..... 750.000,00 USD

10.2 Turn-key furnace installation, commissioning and operators training on site,
PRICE .....40.500,00 EUR

10.3 Delivery DDU Therm-Tech plant, Waukesha, WI,
PRICE .....37.200,00 EUR

This offer remains valid during the thirty (30) days from the date of its issue.

11.GENERAL TERMS OF SALE

1. General provisions

1.1 All deliveries and performances from SECO/WARWICK SA (hereinafter referred to as SWSA) are subject to the below stated principles which constitute an integral part of the contract and which the Buyer confirms to understand as complete and exclusive expression of the contract between the Buyer and SWSA. Any supplementary or different conditions or provisions will be binding only as far as they have been approved by SWSA in writing.

1.2 The principles stated below are considered accepted when the Buyer accepts the SWSA quotation through lodging their order or signing a contract.

2. Quotation / order confirmation

2.1 SWSA quotations are binding for SWSA only if explicitly stated so.

2.2 The Buyer's order is not binding until confirmed by SWSA in writing and only within the focus of such confirmation.

3. Documents

3.1 Specifications printed in catalogues, promotional brochures, quotation and contract documents in the form of illustrations, drawings, dimensions, weights, consumption and output factors as well as other specifications are only rough data and are not binding for SWSA unless explicitly stated otherwise.

3.2 In exceptional cases SWSA reserve the right to alter the design, especially if this is justified by the need for material replacements not leading to deterioration of product quality.

3.3 Intangible property rights protected by the provisions in the act on industrial property rights and the act on copyright, especially articles protected with property rights, patents for inventions, utility designs, trademarks, trade names, marks of origin, names of origin, topographies of integrated circuits, improvement designs, information on the proper use of inventions, other information and tests of technical nature which are directly ready for use in business and research activity, information of organizational nature, as well as other made available to the Buyer by SWSA when fulfilling the duties and obligations hereunder, are the property of SWSA. Products on which interest transferred to the Buyer has been recorded are vested with SWSA.

The Buyer has no rights whatsoever to use such drawings and documents for other purposes or to copy them, make multiple copies thereof or to make them available to third parties. Such documents do not transfer the ownership title or imply granting of any licence. Drawings and other documents which remain the property of SWSA must be returned immediately to SWSA on request together with all copies that had been made from them.

3.4 The Buyer shall be obliged not to use for any other purposes, as well as not to make available to any other parties any elements, information and technical documentation on which manufacturing of the equipment ordered by the Buyer was based.

3.5 All sales references and all documents available to customers are to be returned to SWSA if requested, including any copies made of them.. In the event the order was placed elsewhere than with SWSA, all such references and documents must be returned immediately without any special request.

3.6 After selling the equipment SWSA shall have the right to enter the unit sold and the customer's data onto a standard referential list covering the name and type of equipment, date of sale, name of customer and country. Signing of these General Terms of Sale is tantamount to agreeing to have such data included in the referential list. Reservations, if any, may be forwarded by the customer in writing.

3.7 The parties hereto shall be obliged to keep secret – during the term of the Agreement on General Terms of Sale and after it has been dissolved- of any information pertaining to the contents of this agreement as well as the activities run by the other party, which are of confidential nature and disclosure of which may be to the prejudice of the other party.

3.8 None of the parties hereto can, without a written consent of the other party, disclose any information on the present agreement. This restriction does not refer to disclosing information to any authorities, institutions and courts – if such an obligation has been imposed on by the regulations in force, as well as to businesses rendering services in business, legal, financial or tax consultancy, and services similar to them (including auditors of the Parties hereto); provided that the Parties shall bear full responsibility for keeping this information secret by the above-referred to organizations.

4. Prices, packaging, insurance, permits

4.1 SWSA sales prices are quoted net and as such do not incorporate the value added tax, customs duties and other fees which SWSA may charge the Buyer with pursuant to law regulations currently in force.

