



TECHNICAL REQUIREMENTS

ELECTRICAL

Document No. OL-TR-ER-000

GENERAL

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| 03 | | | | | |
| 02 | Update | 09-10-2024 | SK | ORLEN Lietuva | ORLEN Lietuva |
| 01 | Update | 28-10-2019 | EK | ORLEN Lietuva | ORLEN Lietuva |
| 00 | Final Issue | 15-Sep-14 | D 2 RT' engineering | ORLEN Lietuva | ORLEN Lietuva |
| Rev. | Revision description | Date | Prep. by | Check. by | Appr. by |

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1. SCOPE

- 1.1 Do not use some part of that document or part of technical requirements if that type of equipment or activity not used in your project or not included in scope of work.
- 1.2 The present document is intended to define the general requirements for the designing of electrical section that shall be used as the basis for the project involved in the general project of electrical system. The prescriptions of this document shall be applied for the all electrical activities – power supply network, illumination, communication, earth connection, electric heating, ,device wire connection and etc.
- 1.3 The purpose of these prescriptions is to indicate important obligatory requirements of normative documents and customer which will guarantee the whole electrical system shall be safe, reliable, fitted for higher future loads, simple to maintain, easy to operate, easy to change the equipment and protected against harmful corrosive environment.

2. REFERENCES

The actual (newest) revision of documents shall be used.

The following standards, regulations, normative documents and other documents are referenced in the package of technical requirements:

2.1 Normative Documents of the Republic of Lithuania

Elektros energetikos įstatymas VIII-1881 (aktuali redakcija nuo 2019-07-01)

Elektros tinklų naudojimo taisyklės, patvirtintos energetikos ministro 2012 m. birželio 18 d. įsakymu Nr. 1-116 (Žin., 2012, Nr. 69-3562)

Elektros įrenginių įrengimo bendrosios taisyklės, patvirtintos energetikos ministro 2012 m. vasario 3 d. įsakymu Nr. 1-22 (Žin., 2012, Nr. 18-816)

Elektros linijų ir instaliacijos įrengimo taisyklės, patvirtintos energetikos ministro 2011 m. gruodžio 20 d. įsakymu Nr. 1-309 (Žin., 2012, Nr. 2-58)

Elektros įrenginių relinės apsaugos ir automatikos įrengimo taisyklės, patvirtintos energetikos ministro 2011 m. gegužės 27 d. įsakymu Nr. 1-134 (Žin., 2011, Nr. 67-3199)

Skirstyklų ir pastočių elektros įrenginių įrengimo taisyklės, patvirtintos energetikos ministro 2011 m. gruodžio 15 d. įsakymu Nr. 1-303 (Žin., 2011, Nr. 165-7886)

Specialiųjų patalpų ir technologinių procesų elektros įrenginių įrengimo taisyklės, patvirtintos energetikos ministro 2013 m. kovo 5 d. įsakymu Nr. 1-52 (Žin., 2013, Nr. 27-1299)

Apšvietimo elektros įrenginių įrengimo taisyklės, patvirtintos energetikos ministro 2011 m. kovo 3 d. įsakymu Nr. 1-28 (Žin., 2011, Nr. 17-815)

Galios elektros įrenginių įrengimo taisyklės, patvirtintos energetikos ministro 2012 m. sausio 2 d. įsakymu Nr. 1-1 (Žin., 2012, Nr. 5-151)

Elektros tinklų apsaugos taisyklės, patvirtintos energetikos ministro 2010 m. kovo 29 d. įsakymu Nr. 1-93 (Žin., 2010, Nr. 39-1877)

Elektros energijos gamintojų ir vartotojų elektros įrenginių prijungimo prie elektros tinklų tvarkos aprašas, patvirtintas energetikos ministro 2012 m. liepos 4 d. įsakymu Nr. 1-127 (Žin., 2012, Nr. 82-4279),

Elektros energijos tiekimo ir naudojimo taisyklės, patvirtintos energetikos ministro 2010 m. vasario 11 d. įsakymu Nr. 1-38 (Žin., 2010, Nr. 20-957)

Saugos eksploatuojant elektros įrenginius taisyklės, patvirtintos energetikos ministro 2010 m. kovo 30 d. įsakymu Nr. 1-100 (Žin., 2010, Nr. 39-1878), įsakymo pakeitimas – 2012 m. spalio 23 d. įsakymu Nr. 1-207 (Žin., 2012, Nr. 124-6254, 2015-11-12 įsakymas Nr. 1-259)

Civilinės aviacijos elektros įrenginių naudojimo ir priežiūros taisyklės, patvirtintos susisiekimo ministro 2001 m. balandžio 2 d. įsakymu Nr. 85 (Žin., 2001, Nr. 35-1204)

Elektros įrenginių bandymų normų ir apimčių aprašas, patvirtintas Lietuvos Respublikos energetikos ministro 2016 m. spalio 26 d. įsakymu Nr. 1-281

Elektros tinklų statybos rūšių ir elektros įrenginių įrengimo darbų rūšių aprašas, patvirtintas Lietuvos Respublikos energetikos ministro 2016 m. rugsėjo 13 d. įsakymu Nr. 1-245

Elektrinių ir katilinių technologinių parametrų matavimo tikslumo normos, patvirtintos ūkio ministro 2000 m. birželio 16 d. įsakymu Nr. 223 (Žin., 2000, Nr. 52-1512)

Dispečerinio elektros energetikos sistemos valdymo nuostatai, patvirtinti Lietuvos Respublikos energetikos ministro 2015 m. vasario 20 d. įsakymu Nr. 1-54;

Statybos techninis reglamentas STR 2.01.06:2009 „Statinių apsauga nuo žaibo. Išorinė statinių apsauga nuo žaibo“, patvirtintas aplinkos ministro 2009 m.

lapkričio 17 d. įsakymu Nr. D1-693 (Žin. 2009, Nr. 138-6095)

Veiklos elektros energetikos sektoriuje leidimų išdavimo taisyklės, patvirtintos Lietuvos Respublikos energetikos ministro 2013 m. spalio 22 d. Nr. 1-212

HN-98:2014

Lietuvos higienos norma HN-98:2014 „natūralus ir dirbtinis darbo vietų apšvietimas. Apšvietos mažiausios ribinės vertės ir bendrieji matavimo reikalavimai“ Lietuvos Respublikos sveikatos apsaugos ministro 2014 m. balandžio 30 d. įsakymo Nr. V-520 redakcija Requirements for the Illumination of Work Places. Hygiene Standards

Įrangos ir apsaugos sistemų, naudojamų potencialiai sprogioje aplinkoje, techninis reglamentas, patvirtintas ūkio ministro 1999 m. gruodžio 27 d. įsakymu Nr. 432 (Žin., 2000, Nr. 7-198), Lietuvos Respublikos ūkio ministro 2016 m. gegužės 11 įsakymo Nr. 4-360 redakcija) Technical Regulations for Equipment and Protection Systems Used in Potentially Explosive Atmosphere.

Darbuotojų, dirbančių potencialiai sprogioje aplinkoje, saugos nuostatai. Valstybės žinios, 2005-10-06, Nr. 118-4277, 2014 m. vasario 26 d. Nr. A1-114 Safety Regulations for the Employees Working in Potentially Explosive Atmosphere.

RSN 156-94

“Statybinė klimatologija. RSN 156-94“, Valstybės žinios, 2002-10-04, Nr. 96 -4230. Structural Climatology

Aukštų statinių ženklinimo taisyklės. Civilinės aviacijos administracijos direktoriaus 2009 m. kovo 27 d. įsakymo Nr. 4R-72 redakcija. Regulations on Marking of Tall Structures.

