ETS ENGINEERING LLC

2020

OBJECTIVES AND OPERATIONAL PRINCIPLES

LLC «ETS Engineering» was founded by a team of engineers and experts in power electronics.

Members of our team executed dozens of projects in the market sector of High Power and High Current Converters.

The company's mission is to keep experience of the previous generations in the market sector of high current and develop a new level of competence using up-to-date components and state-of-art technologies.

Company profile:

- Design, manufacturing, installation and commissioning of power semiconductor converters (rectifiers) with **current range of 1…150kA DC and voltage up to 1500V DC**
- Customized retrofit solutions with respect to layout of AC/DC busbar system and auxiliary equipment
- Cooling and control systems
- Engineering of DC busbar systems
- Engineering of DC substations
- Maintenance and service

Main industry applications:

- ❑ Aluminum/light metals electrolysis
- ❑ Metal refining
- ❑ Chlorine and caustic
- ❑ VAR and DC Arc furnaces
- ❑ Graphitization

MAJOR CUSTOMERS

The Aluminum Company of Egypt (Egyptalum)

RUSSIAN COPPER COMPANY

VSMPO AVISMA

RUSAL

NORNICKEL

Control system for DC thyristor substation

Year: 2015-2017
Process: magnesium electrolysis
Equipment: **6** rectifier groups **63kA/450V**
Delivery: 6 pcs. LCC for thyristor groups (fully digital thyristor control with optic lines for control pulses), master control cabinet, substation operator SCADA control room, potline current optical sensor
Cooling: glycol/air
Semiconductors: thyristors
Scope ("turn-key"): full substation and equipment engineering, manufacturing, software development, erection and commissioning, power quality analysis and recommendations, local stuff training
Specifics: full replacement of existing group/substation control system, keeping substation in operation.

Rectifier group 28кA/60V with control and cooling system

Year: 2016…2022

Process: VAR (titanium vacuum arc remelting)

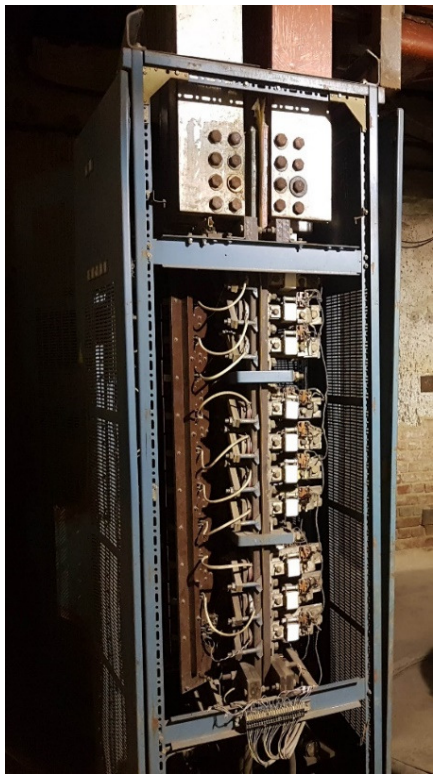
Amount: 8 in operation/erection + 7 manufacturing/contracted