4.2 Unless the Buyer explicitly requests so, SWSA do not insure the goods ordered against transport risks. The cost of such insurance is borne by the Buyer.

4.3 Packaging and shipment cost will be added to the price of goods.

4.4 In case, as it may be specified in Polish regulations, the goods on offer require export permit, the Buyer shall provide SWSA with Import Certificate issued by a relevant governmental authority of his country or Final User Declaration in accordance with requirements defined in art. 23 in the Act (of November 29th, 2000 on international trade of goods, technologies and services which bear strategic importance from the point of view of state security as well as which are important for maintaining international peace and safety) containing staff required by the Polish Export Control Department (DKE), each time within 30 days upon signing the contract.

4.5 The Buyer agrees that export of the equipment without the above-mentioned permit cannot be performed. In case the above-referred to period of 30 days is exceeded, the dispatch of the goods shall be prolonged by the time by which it has been delayed. All the costs and risks due to the delay of the dispatch shall be borne by the Buyer.

5. Transfer of risk

5.1 Unless clearly stated otherwise, the risk is transferred onto the Buyer as of the moment the goods are made available to his disposal in accordance with the EXW INCOTERMS 2000 rules. In other cases the risk is transferred onto the Buyer from the moment the goods are trusted with the first carrier.

5.2 In the event the shipment is delayed due to the Buyer's failure to perform their duties or if the delay results from reasons independent of SWSA, the risk is transferred onto the Buyer from the moment they are informed by SWSA about readiness to dispatch.

6. Delivery terms and dates

6.1 Detailed delivery dates are agreed by the parties in the contract, these dates are of an approximate character and are not binding upon SWSA. SWSA shall take every endeavour to meet delivery dates, however adherence to delivery date depends on timely fulfilment of contractual obligations by the Buyer, including the date of accepting the offer and furnishing the necessary information as well as timely fulfilment of contractual duties by contracting parties or sub-suppliers of SWSA, so that SWSA can fulfil its obligations undertaken towards the Buyer. Any alterations requested by the Buyer may cause extension of delivery date. The goods are considered to be delivered on time if they are transferred to the first carrier or if they are notified as ready for shipment before the contractual delivery date. Partial shipments are allowed. Minor defects do not influence the Buyer's obligation to receive the goods; in such a case it is assumed that the delivery date has been maintained. The place of delivery shall be the registered office of SWSA upon terms and conditions of EXW Incoterms 2000, unless otherwise agreed upon by the Parties.

6.2 In the event a delivery is delayed for the reasons attributed to the Buyer or if the Buyer fails to receive the shipment in due time, SWSA have the right, at their discretion and with no responsibility, to store the goods at the Buyer's risk, invoice them as Ex Works and charge the Buyer with storage cost. If storage is

effected in SWSA warehouses the storage cost is not less than 1,0% of the invoice value for each month beginning from the date of notification of readiness to ship. SWSA have the right to assign another date of reception and after that date they have the right to sell or to arbitrarily dispose of the goods. Sale of goods or another disposal thereof do not discharge the Buyer form payment for the goods.

6.3 In case the delivery is delayed for unforeseeable reasons beyond SWSA control - acts of force majeure, the delivery date will be reasonably extended. In such an event the Buyer is not entitled to terminate the contract nor to lay any claims for delay of delivery.

6.4 SWSA, without bearing any responsibility nor waiving any claims against the Buyer may refuse to perform the delivery in any of the following situations:

6.4.1 The Buyer has not observed or does not observe any of the provision in the order or the agreement.

6.4.2 Refusal of or a delay in the delivery has been caused by circumstances being out of control of SWSA, not restricted only to force majeure or national enemy, which may have been brought about by such events as: fire, unfavourable events, strikes, problems with labour, negligence on the part of the Buyer, lack of labour force, missing materials, breakdowns, delays in material supply by sub-suppliers, refusal of or a delay in issuing the relevant permit by the Polish DKE.