Bendrosios gaisrinės saugos taisyklės (Valstybės žinios, 2010-08-19, Nr. 99-5167), 2018 m. lapkričio 7 d. Nr. 1-388. General Fire protection safety rules.

PST-07-97

Chemijos pramonės įmonių priešgaisrinės saugos taisyklės (Vidaus reikalų ministerijos 1997 12 30 įsakymu Nr. 594). Fire protection safety rules of chemical industry plant

2.2 Standards of the Republic of Lithuania

LST EN 62305-1

Apsauga nuo žaibo. 1 dalis. Bendrieji principai

LST EN 62305-2

Apsauga nuo žaibo. 2 dalis. Rizikos valdymas

LST EN 62305-3

Apsauga nuo žaibo. 3 dalis. Fizinė žala statiniams ir

pavojus gyvybei

| | |
|-----------------------|--|
| LST EN 62305-4 | <i>Apsauga nuo žaibo. 4 dalis. Elektrinės ir elektroninės sistemos statiniuose</i> |
| LST EN 60079-0 | <i>Sprogiosios atmosferos. 0 dalis. Įranga. Bendrieji reikalavimai</i> |
| LST EN 60196 | <i>IEC standartiniai dažniai</i> |
| LST EN 60529 | <i>Gaubtų sudaromos apsaugos laipsniai (IP kodas)</i> |

2.3 Standards of the European Union

2014/34/ES

Dėl valstybių narių įstatymų, susijusių su potencialiai sprogioje aplinkoje naudojama įranga ir apsaugos sistemomis, suderinimo. Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres

1999/92/EC

Directive on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

2014/35/EU

The Low Voltage Directive (LVD) (2014/35/EU)

2014/30/EU

Electromagnetic Compatibility (EMC) Directive

2.4 International Electrotechnical Commission Standards (IEC)

IEC 60617

Graphical symbols for diagrams

2.5 Standards for Classification of Hazardous Areas

2012 m. rugpjūčio 24 d. Akcinės bendrovės „ORLEN Lietuva“ Generalinio direktoriaus įsakymu Nr. TV1(1.2-1)-216 „Dėl sprogimo rizikos vertinimo ir potencialiai sprogusių aplinkų nustatymo taisyklių tvirtinimo“

LST EN 60079-10-1

Sprogiosios atmosferos. 10-1 dalis. Zonų klasifikavimas. Sprogiosios dujų atmosferos. Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres (IEC 60079-10-1) EN 60079-10-1

LST EN 60079-10-2

Sprogiosios atmosferos. 10-2 dalis. Zonų klasifikavimas. Degių dulkių atmosferos. Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust atmospheres (IEC 60079-10-2) EN 60079-10-2

LST EN 60079-20-1

Sprogiosios atmosferos. 20-1 dalis. Medžiagų

charakteristikos dujoms ir garams klasifikuoti. Bandymo metodai ir jo duomenys

API 505

API rekomenduojama praktika Nr.505 potencialiai sprogių aplinkų nustatymui tam, kad išdėstyti elektros įrangą naftos perdirbimo įrenginiuose, 1 leidimas, 1997 m. lapkričio mėn. (API Recommended Practice 505, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities, 1st Edition, November 1997)

IP 15

Potencialiai sprogių aplinkų nustatymo principai įrenginiuose su degiais skysčiais, IP saugios praktikos naftos perdirbimo pramonėje modelio 15 dalis, 3 leidimas, 2005 m. liepos mėn. (Area Classification Code for Installations Handling Flammable Fluids, Part 15 of the IP Model Code of Safe Practice in the Petroleum Industry, 3rd Edition, July 2005)

2.6 Standards for Equipment of Hazardous Areas

LST EN 60079-0

Electrical apparatus for explosive gas atmospheres -- Part 0: General requirements

LST EN 60079-1

Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d"

LST EN 60079-2

Explosive atmospheres - Part 2: Equipment protection by pressurized enclosure "p"

LST EN 60079-6

Explosive atmospheres - Part 6: Equipment protection by oil immersion "o"

LST EN 60079-5

Explosive atmospheres - Part 5: Equipment protection by powder filling "q"

LST EN 60079-7

Explosive atmospheres - Part 7: Equipment protection by increased safety "e"

LST EN 60079-14

Explosive atmospheres -- Part 14: Electrical installations design, selection and erection

LST EN 60079-15

Explosive atmospheres -- Part 15: Equipment protection by type of protection "n"

LST EN 60079-17

Explosive atmospheres -- Part 17: Electrical installations inspection and maintenance

LST EN 60079-18

Explosive atmospheres -- Part 18: Equipment protection by encapsulation "m"

| | |
|--------------------------|--|
| LST EN 60079-25 | <i>Electrical apparatus for explosive gas atmospheres - Part 25: Intrinsically safe systems</i> |
| LST EN 60079-26 | <i>Explosive atmospheres - Part 26: Equipment with Equipment Protection Level (EPL) Ga</i> |
| LST EN 60079-30-1 | <i>Explosive atmospheres - Part 30-1: Electrical resistance trace heating - General and testing requirements</i> |
| LST EN 60079-30-2 | <i>Explosive atmospheres - Part 30-2: Electrical resistance trace heating - Application guide for design, installation and maintenance</i> |
| LST EN 60079-32-1 | <i>Explosive atmospheres - Part 32-1: Electrostatic hazards, guidance</i> |
| LST EN 60079-32-2 | <i>Explosive atmospheres - Part 32-2: Electrostatics hazards - Tests</i> |
| LST EN 60079-33 | <i>Explosive atmospheres - Part 33: Equipment protection by special protection 's'</i> |

2.7 OL Specifications

2.7.1 General

| | |
|---------------------|-----------------------------|
| OL-TR-GR-000 | <i>General Requirements</i> |
|---------------------|-----------------------------|

2.7.2 Electrical

| | |
|---------------------|---|
| OL-TR-ER-001 | <i>Electrical. Electrical Buildings</i> |
| OL-TR-ER-002 | <i>Electrical. Medium Voltage Switchgear Units</i> |
| OL-TR-ER-003 | <i>Electrical. Low Voltage Panels</i> |
| OL-TR-ER-004 | <i>Electrical. Low Voltage Switchgear Units</i> |
| OL-TR-ER-005 | <i>Electrical. Low Voltage Motor Control Centers</i> |
| OL-TR-ER-006 | <i>Electrical. Self-Restarting Panel and System</i> |
| OL-TR-ER-007 | <i>Electrical. Motor Group Switch Off Systems</i> |
| OL-TR-ER-008 | <i>Electrical. Motor Control Devices (VSD, Soft Starters)</i> |
| OL-TR-ER-009 | <i>Electrical. Power Control Devices</i> |
| OL-TR-ER-010 | <i>Electrical. Medium Voltage Motors</i> |
| OL-TR-ER-011 | <i>Electrical. Low Voltage Motors</i> |
| OL-TR-ER-012 | <i>Electrical. Capacitors and Reactive Power Compensation Units</i> |

