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1.0 INTRODUCTION

This specification gives the minimum requirements for design, materials, selection criteria, manufacturing and inspection of the electrical installation parts of package units for NIS - Pancevo Oil Refinery.

2.0 CODES AND STANDARDS

The electrical part shall be designed, constructed and tested in accordance with the requirements of this specifications and the edition of the applicable National and/or International Codes and Standards.

Where a conflict between the codes, etc., might exist, the most stringent requirements shall govern.

IEC 60073	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Coding Principles for Indicators and Actuators
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60079-14	Explosive atmospheres Gas & Dust - Part 14: Electrical installations design, selection and erection
IEC 60204	Safety of machinery – Electrical equipment of machines
IEC 60227	Polyvinyl Chloride Insulated Cables of Rated Voltages up to and Including 450/750 V
IEC 60287	Electrical Cables – Calculation of the Current Rating
IEC 60332	Tests on electric and optical fibre cables under fire conditions
IEC 60364	Electrical Installations of Buildings
IEC 61439	Low-voltage Switchgear and Control Gear Assemblies
IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV
IEC 60445	Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 60668	Dimensions of Panel Areas and Cutouts for Panel and Rack-mounted Industrial Process Measurement and Control Instruments
IEC 61000	Electromagnetic Compatibility
IEC 62305	Protection of Structures against Lightning
IEC 61082	Preparation of Documents used in Electro technology

2.1 CE MARKING

All electrical equipment, materials and components shall be CE certified, shall bear CE marking and shall be compliant to applicable EC directives.

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2.2 SERBIAN AUTHORITY REQUIREMENTS

All equipment shall be in compliance with Serbian legislation and law requirements. Equipment vendors shall deliver all documentation requested by Serbian law (e.g. Serbian Ex Certificate) to be able to put equipment in operation in Serbia.

All electrical equipment for use in hazardous area will be certified according ATEX (94/9/EC) directive.

3.0 DESIGN AND CONSTRUCTION

The scope of the electrical installation belonging to the package unit is defined in the requisition.

3.1 SYSTEME VOLTAGE LEVELS

3.1.1 The electrical supply systems will meet the requirements given in IEC 60204-1, clause 4.3.

Voltage and frequency maximum variations in the supply system shall remain within the following limits:

- Voltage U_n max/min $\pm 10\%$
- Frequency 50 Hz max/min $\pm 1\%$

3.1.2 The applicable system voltages and their range of application are indicated in table 1.

System	Nominal Voltage[V]	Fr. [Hz]	Wires	Earthing method	Description
AC	6 000	50	3	Resistance	150 kW < Motors
	400	50	4	Solid	0.18 kW < Motors = < 132 kW
	230	50	3	Solid	Motors = < 0.18 kW
	400/230	50	5	Solid	Lighting, small power and UPS
	230	50	3	Solid	Lighting, small power, control circuits and contactor coils
DC	110		2		Control circuits and trip coils of circuit breakers
	24		2		Instruments

Table 1

3.1.3 For panels it is preferred to have one (1) power source, i.e. the control power to be derived from this source.

3.1.4 The system design shall be such that the system stability is maintained when the supply voltage and frequency remain within the limits given in paragraph 3.1.1.

3.1.5 When the complete power distribution system design is included in the scope the following criteria apply:

- The motor terminal voltage shall not drop below 90% of the nominal voltage during starting and 95% during normal operation.
- Voltage drop in cable between distribution board and first connection box in the circuit for lighting and small power circuits shall not exceed 2%.

To allow verification of the above criteria the system short circuit rating will be specified.

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3.1.6 In TN-S systems the neutral and the PE conductor shall be separated.

3.2 DEGREE OF PROTECTION

3.2.1 The minimum equipment enclosure protection shall be conformed to IEC 60529 as follows:

- IP 31 Indoor
- IP 20 Panels with open doors (life parts shielded)
- IP 55 Outdoor
- IP 65 Outdoor (where an explosive atmosphere of dust is present - Zone 21, 22)
- IP 66 Outdoor (electric motors for air coolers)

Floor mounted panels shall be equipped with gland plates and the proper cable glands which maintain the specified degree of protection. In addition the installation, including the enclosures, shall be suitable for the environmental conditions specified on the site and utility data sheet.

3.2.2 The explosion protection type of the electrical equipment and materials shall be in accordance with the area classification and conform IEC 60079-14, clause 12. When certain materials require being of a particular type of protection, this will be specified in the requisition.

3.2.3 Zone classification, gas group and temperature class shall comply with the requisition to which this specification belongs.

3.2.4 All materials installed inside a hazardous area shall have a certificate of conformity or a declaration of compliance issued by the appropriate authority.