6.4.3 The Buyer is planned to be subjected to bankruptcy, liquidation or insolvency, his property is pledged covering creditors' security interests, or proceedings in bankruptcy or proceedings to declare bankruptcy has been commenced against him.

6.4.4 The Buyer shall demand and SWSA shall agree in writing to changes or modifications in management subject hereto.

7. Terms of payment

7.1 Payments should be effected according to the provisions of the contract or order confirmation.

7.2 Payments are effected exclusively into SWSA account and are free of transfer charges, effected at agreed date without incurring SWSA with deductions, costs and expenses due to acceptance of a bank guarantee, a bill of exchange or a cheque.

7.3 The parties hereto unanimously agree that, if the sales price is fixed in American dollars according to the correct exchange rate on the day the contract is concluded or on another appointed day, and the exchange rate changes by more than 2%, the price shall be each time amended and shall be fixed in accordance with a new exchange rate applied to American dollar binding on the agreed upon payment date.

7.4 The parties hereto exclude the right to deduct claims under the present agreement with any other claims, including exclusion of the right to deduct claims a party hereto is subject to due to the agreement to which the present General Terms of Sale have been attached to.

7.5 SWSA reserve the right to charge statutory interest for delayed payments.

7.6 If delivery, assembly or start-up are delayed for the reasons beyond SWSA responsibility, the payments are due as of the originally agreed date.

7.7 A failure by the Buyer to perform any payment at dates defined in this contract will entitle SWSA to interrupt the work and adjust the delivery date or to deliver after receiving payment. Should such default in payment extend beyond 60 (sixty) days after the required date, SWSA may at any time after that date cancel this contract by written notification to the Buyer by letter or cable. Afterwards, SWSA will have the right to recover the cost of work done and materials delivered and the cost of any damage they have incurred.

7.8 Failure to pay by the Buyer within the required period will constitute a basis to dismiss any claims of the Buyer to SWSA in relation to the delayed delivery or work stoppage resulting from default in payment.

7.9 Effective date of payment is the day when the amount due is received at SWSA bank account.

7.10 A form of compensation shall be contractual penalties resulting from the following:

7.10.1 SWSA shall pay to the Buyer contractual penalties of 10% of the remuneration to SWSA referred to in § 4 for withdrawal from the contract by any of the parties due to the fault of SWSA.

7.10.2 In case the Buyer withdraws from the contract due to the reasons not attributed to SWSA, it shall pay to SWSA remuneration of 10% of the contract value and shall pay all the costs due to the performance of a part of the contract as well as shall pay for the purchased/ordered yet not installed materials and equipment, the deliveries/production of which cannot be cancelled. SWSA shall be obliged to evidence the value of the materials and equipment subject to payment which have not been installed. In the situation referred to herein, within 7 days upon withdrawal from the contract by the Buyer, the parties shall make an inventory of works in course of construction and shall draw up a report specifying the value of these works as well as the value of the ordered and purchased materials and equipment This report shall make grounds for issuing an invoice by SWSA. In case the Buyer does not make the works inventory, SWSA shall make it independently and shall issue the invoice.

7. 11 The above arrangements shall not limit SWSA right to claim damages above the restricted contractual penalties.

8. Retention of title

8.1 SWSA reserve the property title to the goods delivered until full payment is received including all claims resulting from the transaction between SWSA and the Buyer. If the Buyer is in default of any payment due, SWSA reserve the right to demand return of the goods as security of claims.

8.2 Throughout the period of retention of title the Buyer is not entitled to pledge or to otherwise encumber the goods sold. Furthermore, they are forbidden to transfer the property title for those goods onto third parties as a claims security. SWSA must be immediately notified of any confiscation, seizure or other measures imposed by third parties.

8.3 Throughout the period of retention of title the Buyer will take every measures in order to insure the goods delivered against standard risks such as robbery, fire, mechanical damage etc. SWSA reserve the right to institute such an insurance at the Buyer's expense.