| | |
|---------------------|--|
| OL-TR-ER-013 | <i>Electrical. Power Transformers</i> |
| OL-TR-ER-014 | <i>Electrical. Bus Conductors</i> |
| OL-TR-ER-015 | <i>Electrical. Uninterruptible Power Supply</i> |
| OL-TR-ER-016 | <i>Electrical. Accumulators</i> |
| OL-TR-ER-017 | <i>Electrical. Illumination</i> |
| OL-TR-ER-018 | <i>Electrical. Maintenance Illumination and Power Supply Connection Points</i> |
| OL-TR-ER-019 | <i>Electrical. High Building Warning Lights</i> |
| OL-TR-ER-020 | <i>Electrical. System of Heating, Ventilation Air Condition and Pressure Control</i> |
| OL-TR-ER-021 | <i>Electrical. Grounding</i> |
| OL-TR-ER-022 | <i>Electrical. Protection of Direct and Indirect Lighting Effects</i> |
| OL-TR-ER-023 | <i>Electrical. Cathodic Protection</i> |
| OL-TR-ER-024 | <i>Electrical. Cable Trench</i> |
| OL-TR-ER-025 | <i>Electrical. Cable Trays</i> |
| OL-TR-ER-026 | <i>Electrical. Power and Control Cables</i> |
| OL-TR-ER-027 | <i>Electrical. Electrical Heating for Piping and Equipment</i> |
| OL-TR-ER-028 | <i>Electrical. Electrical Heating for Instruments</i> |
| OL-TR-ER-029 | <i>Electrical. Power Supply for Instrument Systems</i> |
| OL-TR-ER-030 | <i>Electrical. Electric Actuators</i> |
| OL-TR-ER-031 | <i>Electrical. Electric Shock Protection</i> |
| OL-TR-ER-032 | <i>Electrical. Overvoltage Protection</i> |
| OL-TR-ER-033 | <i>Electrical. Telecommunications Installation</i> |
| OL-TR-ER-034 | <i>Electrical. Secure and Fire Safety Systems Installation</i> |
| OL-TR-ER-035 | <i>Electrical. Remote Control System of Substation</i> |
| OL-TR-ER-036 | <i>Electrical. General Electrical Erection Procedures</i> |

3. TERMS AND DEFINITIONS

AJB: Auxiliary junction box.

ALT: Automatic load transfer.

AD: Heat tracing junction box.

AC: Alternating current

DC: Direct current.

DCS: Distributed Control System of Process.

DE: Drive end.

Electrical Equipment Room (EER of EIP (Lithuanian)): room in substation or other building for installation of switchgears, distribution panels, motor control centers and other type of electrical power and control equipment's.

HOA: Hand-Off-Auto.

HV: High voltage, the voltage above 110kV AC.

Local Rules: Rules, regulations and other documents (include Owner specifications, requirements, etc.) which are regulating the electrical sector in Lithuania.

LV: Low voltage, the voltage from 50V till 1000V AC and from 75V till 1500V DC.

MCC: Motor control centers.

MCS: Motor control station

MJB: Main junction box.

MV: Medium voltage, the voltage from 1000V till 35kV AC.

NDE: Not drive end.

OL: Akcinė Bendrovė "ORLEN Lietuva".

ONAN: Cooling system "Oil Natural Air Natural".

RCD: Residual current circuit breaker.

RIEU: Rules for the Installation of Electrical Units. Elektros įrenginių įrengimo taisyklės

SD: Junction Box (power, control circuits)

UPS: Uninterruptible Power Supply (System).

VSD: Variable speed driver.

4. GENERAL

- 4.1** Electrical section design of the project shall be approved by OL Chief Engineer of Electrical and Automation department. Only folder with full set of prepared documents should be given by CONTRACTOR for signing. The responsibility in quality, quantity and truth of technical solutions of CONTRACTOR will stay after approval of OL.
- 4.2** The operational and mechanical capacity of the electrical units shall be selected and coordinated according to the normative documents and standards mentioned below and other documents valid in the Republic of Lithuania.
- 4.3** If not discussed another limit of design, the power supply project should have all inside and outside circuits of power supply of object.
- 4.4** The electrical part of project should satisfy technical requirements of power connection which prepared OL after receiving request from designer. In request should be indicated this information: the category of reliable power supply to the customers, required power (installed and calculated), voltage, size and starting type of motors >1MW, location of main power users.

5. THE QUALITY CONTROL OF MATERIALS AND CONSTRUCTION.

- 5.1** The OL or his representative shall approve all materials, units and constructions. The approval does not exempt the CONTRACTOR from liability for proper electrical project and installation, application of materials and their functioning.
- 5.2** All electrical equipment and materials shall be new, not used and tested. This information shall be included in the test report.
- 5.3** The delivered and installed equipment and materials shall be the standard units of the manufacturer, used for the production of such equipment and shall meet the manufacturer's up-to date construction.
- 5.4** The housings of electrical installations shall meet LST, EN and IEC standards and the threads are to be of metric system
- 5.5** The equipment and materials manufacture shall be granted ISO 9000 certificate or equivalent.
- 5.6** Only those electrical equipment which producers are in OL Vendor List and which have the representatives in Lithuania shall be supplied. In the event there are no representatives, equipment supply shall be coordinated separately with OL. The address, telephone No., person and company name of local representative should be indicated in as build documentation as separate list of all equipment.
- 5.7** Labelling of Equipment and Units shall be on Lithuanian. The name of equipment and texts on labels should be approved by OL.

6. LOCAL CLIMATIC CONDITIONS

For data see para. 5 of *OL-TR-GR-000* and Table 1.

Table 1. Local Climatic Conditions

| Description | Value |
|--|--------------|
| The lowest average 24 hours temperature | -26.9 °C |
| The highest average 24 hours temperature | +25.1 °C |
| Average annual relative humidity | 81 % |
| Average annual precipitation | 788 mm |
| Maximum annual number of thunderstorm days | 42 |

7. POWER SUPPLY SYSTEM

7.1 Reliability of Electrical Power Supply to the Users

The categories of reliable power supply to the users shall meet the requirements of RIEU and are divided into:

7.1.1 Category 1: Electrical power users, because of them, in case of the failure of electric power transfer, the danger arises for human life, huge material losses are incurred, sophisticated process are discomfit.

7.1.2 Category 2: Electrical power users, because of them, in case of the failure of electric power transfer, industry production losses are incurred, the monster outages of employees, machinery and industry transport are emerging.

7.1.3 Category 3: All other electrical power users to which the definitions of the first and secondary categories users are not applied.

7.2 Voltage Levels

The levels of voltage indicated below are standard and shall be used for the listed applications, other levels of voltages, which are not indicated in list but CONTRACTOR want to use it, CONTRACTOR should prepare the substantiate of technical and commercial sides and will get approval of it by OL:

7.2.1 Existing Power Supply Networks

Refinery powered from 110 kV power system of Lithuanian electricity transmission system operator Litgrid AB.

The Existing and new Power distribution system data see Table 2.

Table 2. Existing Power Supply Networks

| Description | Voltage | No. of Phases | Frequency | Neutral |
|--------------------|----------------|----------------------|------------------|---|
| Medium voltage | 6300 V | 3 | 50 Hz | Compensated (resonant grounded) neutral |
| Low voltage | 230 / 400 V | 1, 3 | 50 Hz | Solidly-grounded neutral, TN-C-S |

7.2.2 Special Power Supply Networks

See Table 3.

Table 3. Special Power Supply Networks

| Description | Voltage | No. of Phases | Frequency |
|---|----------------|----------------------|------------------|
| Illumination, heat tracing, heating, auxiliary | 230 / 400 V | 1, 3 | 50 Hz |
| LV switchgear control, protection, measuring circuits | 230 V | 1 | 50 Hz |
| MV switchgear control, protection circuits | 110 V | 1 | DC |
| MV switchgear measuring circuits | 100 V | 1, 3 | 50 Hz |
| Process measuring device and instrumental | 24 V | 1 | DC |

7.2.3 Related Voltage Levels of Electrical Equipment

See Table 4.