For each individual intrinsic safe circuit the permissible parameters of wiring external to the package unit wiring shall be specified (refer to IEC 60079-11).

3.2.5 All electrical equipment installed in outdoor areas shall be covered with canopy to protect from rainwater.

3.2.6 Areas within the package unit shall be classified by Seller for the degree and extent of hazard in line with local (national) codes and standards.

For undefined cases and when no local (national) codes are available the IEC 60079-10 and/or API RP 505 shall be applied.

Seller shall furnish a drawing-indicating zone of classified area and gas group (group IA, IIA/IIB/IIC, etc.) for the package unit. A list of hydrocarbons handled in the package unit with their properties like flash point, ignition, temperature, low explosive limits, etc., shall also be furnished.

The extent of zones (Zone 20, 21, 22) for explosive dust atmospheres will be also provided by Seller for the package unit.

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3.3 GENERAL REQUIREMENTS

- 3.3.1 The package unit electrical installation shall in general follow the requirements of IEC 60204.
- 3.3.2 Materials that are highly persistent or toxic to the environment or considered international potential carcinogens shall not be used.
- 3.3.3 Unless otherwise specified in the requisition motor starters are excluded from the scope. These will be supplied and installed by others and centralized in motor control centers. The related motor control stations and cables to motors and control stations will be supplied and installed by others. However, the unit supplier shall provide adequate cable supporting facilities on the skid.

3.4 PANEL AND BOXES

- 3.4.1 The overall height of floor-mounted panels shall not exceed 2300 mm.
- 3.4.2 Walk-in type enclosures (panels), which will be install inside a hazardous area shall be pressurized in accordance with IEC 60079-13.
- 3.4.3 When a panel comprises more than one (1) circuit, the diversity factor shall comply with table 2.

Number of main circuits	Rated diversity factor
2 and 3	0,9
4 and 5	0,8
6 to 9 inclusive	0,7
10 (and above)	0,6

Table 2 – Values of rated diversity factor

- 3.4.4 Others based on the power consumption figures given by Seller will size feeder cables to the package unit. Terminals and/or bus bars for the connection of external cabling shall be suitable to connect cables as specified in the requisition. If not specified terminal sizes shall be in accordance with table 3, for maximum cross sectional areas.

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Rated current	Solid or stranded conductors		Flexible conductors	
	Cross-sections		Cross-sections	
	min.	max.	min.	max.
A	mm ²		mm ²	
6	0,75	1,5	0,5	1,5
8	1	2,5	0,75	2,5
10	1	2,5	0,75	2,5
12	1	2,5	0,75	2,5
16	1,5	4	1	4
20	1,5	6	1	4
25	2,5	6	1,5	4
32	2,5	10	1,5	6
40	4	16	2,5	10
63	6	25	6	16
80	10	35	10	25
100	16	50	16	35
125	25	70	25	50
160	35	95	35	70
200	50	120	50	95
250	70	150	70	120
315	95	240	95	185

NOTE 1 If the external conductors are connected directly to built-in apparatus, the cross-sections indicated in the relevant specifications are valid.

NOTE 2 In cases where it is necessary to provide for conductors other than those specified in the table, special agreement shall be reached between manufacturer and user.

Table 3 – Minimum and maximum cross-sections of copper conductors suitable for connection

- 3.4.5 Cable access shall be from the bottom or from the sides. Cable glands shall be metallic for metallic enclosures and plastic for plastic enclosures. However, for mechanical stress relief, cables with large diameters may require installation of metallic cable glands. Cable glands for the explosion-proof equipment located in zone 1 and zone 2 (resp. zone 21 and zone 22) areas shall be of explosion-proof type and suitable for the hazardous location.
- 3.4.6 Panels shall be equipped with an earth bar over the full width of the cable connection compartment. The armoring of cables and/or the earthing conductor shall be connected to this bar.
- 3.4.7 Instrumentation and electrical control and signaling devices may be contained into one (1) panel with mechanical separations, but preferably separate.
- 3.4.8 Electrical control panels shall only comprise electrical components - not pressure lines, etc.
- 3.4.9 Suitable rated space heaters shall be provided in case condensation is expected, in line with Site and utility data sheet requirements.
- 3.4.10 Internal wiring shall be bundled/bunched, or installed in plastic ducts.
- 3.4.11 Panel Mounted Components
- Each distribution panel shall have a supply disconnection device in accordance with IEC 60204-1, clause 5.3. When a neutral is required it shall be interrupted as well by this device.
- Signalling and control devices for outgoing circuits shall be flush mounted.
- Color-coding of signal lamps and push buttons shall be in accordance with IEC 60073.

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Control circuits shall be separately protected against short circuit. Small power branch circuits shall have earth fault protection.