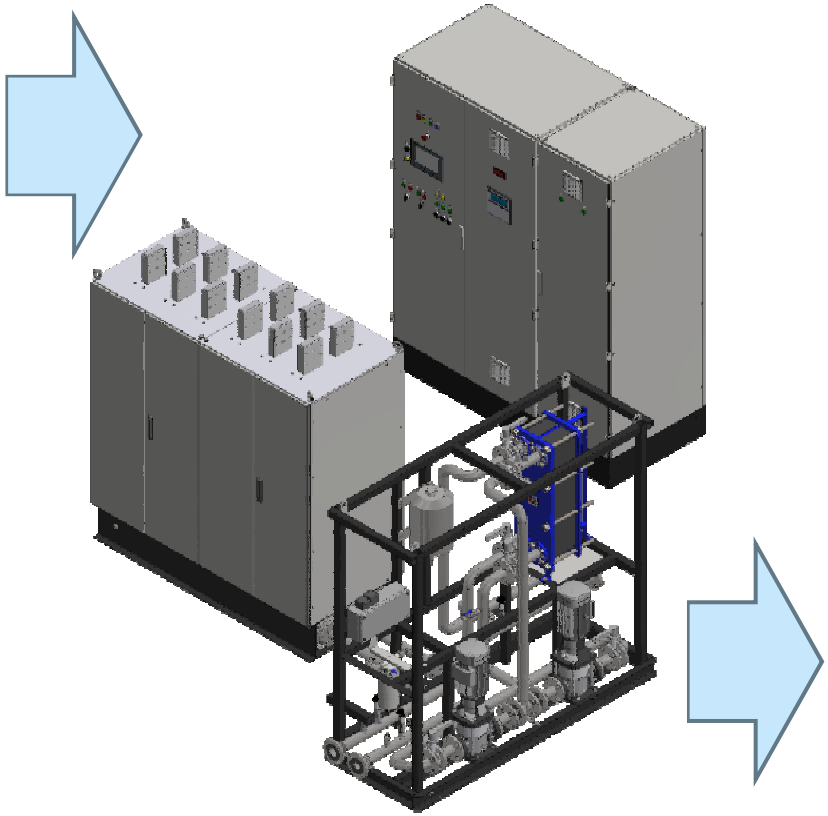
Cooling: water/water

Semiconductors: thyristors

Specifics: dry-type embedded transformer, shelter with aluminum walls IP54, auxiliary rectifier for arc stabilizing, each thyristor conductivity and reverse current monitoring, fully digital thyristor control with optic lines for control pulses, optical DC meter, complete factory testing witnessed by the end customer

Rectifier 25kA/60V with control and cooling system (retrofit)
Year: 2019
Process: VAR (titanium vacuum arc remelting)
Amount: 1+1
Cooling: water/water
Semiconductors: thyristors
Specifics: a specific design to meet existing busbar system and place available , auxiliary rectifier for arc stabilizing, each thyristor conductivity and reverse current monitoring, fully digital thyristor control with optic lines for control pulses, optical DC meter, complete factory testing witnessed by the end customer





Rectifier 6.3kA/450V

Year: 2015-2017
Process: nickel electrolysis
Equipment: Rectifier groups
Total amount: 20
Cooling: air direct
Semiconductors: diodes
Specifics: replacement with new units with the same dimensions and Busbar arrangement

Rectifier unit (‘block’) 8kA/1000V + overvoltage protection cabinet

Year: 2017
Process: aluminum electrolysis
Equipment: Rectifier groups
Total amount: 16
Cooling: air direct
Semiconductors: diodes
Specifics: replacement with new units with the same dimensions

Rectifier group 25kA/450V with control and cooling system
Year: 2016
Process: fluorine electrolysis
Cooling: water/water
Semiconductors: thyristors
Scope: rectifiers (‘blocks’) 6.3kA/450V (4 pcs.),
overvoltage protection cabinets(4 pcs.),
local control cabinet, cooling station,
2 remote control cabinets