Table 4. Related Voltage Levels of Electrical Equipment

| Equipment | Voltage | No. of Phases | Frequency |
|---|--|----------------------|--|
| Electric motors 0 ÷ 0,5 kW | 230 V | 1 | 50 Hz |
| Electric motors 0,5 ÷ 200 kW | 400 V | 3 | 50 Hz |
| Electric motors ≥ 201 kW | 6000 V | 3 | 50 Hz |
| Illumination | 230 V | 1 | 50 Hz |
| Measuring device, testing instrument in LV panels | 230 V | 1 | 50 Hz |
| Power Transformers | 6.0 kV ±2x2.5% / 0.4 kV | 3 | |
| MV Switchgear | 6.3 kV | | |
| MV Capacitors | > 6,3 kV | | |
| MV Cables | 6 / 10(12) kV | | |
| MV Surge arresters | U _c – 6.6 ÷ 7.2 kV; 8 / 20μs 10 kA ≤ 23 kV | | |
| MV Metering voltage transformers | 6.0 kV / 100 V / 100/√3 | | |
| LV Capacitors | > 400 V | | |
| LV Switchgear | > 400 V | | |
| LV Cables | 3 Phases – H07 (450 / 750 V), 1 Phase – H05 (300 / 500 V) | | |
| Rated voltage UPS output (range <10kW) | 230 V ±1% statically, ±5% dynamically | 1 phase TN-S | 50Hz ±0.1% on supply from batteries ±6% on by-pass operation |
| Rated voltage UPS output (range ≥10kW) | 400V ±1% statically, ±5% dynamically | 3 phases TN-S | 50Hz ±0.1% on supply from batteries ±6% on by-pass operation |
| DC system for MV control circuits | Input 3 phases 400V | 110 VDC | Output voltage stability <1% |

7.3 Electrical Power Distribution System

7.3.1 The design of electrical energy distribution system shall be based on general radial system. The 3 level substations are used for MV power distribution in refinery: a) Main Substations - incomings from 110 kV public Transmission power system for conversion 110/6 kV and powering Distribution and main process Power Substation; b) Distribution

Substations – for distribution power of Main substations to Refinery auxiliary process Power Substations; c) Power Substation – for powering Refinery main and auxiliary process users and they are close to process units.

- 7.3.2** The switchgears of 6.0 kV and 6.0 / 0.4 kV will be supplied from existing Power distribution systems, with at least two independent incomings, designed for power supply the Category 1 technological equipment. The critical users of category 1 which are necessary for safe process stoppings or safe operation of process unit shall have additional autonomous power source or independent power source. Single incoming substations might be used in case the technological equipment is the category 3 user of the electrical power only.
- 7.3.3** The capacity of power transformers shall be such that single transformer could withstand 100% load, while the other power transformer is disconnected. The required capacity of power transformer shall be based on the cooling efficiency of the transformer itself when the temperature rises up to 65°C.
- 7.3.4** Electrical equipment shall fully correspond to the rated levels of electrical system. The design of power system and electrical equipment shall ensure safe and reliable power supply and uninterruptable operation of facilities and shall permit periods of continuous operation of at least 4 years. To fulfill the above requirements the 2 independent power sources system shall be used – powering from 2 separate transformers and from switchgear sections, split power routes/cable trays, autonomous power sources, automatic changeover, automatic restarting and other activities.
- 7.3.5** Electrical power system shall be fully protected against short-circuit to earth and short circuits between the phases. The faults in electrical system shall be isolated close as possible with minimum disturbance of power system and plant
- 7.3.6** In the electrical rooms it should be installed redundancy HVAC system. Also overpressure systems if they are located near to explosive atmospheres.
- 7.3.7** The neutral of existing 6,0 kV network is compensated (resonant grounded) and neutral of 400 V, 3 phase and 4, 5 -wire network is solidly grounded.
- 7.3.8** Current conductors shall be marked L1, L2, L3, PEN from left to right and from up to down having a look from the front view of switchgear.
- 7.3.9** Short Circuit Ratings on electrical network. CONTRACTOR should do the study to determine values of short circuit, the existing and design equipment should be evaluated in study. OL will provide the technical data of existing MV and LV equipment and cables. OL will not provide the detailed study of short circuit of existing electrical network. The values of short circuit level and short circuit power of 110 kV system will be provided after request of designer and receiving actual values from Power Transmission Operator.
- 7.3.10** The design of electrical installation and location of electrical equipment's shall ensure that access is provided for all operational and maintenance purposes and all operating and maintenance activities can be performed safely and conveniently.
- 7.3.11** The design of electrical infrastructure shall ensure that plant will have safe start-up and shut-down.

8. CLASSIFICATION OF HAZARDOUS AREAS

- 8.1** For reference standards see para. 2.5.

- 8.2 The classification methodology is used according to the customer's prescription, i.e. according to the methodology specified in LST EN 60079-10 standard. Good practices manual for explosive atmosphere classification of any country, corresponding to the requirements of EU Legal Acts, might be used as a methodical material, when performing the classification of hazardous areas. See detail requirements in special OL specifications and standards for hazardous areas and risk assessment.

9. EQUIPMENT IN HAZARDOUS AREAS

- 9.1 For reference standards see para. 2.6.
- 9.2 Electrical installations and equipment designed for the operation in explosion hazardous areas must be manufactured and certified according to the (ATEX) requirements of EU Legal Acts and shall be marked according to (ATEX) requirements.
- 9.3 Electrical equipment intended for operation in potentially explosive atmospheres should be executed in accordance with requirements indicated in Explosion Proof Execution Certificates or Validation Statements.
- 9.4 Obligatory Regulations of European Union should be applied (after earlier obtaining of OL'S acceptance) in the case when economic reasons indicate on solutions different from above mentioned ones.
- 9.5 Explosion proof certification of equipment shall be provided for installation area temperature.
- 9.6 Electrical installations and equipment intended for operation in potentially explosive atmospheres should be executed in accordance with requirements indicated in below given regulations upon considering of detailed requirements which are obligatory at OL.
- 9.7 Electric motors executed in accordance with the following standards or its equivalents should not be selected for using in hazardous areas:

LST EN 60079-15 *Electrical apparatus for explosive gas atmospheres. Part 15: Construction, test and marking of type of protection "n" electrical apparatus (IEC 60079-15)*

LST EN 60079-7 *Explosive atmospheres - Part 7: Equipment protection by increased safety "e"*

- 9.8 Obligatory Regulations of European Union should be applied (after earlier obtaining of OL acceptance) in the case when economic reasons indicate on solutions different from above mentioned ones.
- 9.9 Suitable electrical units shall be selected for the operation in explosion hazardous areas specified in LST EN 60079–10 standard.
- 9.10 Engineering or Design Contractor deliveries to OL the following Specifications (data sheets) of electrical equipment for explosive atmospheres prepared on the base of design elaboration. That specification should contain the following data but not restrict in it:
- a) Equipment type;
 - b) Explosion protection marking;

- c) Electrical parameters;
- d) Ambient temperature;
- e) Quantity;
- f) List of documents (instructions, declarations of conformity, certificates);
- g) Recommended manufacturer name if it is necessary for implementation of design solutions.