When circuit breakers are used special attention shall be paid to their breaking capacity.

Thermal overload devices shall have a manual reset.

Signal loops shall be fail-safe. Protection circuits shall operate according to the operating current principle.

Seller shall ensure that protective devices in his system are selective with the upstream protections.

3.4.12 Cable entries shall be executed for metric threaded glands.

3.5 ELECTRIC MOTORS

3.5.1 Motors shall be supplied without frequency converters where variable speed drivers are required. The proper selection of frequency converters will be done by engineering company (Buyer) according to Seller's requirements.

3.5.2 In case motors receive power from a motor control center that is excluded from the scope the type of motor overload protection will be specified in the requisition.

3.5.3 Asynchronous motors are preferred.

3.5.4 All motors shall be in IE3 Efficiency class.

3.5.5 All MV motors will be equipped with temperature sensors (PTC as minimum) and anticondensation heaters. The temperature sensors will be wired to motor protection relay.

3.5.6 All motors driven by VSD (Variable Speed Drives) should be equipped with temperature sensors (PTC as minimum) for windings and bearings, one insulated bearings. For this motors use armoured cable with copper screen and fourth wire divided into 3 symmetrical conductors.

3.6 CABLE AND WIRING INSTALLATIONS

3.6.1 Conductor identification inside panels shall be in accordance with IEC 60204, clause 15.2.

3.6.2 All interconnecting cabling shall as a minimum comply with IEC 60227 and shall be no flame propagating as per relevant part (depending upon method of laying) of IEC 60332.

3.6.3 The minimum cross section of interconnecting cabling/wiring shall be as follows:

- LV power: 2.5 mm², Cu
- Control: 2.5 mm², Cu
- Inside panels: 2.5 mm², Cu

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- 3.6.4 Cables shall be sized in accordance with IEC 60364-4.
- 3.6.5 The earthing conductor size shall be in accordance with IEC 60204-1, table 1.
- 3.6.6 All power cables in the plant must be PP41 (Cu/PVC/STA/PVC) or similar type. Multi core configuration for all power and control electrical cables is considered.
- 3.6.7 Flexible cables shall only be used for flexible connections. However, the use of flexible cables and cords shall be avoided as far as possible.
- 3.6.8 Aboveground cables shall be mechanically protected either by open conduits or by cable trays with covers.
- 3.6.9 Where practical cables shall be grouped in cable trays. Single cables may be installed in open conduit.
- 3.6.10 All electrical cable trays shall be of prefabricated hot-dip galvanized steel. The support distance of horizontal installed cable trays shall be such that on top of the maximum cable load a point load of 800 N can be absorbed at any point. Cable tray make and type shall be subject to approval by Buyer. The initial tray loading shall not exceed 75% of the maximum single layer capacity.

The cable tray accessories, such as horizontal/vertical bends, tees, etc., shall be of hot-dip galvanized steel.

The cable trays and accessories are placed on the racks/supports and joined by couplers.

- 3.6.11 Cables running on cable ladders shall be securely fastened in a single layer with UV resistant tie wraps.
- 3.6.12 The clearance between hot surfaces and cables shall be minimum 300 mm.

3.7 EARTHING INSTALLATION

- 3.7.1 Unless otherwise specified in the requisition, earthing system/installation, which is in scope of the package unit supplier delivery, shall include safety earthing, static earthing, lightning protection and instrument earthing systems as required in accordance with the relevant IEC standards and the area classification requirements.
- 3.7.2 The earthing installation shall meet the requirements of IEC 60364-5-54.
- 3.7.3 Generally the main earthing loop or grid system will be underground using bare copper conductor cross section 70 mm² for main earthing grid and 35 mm² for branches. Where necessary, earthing system(s) will be installed overhead including earthing conductors connected to the earthing bus-bar(s) with removable connections.
- 3.7.4 The package unit earthing system shall be connected to the plants earthing grid at least two (2) points diagonally opposite of each other.
- 3.7.5 Inside hazardous areas all in-line instruments and valves that are clamped between nonconductive packing shall be bonded with a conductor of 16 mm². For this purpose adequate lugs shall be provided on both the instrument (valve) and the pipeline.
- 3.7.6 The armoring of (power) cables shall be used for earthing continuity in combination with the earthing grid, i.e. connected to the distribution panel's earth bar and in motors to the earth bolt inside the main connection box.
- 3.7.7 Lightning protection shall, when required, follow the requirements of IEC 62305-1, protection level 1.