Control system for rectifier 37.kA

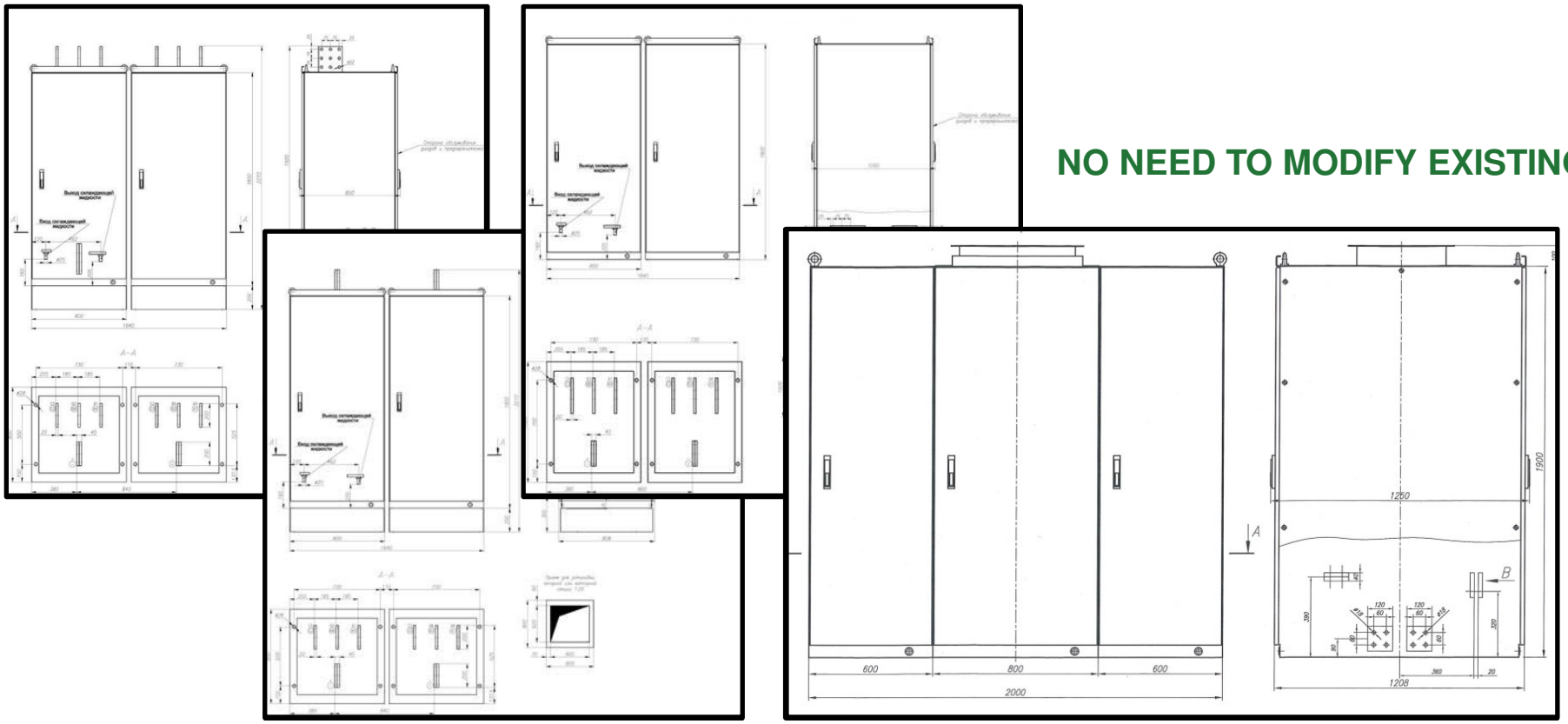
Year: 2019,2020
Process: cupper refining
Equipment: **2** rectifier groups **37.5kA+ 1** rectifier group 2**5kA**
Delivery: LCC for thyristor groups (fully digital thyristor control), remote control
Cooling: water
Semiconductors: thyristors
Scope: EPC

SEMICONDUCTOR EQUIPMENT - RETROFIT

Upgrade (Retrofit) of existing out-of-date (outworn) rectifiers improving technical characteristics of rectifier units with respect to their overall dimensions and layout of terminals.

Cooling: air, water, glycol/air
Connections: rectifier design is made to suit existing busbar
Control system: could be in scope upon customer request

Replacement of equipment, installed in 1960…1980s



NO NEED TO MODIFY EXISTING BUSBARS

Maintenance of our and third party equipment manufacturer's on single or long-term basis

Commissioning of third party equipment manufacturer's

Projects finished:

Annual maintenance procedure for 5 rectifiers 37.5kA on Russian Copper Company (2018, 2019, 2020…)

VSMPO-AVISMA commissioning of 2 third party rectifiers after repairing (2018)

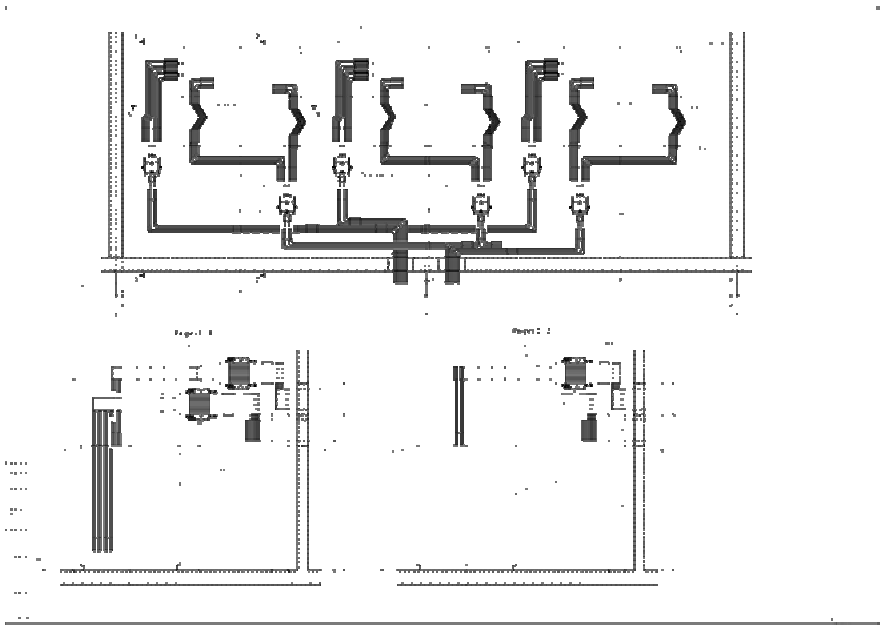
Egyptalum delivery of components for rectifier cooling system (2019)