- 9.11** Together with Electrical equipment for explosive atmospheres the following documentation shall be delivered:
- a) Detailed technical data sheet;
 - b) Manuals (installation, operation, maintenance) in Lithuanian;
 - c) ATEX declaration of conformity;
 - d) Factory testing and measurement reports (for motors, panels, assemblies);
 - e) Drawings (additionally for electric motor shaft drawing, explosion safety element layout drawing with specified allowable gap dimensions),

- 9.12** Electrical installations in TN-S arrangement for powering of users in potentially explosive atmospheres should be equipped with devices enabling disconnection of phase and neutral circuits.

- 9.13** Substations and electrical rooms shall be located in not explosion atmosphere and not less than 15 m away from rooms and outside equipment with explosive atmospheres. More details see local rules.

10. REQUIREMENTS FOR INSTALLATION OF ELECTRICAL BUILDINGS AND LINES

- 10.1** Power lines, installation of secondary circuits, cable lines shall meet the requirements stated in RIEU”.

- 10.2** Control and communication cables shall be installed only above the power cables and separated by fire proof partitions.

- 10.3** Cables up to 1000 V shall be installed above the >1000 V cables and separated by fire proof partition.

- 10.4** The units transferring load technologically to each other (marked by letters “A” and “B”) shall be connected to different bus sections (1st and 2nd) of switchgears. The remaining load shall be evenly divided between the bus sections.

- 10.5** Cable lines of (power and control cables) reserved users and from different bus sections (1st and 2nd) of switchgears and of independent power sources (power transformers, UPS, etc.) shall be laid not less than 0,6 m distance between each other, different trays on opposite side of route shall be used. This requirement valid for all routes from switchgear (source) until consumer.

- 10.6** The fireproofing systems of best practice for above ground cable trays should be used in risk zones of fire. The underground trays or fireproofed cable, coating, sheets, panels (>0,75h) for above ground trays can be used.

- 10.7** The using of fireproofing equipment (actuators, junction box, control panel) should be decided in design and HAZOP study.

- 10.8** In case the substation buildings are required to have the foundations, it should be envisaged the outside and inside walls to be waterproof with appropriate drainage along the whole perimeter. An appropriate sealing shall also be performed at the

incoming locations of all cable ducts using the certified according local rules sealant. Spare cable ducts will be sealed in order the water to be shut out.

- 10.9** All cables shall be protected against mechanical impact in places where cables come from the ground and are located less than 2.5 m above the ground level, the conduits, covered cable trays or ladders, fencing of the cable rack shall be used. The direct access and touching possibility to the cables shall be avoided in process unit or other open areas. .

11. COMMON REQUIMENTS FOR EQUIPMENTS

- 11.1** All switchgear shall be prepared to use lock out, tag out (LOTO) system.

12. DESIGN DOCUMENTS

- 12.1** The stages of Technical-detail or Detail design (next - Design) shall be applicable for modernization, renovation or update of existing electrical equipment and installations. General types of technical drawings and data are specified below.

- 12.2** The electrical part of Design should be prepared in separate folder/package and only full set should be offered for approval for OL electrical department. Single documents should be offered for comments only. The design should have minimal set of following documents:

- a) Title page;
- b) Agreements list;
- c) Index of drawings and documents;
- d) Basic data sheet;
- e) General notes;
- f) Plot plan;
- g) Aboveground and underground cable route plan with section and indication of each cable;
- h) Electrical lighting plan and installation drawing;
- i) Lightning protection;
- j) Grounding drawings;
- k) Heat trace drawings;
- l) Key One Line diagram
- m) Single (One) line diagrams (SLD) of switchgears, panels;
- n) Calculating/Protection settings diagrams and report of each switchgear and panel;
- o) Discrimination chart diagrams of protection curves.
- p) Control Schematic drawings;
- q) Wiring diagrams;
- r) Logic diagrams of programing elements (controllers, relays, VSD, actuators, etc.)
- s) Interconnection diagrams;
- t) Layout of panels;
- u) Layout of electrical rooms;
- v) Demolition description, bill;
- w) Cables lists;
- x) User list;
- y) Electrical load list
- z) Overall and separate for each part of design bill of materials;
- aa) Overall and separate for each part of design bill of works;
- bb) Installation details and sections of grounding, lighting, power, heat tracing, etc.

- cc) Electrical Calculation reports of Electrical system study (reliability, power flow), Short circuit, Voltage drop, Harmonic analysis of electrical system, motor start-up and self-restart and others.
- 12.3** The Technical design and Design package of electrical part shall have separate applicable folders of:
- a) Cable routes.
 - b) Power supply – from power system till power substation.
 - c) MV and LV installation.
 - d) Relay protection and automatic.
 - e) Lighting.
 - f) Grounding and lightning protection.
 - g) Heat tracing.
 - h) Uninterruptable and buck up powering.
 - i) Installation of buildings.
 - j) Self-restarting system.
 - k) Cathodic protection.
 - l) Electrical calculations.
 - m) Electrical SCADA system.
 - n) Electrical accounting system.
 - o) Fire protection and signalization.
 - p) Other parts according needs – civil, construction, savage, fire protection and signalization, security.
- 12.4** The plot plan and the layout drawings will contain the requirements for:
- a) The location of substations, buildings, transformers, and switchgears, and as well as for the place of drives/motors and control devices, panels, cable ducts, illuminators, sockets, equipment systems, communication devices and additional electrical equipment;
 - b) The cable route powering, illumination, control, communication, equipment and grounding;
 - c) SI system measuring units and values will be used in all drawings and technical data.
 - d) The distances from existing structures till new designed equipments, constructions, buildings shall be provided as well as coordinates and North direction arrow.
- 12.5** The detailed drawings will be prepared for the location of substations and switchgears and for the installation of transformers, illumination equipment, holders, apparatus, grounding, etc.
- 12.6** The typical installation drawings of power equipments, switchgears, distribution board and panels, cables, lighting, grounding, lightning, heat tracing, etc. will be prepared for similar installation work and the requirements for typical electric materials will be indicated.
- 12.7** Drawings for cable laying will be prepared where it will be indicated the physical place, measurements and identification of each cable tray, proper marking and location indication of the cables in that trays.
- 12.8** Detailed initial diagrams, cable laying and interconnection diagrams will be prepared where the cable installation requirements for supply and control circuits are specified.
- 12.9** According to the block-diagrams of the plant or technological process the zone classification drawings will be prepared where the limits of explosion risk zones are indicated. Hazardous area type shall be indicated in layout drawings of lighting and electrical equipment in field and process area also.

- 12.10** The prepared drawings of all control panels (used for example in process units, substation buildings or Control Room) made under the placed order will clear specify the physical location of all control panel devices, controls and cable installation routes. Proper marking and identification will be specified as well. It will be avoided to prepare separate drawings for typical control panels.
- 12.11** Feeders, Electrical apparatus in Switchgears and Panels shall be numbered from left to right and from top to down. Apparatus numbering shall be related to its place in switchgears: “number of cubicle – line number / place in line”. Examples: 1-2, 6-3, 1-1/2, 5-3/1. In single doors panels simple numbering can be used: 1, 2, 3... The same numbering and not mixed view of feeders in one line diagrams shall be used.
- 12.12** Equipment identification numbers being shown in electric drawings will be according to the Project specification. Those numbers will be shown for evidence in the design and manufacturer’s drawings.
- 12.13** Electrical users, feeders, panels, switchgears, substations and electrical rooms should have additional electrical operational name/number according OL requirements and approval and shall be indicated in one line diagrams and on apparatus, sheets, covers, and doors also.
- 12.14** The internal and front layout drawings of switchgears and panels shall be prepared in design and shall be provided for OWNER review and comments.