9 Guarantee and warranties

9.1 SWSA guarantee that the goods sold pursuant to these terms are free of defects whether physical or legal.

9.2 Liabilities or warranties by SWSA do not cover the manufacturing process or production quality for which the goods may be applied.

9.3 In no event whatsoever shall SWSA be held liable for any loss, damage or expenses resulting directly or indirectly from the application of their equipment including (but not restricted to) indirect damage and conditional liability of any nature.

9.4 On any account shall SWSA be liable for a loss in the profits that the Buyer would incur as a result of non-performance or negligent performance of any of the provisions herein by SWSA.

9.5 This guarantee does not cover easily worn components such as (but not restricted to): light bulbs, fuse elements, seals, wedge belts, glass tubes of rotameters, filter inserts, glow plugs, workload fixtures, thermocouples and vacuum heads, heating elements and screens made of hard fusible materials for vacuum furnaces, oils for mechanical and diffusion vacuum pumps, elements of heat-resistant steel working in high temperatures and elements such as workload slides, ceramic furnace hearth and minor ceramic elements. The guarantee does not cover defects resulting from improper use or neglect on the part of the Buyer of carrying out periodic inspections and maintenance procedures as provided for in the Instruction Manual.

9.6 This guarantee does not apply in the case the Buyer has introduced any alterations or modifications or if the erection, assembly or start-up were carried out without SWSA supervision or in a way incompatible with the methods recognised by SWSA.

9.7 Components and materials used for manufacturing SWSA products are covered with their manufacturers warranties. SWSA will enforce the rights from this title on behalf of the Buyer.

9.8 SWSA shall effect free of charge repair or replacement of all elements which are recognised and confirmed by SWSA as faulty or the condition of which have deteriorated significantly provided that the faults have occurred within 12 months from product start-up but not later than 18 months from the date of dispatch. In the event of erroneous design, material, workmanship or manufacturing faults SWSA remain fully liable under this guarantee.

9.9 SWSA commit to start a repair under guarantee not later than 10 days from notifying about a fault.

9.10 Notification of a fault must be forwarded immediately but not later than 7 days from the day it occurred. A complaint must contain a description of a fault.

9.11 Buyer's claims from warranty are excluded.

10 Final provisions

10.1 All arrangements so far concluded between the parties of the contract, whether oral or written, which are contradictory or incompatible with the contract between the parties or with these general terms of sale are hereby rendered void.

10.2 In case the provisions herein become ineffective or unenforceable, they should be replaced with such effective and enforceable provisions that would reflect in the best way the intention, the business purpose and the expectations of the Parties when signing this agreement. If ineffectiveness of a single or some of the provisions herein infringed the binding law, or if they could not be enforced, no matter if they are to be treated together or separately, which depends on the validity of a relative provision, and as the result if the passage infringing law has to be removed, a new corresponding passage should be stipulated so that its sense can be acceptable in terms of law. If it is not possible, the desired goal should be achieved by replacing the whole provision so that it can be as close as possible to the business target and intentions of the Parties when signing this agreement. The agreement shall continue to be binding if one of its provisions is or will continue to be invalid.

10.3 Any disputes that might arise in connection with this contract will be subject to Polish Civil Courts having jurisdiction over SWSA headquarter town.

10.4 The regulations of the Polish Civil Code shall apply for all issues not settled in this contract.

12.ACCEPTANCE

These specifications are submitted for the prompt consideration of the PURCHASER. An authorized representative of the PURCHASER shall accept the same within thirty (30) days of the date of this proposal, at the proper place indicated in the lower left-hand corner. It shall then be returned to SECO/WARWICK for approval by SECO/WARWICK and upon such approval, it shall become a binding contract upon both parties hereto.

SECO/WARWICK S.A.
Świebodzin, Poland

_____
Wojciech Modrzyk

VACUUM CARBURIZING &
OIL QUENCHING FURNACES TEAM

Accepted by PURCHASER	Approved by SECO/WARWICK
_____	_____
_____	_____
Date _____	Dated at Świebodzin, Poland
	_____
	_____