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3.8 LIGHTING INSTALLATION

- 3.8.1 In general fluorescent-type lighting fixtures or LED lamps shall be applied, either pole or ceiling mounted. The fluorescent-type lighting fixtures for plant operation location and LED type for new substation and buildings. On platforms poles with 2 x 18 W fixtures shall be used. On other locations 2 x 36 W fixtures shall be used to the maximum extend, fixed to steelwork. Flood lighting shall be provided, when applied, with LED lamps.
- 3.8.2 The lighting system shall be designed to provide a sustained and uniform illumination level of not less than the values given in table 2 or recommended in API RP 540, taking into consideration a fouling factor of 0,8.

LOCATION	AVERAGE [LUX]	TYPE OF LIGHTING FIXTURE ²⁾
In plant operating locations ¹⁾	150	
Platforms ¹⁾	10	
Pump area ¹⁾	50	
Ladders/stairs ¹⁾	50	
Working areas in remaining plant areas	10	
Remaining areas ¹⁾	10	

Table 2

- Note:** 1) Measured at one (1) meter above floor level.
2) The type of lighting fixtures shall be specified in the requisition

- 3.8.3 Lighting fixtures in operating area shall be mounted at least 2.5 meters above floor level. Platform lighting shall be installed such that operators are not blinded nor are bordered by their own shades.
- 3.8.4 Adjacent fixtures shall be connected to different feeder circuits.
- 3.8.5 Emergency lighting shall be provided on escape routes and in vital operator areas. The lighting level on the escape routes shall under emergency conditions be at least 30 Lux.
Emergency lighting fixtures shall form part of the normal lighting installation.
Fluorescent or incandescent lamps will be used for emergency lighting.
- 3.8.6 The maximum allowable voltage drop in the branch circuits shall be 2%, i.e. from the connection box up till the most remote fixture on the package.
- 3.8.7 Socket outlet combinations in process areas shall be spaced to allow 50 m extension cables to reach all operating areas. Socket outlet combinations shall be 1 x 24 V AC, 16 A via built-in transformer with integral switch for hand lamps.

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3.9 MAINTENANCE SOCKET OUTLETS

- 3.9.1 The requirement for maintenance power on the package will be specified in the requisition.
- 3.9.2 Socket outlets with plugs shall be provided in process areas and other locations where maintenance or repair work is expected during shutdown.
- 3.9.3 Spacing shall be such that these areas can be reached with a 50 m extension cable.
- 3.9.4 Sizing shall be as follows:
- 3-phase, 63 A (32 A), 5-pin
- 3.9.5 Socket outlets will be connected to distribution panels. For maximum voltage drop see paragraph 3.1.5.

3.10 ELECTRIC TRACING

- 3.10.1 Heat loss calculations shall be based on the minimum design ambient temperature.

4.0 INSPECTION AND COMMISSIONING

All equipment and material shall be tested and/or inspected in accordance with the applicable project engineering specification prior to installation on the package unit.

The package unit shall be tested at the manufacturer's workshop generally in accordance with IEC 60204-1, clause 20.

After installation completion field tests shall be performed in accordance with the approved commissioning procedures.

The intention for witnessing the tests and eventual supplementary inspection items will be specified in the requisition.

5.0 CORROSION PROTECTION

All metal parts belonging to the electrical installation shall be protected against corrosion in accordance with the manufacturer's standard corrosion protection system suitable for the environmental conditions specified on the site and utility data sheet.

Surface preparation and painting shall be Seller's standard for the environmental conditions specified on the Site and utility data sheet. Seller shall submit in his quotation his standard surface preparation and painting system for Buyer's review.

Color of the topcoat of panels shall be Seller's standard unless a specific color is specified in the requisition.

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6.0 MARKING

6.1 MARKING OF WIRING

6.1.1 Wiring shall be marked in accordance with IEC.

6.2 IDENTIFICATION OF EQUIPMENT TERMINALS

6.2.1 Equipment terminals shall be identified in accordance with IEC 60445.

6.3 RATING PLATES

6.3.1 Rating plates shall comprise all information as required by the relevant standards, and shall be attached to the equipment on a well visible place.

6.3.2 Plates and labels for indoor use shall be made of "Resopal", or similar, in white color with black letters print and shall be fixed in such a way that they are easy to replace.

6.3.3 Rating plates for apparatus that will be installed outdoor and motor rating plates shall be of stainless steel and shall be fixed with corrosion resistant screws or rivets.

6.3.4 Additional plates shall be provided indicating the equipment number and/or description.

6.3.5 Sizes and letter heights of nameplates and equipment number plates will be specified in detail in the inquiry documents.

7.0 SELLER DOCUMENTATION

Seller shall, as a minimum, provide all documentation as requested on the "Requirements for Documents" forms.

Each panel shall be shipped with an "As-built" set of schematics and installation, operating and maintenance instructions.