13. DIAGRAMS AND DRAWINGS REQUIREMENTS

- 13.1** Basic data sheet shall include data of installed power, voltage, reliability category, total line length and other basic data of designed object.
- 13.2** General notes shall include description of design solutions which are made in this part or folder of design, how and why those are made, general notes for build contractor and other important notes which clarify design solutions.
- 13.3** Plot plan shall have overall and partly layouts of object, include main cable routes, electrical buildings and rooms, field layout of panels and main users – motors, electric heaters, actuators (MOV). Plot plans and layouts of field installations shall be provided for 0 level and for each level and platform.
- 13.4** Electrical lighting plan shall include layout of fixtures (altitude, type, installation type, and power), the top and side view drawings of installation, layout of cables and JB, illumination level, hazardous area type.
- 13.5** Lightning protection drawing shall have data and layout of lightning rods, height of it and covering area, report of calculations and risk assessment.
- 13.6** Grounding drawings shall have layout of underground and above ground wiring, layout of all grounding points of field and internal equipment and structures, details of grounding.
- 13.7** Heat trace drawings shall include data sheets, electrical part (one line diagrams, control diagrams, panel drawings, wiring diagrams, etc.), line list with tracing calculations and include tracing data and materials, JB, etc), control panel, controllers, thermostats settings list, isometric drawings of tracing lines, tanks, etc. with layout of heat trace cables, JB, sensors.

- 13.8** Cable list shall include data of line number, cable type, size, length, start and finish addresses, conduit size and length. Cable list shall include all type of cable lines – power, control, telecommunication, etc.
- 13.9** The symbols of electric elements in single line diagrams and control circuit diagrams must be according IEC standards. The legend of symbols shall be included in each package or folder.
- 13.10** Minimum information required in single-line diagrams of switchgear and panel for each line, feeder:
- a) Feeder No;
 - b) Operational name of electrical power user;
 - c) Rated power of user;
 - d) Rated current;
 - e) Cable length, cable type, cross section and number of wires and cables;
 - f) Circuit breaker and protective apparatus (thermal relay) tag, type, rated current, setting of overload, short circuit, over current for LV and ANSI code of protections used in feeder for MV. MV settings shall be provided in separate table or report;
 - g) Contactor tag, type, size.
 - h) Current and voltage transformer tag, type and transformation ratio, precision class;
 - i) Designed/calculated power;
 - j) Single-phase short-circuit current of each LV feeder or minimal short circuit value;
 - k) Voltage drop in line;
 - l) System voltage, maximal, minimal and peak value of short circuit in busbar;
 - m) The installed, calculated power and current for each bus bar of MV and LV switchgear;
 - n) Rated voltage, current, Icu, Ipeak, size and number of busbars and power circuit conductors;
 - o) Type of user (motor, panel, heater, etc.) and rated data of it – current, start-up current, power, power factor, etc.
- 13.11** The drawings of internal electrical installation arrangement and sections shall be delivered to switchgears, panels and motor control centers.
- 13.12** Notes on single-line diagrams may be written also in English, but the recommendations for electrical installation contractor of installation, operation and maintenance shall be in Lithuanian and in English languages.
- 13.13** Schematics control and wiring diagrams shall be furnished for control circuits of all equipment (motors, lighting, etc.). Schematics shall be drawn in the form of vertical (preferred) "ladder" diagrams, with line numbers marked in a grid pattern and relay contact line numbers indicated in the margin where relays coils appear. All wire numbers of outside connections shall be indicated on the schematics diagrams. Spare not used contacts shall be indicated also.
- 13.14** In controls circuit diagrams shall be shown all circuits and elements, include control, measure and other elements which are outside switchgear or panel – like control buttons, switches, current transformers and others.
- 13.15** **Format of Drawings**
- 13.15.1** All drawings will be prepared using ACAD 2000 or more sophisticated version with standard blocks or layers and will be plotted using switched on "SNAP" and "ORTHO".

- 13.15.2** The designing managers shall have to co-ordinate all ACAD drawings supply issues with the representative of the OL seeking to assure that the current menu should be available. The whole personnel (that want) will use that menu in order to reach the compatibility of the drawings supply.
- 13.15.3** The drawings format will be according to drawing measurements (A1, A2, A3, and A4), specified in ISO 5457 standard.
- 13.15.4** The measurements of the units and components shall be in metric system, metric measurements shall be used in drawing text, standard margins, layers, etc.
- 13.16** Complete set of ACAD drawing files will be delivered. The name of ACAD drawing files will describe the drawing type and No. The name length is not more than 32 characters.
- 13.17** The cable catalogue drawings contain the cable number, start, direction of destination, measurements, approximate length, purpose, phase number, voltage, cable data and feeder route (that also covers the tags of cable trays section), etc.
- 13.18** The “List of control requirement”, “List of outgoing cables” should be prepared by CONTRACTOR.

14. CALCULATIONS REQUIREMENTS

14.1 General Issues

The calculations will be done seeking to justify the selection and size of electrical equipment: transformers, bus conductors, switchgears, panels and cables. The calculation results will be presented to the OWNER for review and approval.

Calculation perform by valid standards methodic. Detailed calculations must be provided indicating calculation formulas, input data and results.

14.2 Electric Load of the Plant or Aggregate Substation

- 14.2.1** The “List of electrical power users” for each aggregate substation, switchgear and panel will be prepared that will include the load for motors, illumination, heating and other equipment supplied from the substation. The engines of units, classified as spare, will be in the list and included into the definition of connected loads. The nominal/installed and using/maximal one our power should be indicated.

- 14.2.2** Taking into consideration the “List of electrical power users” the values of transformers and the requirements for the correction of power ratio at nominal and highest load will be calculated. Nominal and highest loads of substations, lines and transformers are presented in kilowatts, kilovolt- amperes and power factor. The calculation of normal load will be used to justify the selection of static capacitors trying to produce the normal system power factor to equal 1.0.

14.3 Breakdown Calculations

- 14.3.1** The instantaneous and circuit breaker breaking currents of aggregate substation 6,0 kV units will be determined using the sources.
- 14.3.2** The contribution of average motor voltage to the breakdowns will be based on initial motor load and plus motor load that should be added without any overrunning of the highest transformer capacity. When estimating the motor load, the prospective adding

of the transformers or the upgrade of the present transformers shall be considered as stated in the Project specification.

14.3.3 In case of 6,0 kV networks 3 or 2-phase (line to line) short-circuit currents at all 6,0 kV user terminals shall be calculated.

14.3.4 In case of 0,4 kV networks 3-phase and short-circuit to earth (line to earth) currents at all user's terminals and line damages for cable feeders that are most remote (the highest resistance) from panel shall be calculated.

14.4 Voltage Drop

14.4.1 The calculations will be done using the system constants that will be derived from the OL's data, supplier system components, examples, cables selection and measurements.

14.4.2 The highest transitional system's impedance or the lowest possible transitional short circuit capacity will be used to calculate the voltage drop related to the requirements for motor start, restart and/or repeated acceleration.

14.4.3 The systems operating under normal conditions with the transformers connected in parallel will estimate taking into account that one transformer is out of operation.

14.4.4 Voltage drop that is applied under normal electrical power distribution system operation conditions will be limited to not more than 3% in branch circuits of motors and feeders. When calculating the normal voltage drop, the effect of transformer leads on secondary circuit voltage will not be considered. Voltage drop will be calculated taking into consideration the data reported on motor and equipment tags and in general will be distributed as follows:

- a) 2% in feeders and feeder branches;
- b) 3% between starters and motors;
- c) 1% between low voltage transformer secondary winding switchgear and motor control centers or starter support;
- d) The voltage on the basic distribution bus installed in the plant will be maintained within the limits not higher than 15% from normal when powerful motors or motor groups are started;
- e) See para. 4.17 of OL specification no. *OL-TR-ER-017* where illumination system voltage drop is specified.