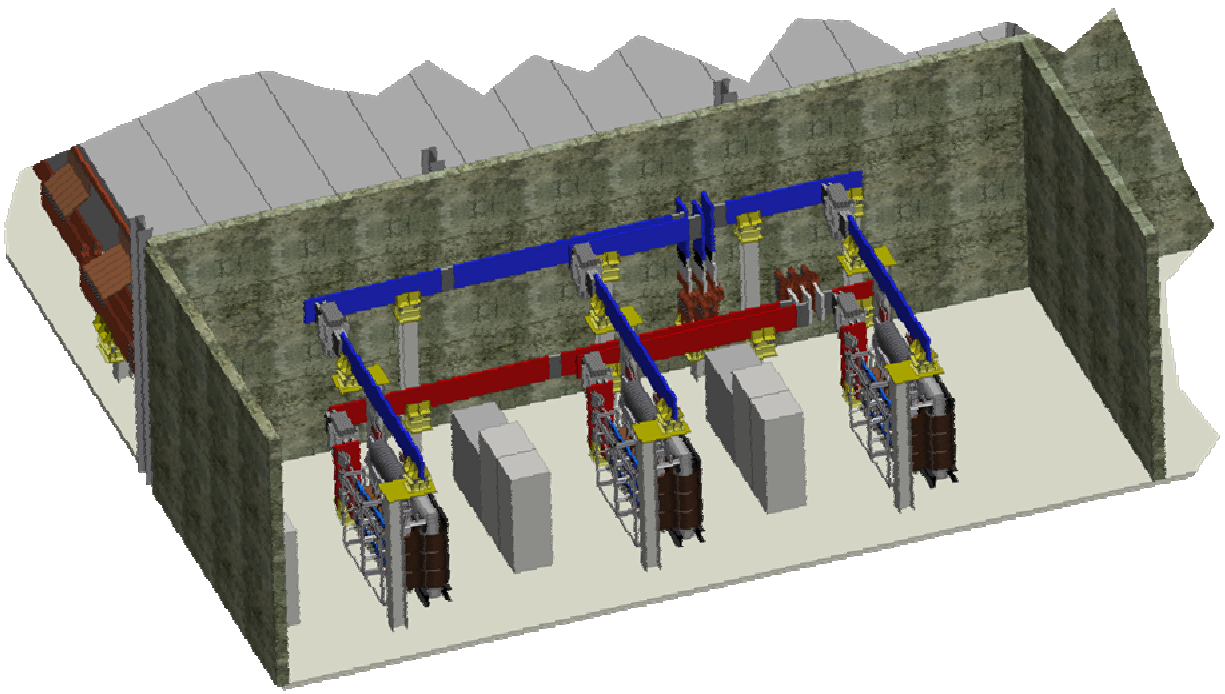
Engineering of DC substation and potline DC bus system

Year: 2015

End Customer: CJSC Russian Copper Company**:**

Scope: DC substation for copper electrolysis. General engineering.





SEMICONDUCTOR EQUIPMENT

Leading specialists of semiconductor sector have more than 20-year experience. They successfully finished dozens of projects.

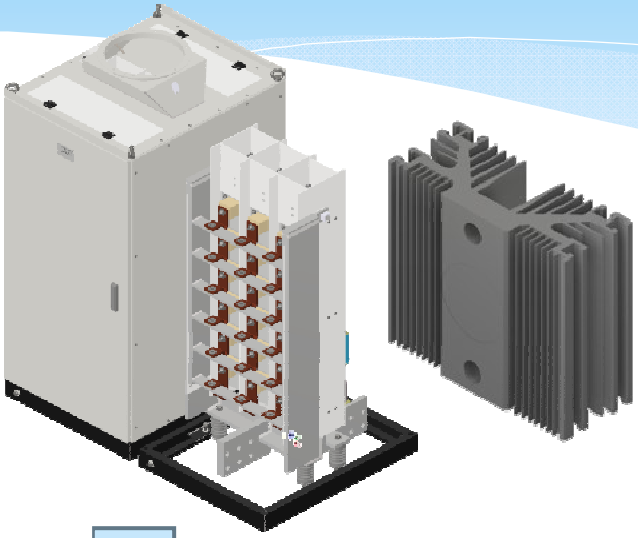
Rectifier units and control systems.
A reasonable fusion of innovations and time-approved solutions.