14.4.5 The final time and current co-ordination curves of all electric system protection devices will be established in such way that simplified single line diagrams would be included. The curves will indicate the protective devices and the lowest and the highest disconnection time of fuses and circuit breakers. Calibration requirements for protective devices will be reported. When the plant load and systems as well as unit types and capacities are properly estimated, the estimation tables (curves are also included) of all electric system protection devices will be presented. Designer shall review and update existing up and down feeders protection settings if its required for proper coordination of designing unit settings with existing power grid.

15. DATA, DOCUMENTS FROM EQUIPMENT'S AND MATERIAL'S SUPPLIER

15.1 OL shall be supplied by the supplier with cable data copies and the copies of all electrical equipment drawings, including the drawings for cable laying, structures, measurements, engines and valve nodes.

- 15.2** OL shall be supplied by the supplier with characteristic curves plotted on industrial standard paper of all control devices for equipment protection.
- 15.3** In addition that was mentioned above the suppliers will be asked to present the electrical equipment origin certificates, detailed specifications with characteristics, response curves, test tolerances and permissible measuring errors, the report of acceptance test performed in the manufacturer's factory, instructions for the installation, operation, maintenance, calibration and adjustment of the units.
- 15.4** Trying to avoid the misunderstandings during the calibration, adjustment and testing of the devices, the supplier shall point out the numbers and the names of the procedures and standards recommended using for testing, calibration and adjustment.
- 15.5** The manufacturers will be asked to present the list of recommended spare parts for whole procured electrical equipment with the data documentation of the seller intended for "information".

16. TESTING AND INSPECTION IN THE PRODUCER'S FACTORY

"Designed" unit nodes (contrary to consumer's goods or mass production) will be tested in the factory according to the standards and codes listed in the unit specifications and the manufacturer will present the copies of the certified testing reports to the OL. Although if the formal testing is not required in the presence of witnesses, the OL or his representative may be willing to be close as bystander when testing is performed in the factory. The OL will test additionally the sophisticated apparatus before factory test. The OL will check whether the units meet the specifications, work quality and finish after factory test. The supplier will be asked to notify at least 10 days before anticipated completion date that the OL could manage to organize the inspection. The units could not be delivered until the inspector does not allow. It is not allowed to perform the testing of the unfinished units as decided by the Inspector.



TECHNICAL REQUIREMENTS

ELECTRICAL

Document No. OL-TR-ER-000

MOTOR CONTROL DEVICES (VFD, SOFT STARTERS)

Document No. OL-TR-ER-008

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| 01 | Updated | 27-11-2018 | E.K. | ORLEN Lietuva | ORLEN Lietuva |
| 00 | Final Issue | 11-Aug-14 | D ² RT' <i>engineering</i> | ORLEN Lietuva | ORLEN Lietuva |
| Rev. | Revision description | Date | Prep. by | Check. by | Appr. by |

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TABLE OF FIGURES

1. SCOPE

The present document is intended to define the technical requirements of the motor control devices (VFD, soft starters).

2. REFERENCES

The following standards, acts of law and other documents are referenced in the standards:

| | |
|------------------------------|--|
| LST-EN 60079-0:2004 | <i>Electrical apparatus for explosive gas atmospheres (other than mines). Part 0: General requirements</i> |
| LST-EN 60079-14:2001 | <i>Electrical apparatus for explosive gas atmospheres. Part 14: Electrical installations in hazardous areas (other than mines)</i> |
| LST-EN 61000-6-2:2003 | <i>Electromagnetic compatibility (EMC). Part 6-2 Generic standards. Immunity for industrial environments</i> |
| LST-EN 61000-6-4:2007 | <i>Electromagnetic compatibility (EMC). Part 6-4 Generic standards</i> |
| LST-EN 61241-14:2004 | <i>Electrical apparatus for use in presence of combustible dust. Part 14: Selection and installation</i> |
| LST- EN 61241-14:2004 | <i>Electromagnetic compatibility (EMC). Part 6-4 Generic standards</i> |
| RIEU | <i>Rules for the Installation of Electrical Units, Vilnius</i> |
| OL-TR-GR-000 | <i>General Requirements</i> |
| OL-TR-ER-000 | <i>Electrical. General</i> |

3. TERMS AND DEFINITIONS

LV: Low voltage, the voltage from 50V till 1000V AC and from 75V till 1500V DC.

MCC: Motor control centers.

DC: Direct current.

RIEU: Elektros įrenginių įrengimo taisyklės.

VSD: Variable speed driver.

DCS: Distributed control system.

4. GENERAL

4.1 Electrical Motors Controlled by Soft-Start Units

4.1.1 Especially, the following aspects shall be considered while selecting Soft Start systems:

- a) Certificates, validation statements or acceptances issued by appropriate Testing Station, Notified Bodies, which define conditions for co-operation of soft-start system with an Ex-proof motor operated in explosion hazardous area.
- b) Motor re-start after a voltage failure.
- c) Informing DCS about own operation and failures.

4.1.2 Soft-start systems shall be installed in low voltage switchgear, or inside boxes with a protection degree IP 20 class, at least:

- a) Installation of the soft-start units inside the boxes can be applied when mounted on the wall of MCC room.
- b) Suitable ventilation shall be designed for soft-start units to provide temperature required by vendor.
- c) Soft-start systems shall be connected through equipment that makes it possible to disconnect the soft-start system input and output. The switch disconnecter shall be used between soft-start unit and feeder cable.
- d) The way of mounting soft starts should be agreed with OL.

4.2 Interaction LV Electric Motor with Frequency Converter (Low Voltage Variable Speed Drivers, LV-VSD)

4.2.1 OL shall be informed that frequency converter will be used. CONTRACTOR is obligated to submit a technical & economic analysis to determine the needs with respect to the use of frequency converters.

4.2.2 Especially, the following aspects should be considered while selecting frequency converters:

- a) Certificates, validation statements or acceptances issued by appropriate Testing Station, Notified Bodies, which define conditions for co-operation of soft-start system with an Ex-proof motor operated in explosion hazardous area.
- b) Motor self-start after a voltage failure.
- c) Informing DCS about own operation and failures

4.2.3 Motors intended for co-operation with frequency converter should be adapted by motor manufacturer for rotating speed control by means of frequency change parameters confirming the above adaptation should be placed both on motor rating plates and in operating & maintenance manuals.

4.2.4 Frequency converters systems shall be installed in low voltage switchgear, or inside boxes with a protection degree IP 20 class, at least:

- a) Installation of the frequency converters units inside the boxes can be applied when mounted on the wall of MCC room.
- b) Suitable ventilation shall be designed for frequency converters units to provide temperature required by vendor.
- c) Frequency converters shall be connected through equipment disconnecting the soft-start system input and output. The switch disconnecter shall be used between LV-VSD unit and feeder cable.
- d) Cables connected to frequency converters shall be screened.
- e) The way of mounting frequency converter should be agreed with OL. The typical diagrams shall be used (see picture 1).

4.2.5 Requirements for LV Frequency Converters:

- a) Each frequency converter has the separate systems of power supply, signalling and control.
- b) Frequency converters of 15 kW and above are to be installed in separate cabinet with forced air circulation.

- c) Cabinets for frequency converters above 250 kW are to be adapted for installation from the top of ventilation ducts.
- d) Each not reserved system of the frequency converter must have the manual service by-pass with signalling of the motor operation state from the converters or from his by-pass.
- e) The frequency converter shall be low harmonic type and have the input system assuring of the input current less than 5% for THDI and less 2% for THDU in all working range of output frequency (from 20Hz till 50Hz).
- f) The THD on LV terminals of power transformers, if sum of non-sinusoidal load is more than 10% of total load, should be less than 10% for THDI and less 2% for THDU in any regime of working.
- g) Control of the driving system with frequency converter:
 - Remote control from DCS (Start, STOP, PERMIT, SET POINT for 4-20 mA CONTROL);
 - Local control from the pushbutton station near the motor (START, STOP);
 - Control system adapted for automatic re-start after instantaneous power failure (start/stop of signal character cannot be used);
 - The motor system must have the motor winding temperature protection based on PTC or Pt 100 sensors in the motor winding.
- h) Indication of the system operation state:
 - Local (frequency converter cabinet) diode signalling of operation states: RUN, READY, PERMIT, FAILURE (durable designation in Lithuanian language: ĮJUNGTAS, PASIRENGĘS, LEIDIMAS ĮJUNGTI, GEDIMAS) and the display for (among other things) readings of measured available parameters, alarms and history events (diode signal panel and the display are to be located on the door of frequency converter);
 - Remote indication:
DCS system - voltage-free contacts (NC) RUN, READY, FAILURE (Lithuanian translation: ĮJUNGTAS, PASIRENGĘS, GEDIMAS) and 4-20 mA signal (motor speed).
- i) The frequency converter must be equipped with the event and alarm register.
- j) AC-AC efficiency at full load should be better than 97%.
- k) Input voltage tolerance +/- 15%.
- l) Noise level at distance of 1m - below 60 dB.
- m) Output voltage maximum distortions - du/dt less than 500 Volt/microsecond.
- n) Overvoltage maximum amplitude up to 750 V.
- o) Protection degree - minimum IP 20.
- p) Access for servicing - only from the front.
- q) Must have the provision for co-operation with personal computer as well as applicable visualization and diagnostic software.

4.2.6 Technical parameters of driving system:

- a) Driving system with frequency converter has the certificate for complete driving assembly (motor and frequency converter) in order to guarantee output voltage of good quality and safety operation.
- b) Driving system with frequency converter full-fills requirements of EU regarding electromagnetic compatibility (EMC):
 - That is resistant to external electromagnetic interference;
 - Neither sends to the power supply network nor emits to the environment self-generated interference (conducted and radiated);
 - Signaling and control cables must be laid in cable trays separated from power cables (maintain minimum distances between cables required by manufacturers of frequency converters).

Control and power cables are to be screened. Screens must be properly earthed.

4.2.7 Additional requirements:

- a) Technical documentation in English and Lithuanian languages. Electronic version (CD or flash drive) and a hard copy of documentation should be delivered. The documentation should include:
 - Documentation from manufacture, as well signaling and control diagrams;
 - Protocols of factory examinations confirming the essential technical parameters;
 - Guarantee certificate for min. 24-month guarantee period from the date of putting the equipment in operation containing detailed guarantee conditions and address of the Guarantor's company;
 - The list of indispensable part for 5-years operation.
- b) Vendor/manufacture should assure execution of acceptance tests of frequency converters confirming fulfillment of the aforementioned requirements:
 - In the factory and on the site for converters of 250 kW and above;
 - On the site for converters below 250 kW.

4.3 Interaction MV Electric Motor with Frequency Converter (Medium Voltage Variable Speed Drivers, MV-VSD)

- 4.3.1** If becomes necessary to use medium voltage electrical motor supply via frequency converter, OL has to be informed about in order to define & agree upon the detailed conditions, technical specifications and data sheet of MV-VSD.

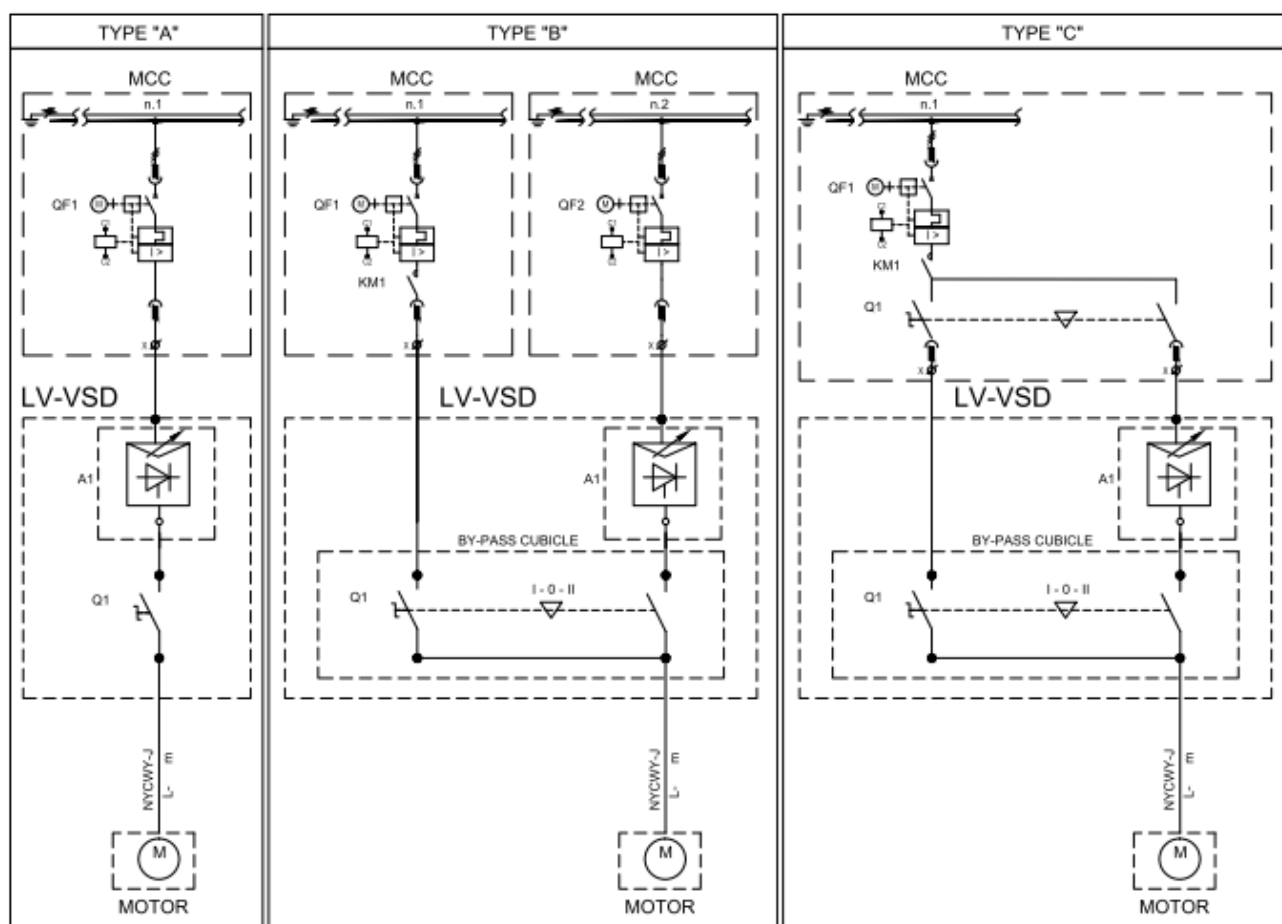


Figure 1. Typical diagrams of LV-VSD