- **All design is performed in 3D-CAD environment. This ensures a deep design analysis and fully elimination of possible mistakes.**
- **Only first-class components from word-leading manufacturers.**
- **Non-flammable insulation from Delmat® и Durostone®.**
- **All contact surfaces are nickel-coated to ensure stable contact resistance.**
- **Flexibles from pressure-welded O_2-free copper with stable electrical resistance, which is critically important for semiconductor devices, connected in parallel.**
- **Fasteners from stainless steel or insulating materials.**
- **Fully digital control system.**

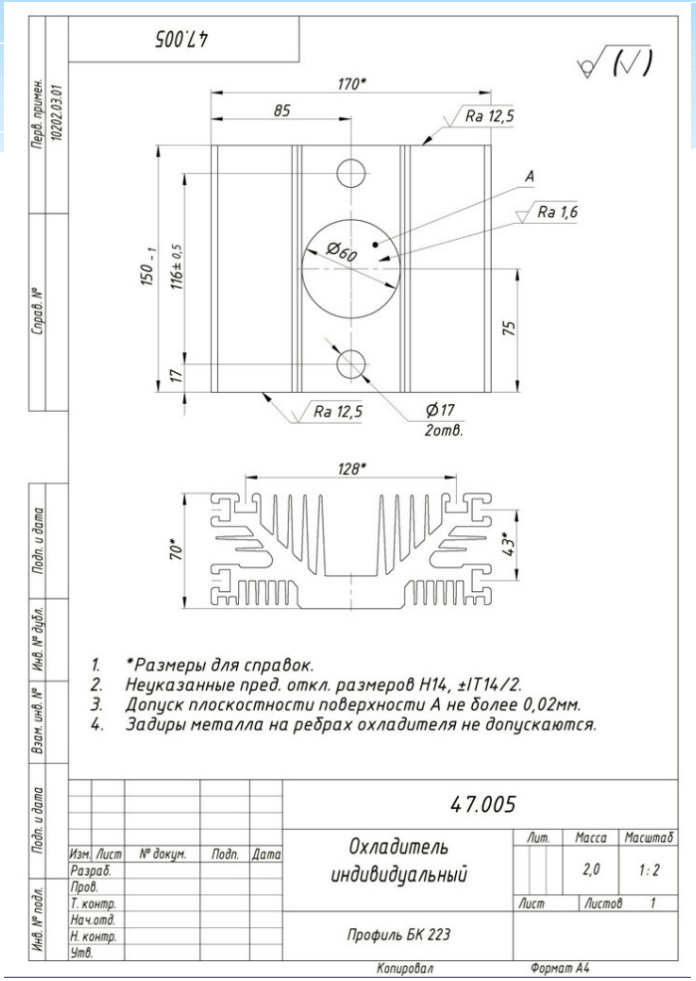
WE ARE FOCUSED ON OUR CUSTOMER'S SATISFACTION WITH THE HIGHEST QUALITY OF GOODS AND SERVICES

3D DESIGN PROCESS

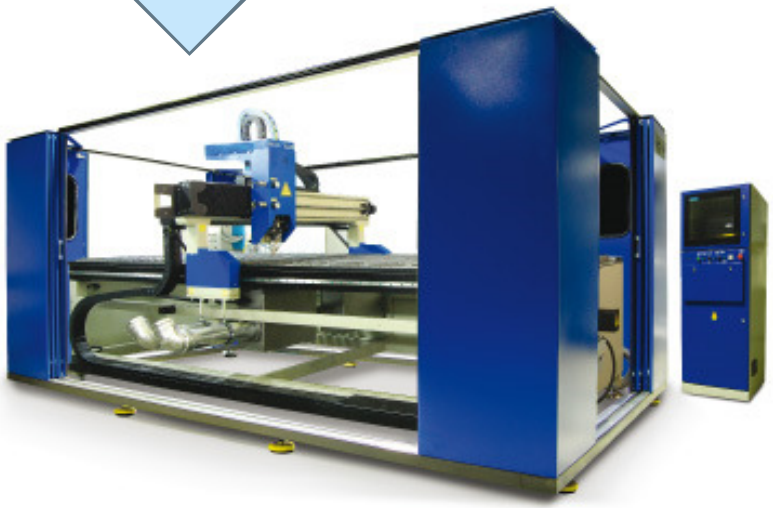
3D model creation and full design analysis



Automatic drawings generation



3D model file export to laser complex



MANUFACTURING

Production building 1

Complex testing

Inside production building 1:
equipment manufactured is ready for packing

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