
PART 1 **GENERAL**

1.1 **RELATED SECTIONS**

- .1 Section 26 05 00 – Common Work Results - Electrical.

1.2 **REFERENCES**

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-2002, Part 4: Electromechanical Contactors and motor-starters.

1.3 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout of identified internal and front panel components.
 - .4 Enclosure types.
 - .5 Wiring diagram for each type of starter.
 - .6 Interconnection diagrams.
- .3 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .4 Shop Drawings:
 - .1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by contractor.
 - .2 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include operation and maintenance data for each type and style of starter.
- .3 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .4 Extra Materials:
 - .1 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.
 - .7 10% indicating lamp bulbs used.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Materials:
 - .1 Provide listed spare parts for each different size and type of starter:
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformer.
 - .5 1 operating coil.
 - .6 2 fuses.

.7 10% indicating lamp bulbs used.

1.7 EXTRA MATERIALS

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal, and with the Waste Reduction Work plan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

- .1 Single or three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One Three overload heaters, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle Key switch pushbutton: NEMA 13 heavy duty oil tight labeled as indicated.
 - .2 Indicating light: NEMA 13 heavy duty oil tight type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control disconnect motor circuit interrupter circuit breaker, and provision for:

- .1 Locking in "OFF" position with up to 3 padlocks.
- .2 Independent locking of enclosure door.
- .3 Provision for preventing switching to "ON" position while enclosure door open.

2.5 VARIABLE FREQUENCY DRIVES

- .1 The drives shall be suitable for centrifugal fans and pumps of the ampere ratings scheduled on the drawings.
 - .1 Drives shall have CSA 2 Enclosures; enclosure complete with disconnect switch and line and load reactors.
 - .2 Drives shall have interface panel in the door to the VFD.
- .2 The drives shall be pulse-width-modulated technology with IGBT power electronics to provide adjustable frequency output with the output voltage proportional to output frequency. The drive operation is controlled via an integral microprocessor.
- .3 The drive shall have the following operation features:
 - .1 Input Voltage/Frequency: 600 V 3 phase/60 Hertz.
 - .2 Output Voltage/Frequency: Input voltage/0-500 Hz.
 - .3 Initial Output Current: 250% of load FLA for 2 seconds.
 - .4 Overload Current: 110% of load FLA for 60 seconds.
 - .5 Operating ambient temperature: -10oC to +40oC.
 - .6 Line voltage variation: +10/-15% of nominal voltage.
 - .7 Line frequency variation: 45 - 65 Hz.
 - .8 Efficiency at full-load: at least 96%.
 - .9 Power factor at full-load: at least 0.96.
- .4 The drive shall have the following protective features:
 - .1 Input phase loss initiating automatic shutdown of drive.
 - .2 Input over-voltage protection.
 - .3 Line surge protection.
 - .4 Output short-circuit and ground-fault protection.
 - .5 Drive overload and motor overload protection.
 - .6 Shorted power electronics initiating automatic shutdown of drive through shunt-trip of MCP.
 - .7 Input filter to minimize harmonics, on the input current, to accepted standards.
 - .8 Line reactor, remote location installed at motor leads.
- .5 The drive shall have the following performance features:
 - .1 Critical speed lockout.
 - .2 Adjustable acceleration/deceleration.
 - .3 Ramp stop selection.

- .4 Speed setting inputs: keypad in face panel and 4-20 mA input from remote source.
- .6 Acceptable manufacturers: Allen-Bradley, Cutler-Hammer, Schneider-Square D, Siemens.

2.4 FULL VOLTAGE REVERSING MAGNETIC STARTERS

- .1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two - 3 pole magnetic contactors mounted on common base.
 - .2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.
 - .3 Three overload relays with heater elements, manual automatic reset.
- .2 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.5 MULTI-SPEED STARTERS

- .1 2 speed starters of size, type, rating and enclosure type as indicated. Starter suitable for constant torque variable torque constant kW type motor and with components as follows:
 - .1 One-3 pole contactor for each winding for separate winding motors.
 - .2 One-3 pole and one-5 pole contactor for each reconnectable winding for consequent pole type motors.
 - .3 Three overload relays with 3 heater elements and manual reset for each speed.
- .2 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.
 - .4 Low speed compelling relay automatic sequence accelerating decelerating relays for each speed.

2.6 MAGNETIC STARTER REDUCED VOLTAGE AUTO-TRANSFORMER

- .1 Auto-transformer starter closed circuit transition type, of size, type, rating and enclosure type as indicated and with following components:
 - .1 Three-3 pole contactors.
 - .2 Auto-transformer with 50%, 65% and 80% 65% and 85% taps.
 - .3 One adjustable pneumatic timing relay.

- .4 One-3 pole manual reset overload device.
- .5 Thermal overload protection of auto-transformers.
- .2 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.7 MAGNETIC STARTER REDUCED VOLTAGE STAR-DELTA

- .1 Reduced voltage star-delta open transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relays and interlocks.
 - .3 Mechanical interlock to interlock one delta contactor and the star contactor.
 - .4 One timing relay.
 - .5 Three pole manual automatic reset overload relays.
- .2 Reduced voltage star-delta closed transition starter, of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole delta contactors with auxiliary relays and interlocks.
 - .2 One-3 pole star contactor with auxiliary relay and interlocks.
 - .3 One-3 pole transition contactor.
 - .4 One set of transition resistors.
 - .5 Mechanical interlock, to interlock one delta contactor and the star contactor.
 - .6 One timing relay.
 - .7 Three pole manual automatic reset overload relays.
- .3 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight, type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.8 MAGNETIC STARTER REDUCED

- .1 Two-step reduced voltage, part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole contactors.
 - .2 Adjustable pneumatic timer.
 - .3 Six manual automatic reset overload relays.

- .2 Three step reduced voltage part winding starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Three-3 pole contactors.
 - .2 One set starting resistors.
 - .3 Six manual automatic reset overload relays.
- .3 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight type and color as indicated.
 - .3 Auxiliary control devices as indicated.

2.9 THREE PHASE MANUAL REVERSING STARTER

- .1 Three phase manual reversing starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight type and colour as indicated.

2.10 THREE PHASE MANUAL TWO SPEED SEPARATE WINDING STARTERS

- .1 Three phase manual two speed separate winding starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Two-3 pole manual motor starters, quick make and break.
 - .2 Six overload relays and manual reset.
 - .3 Mechanical interlock to prevent both switches from closing at same time.
- .2 Accessories:
 - .1 Pushbuttons Selector switches: standard heavy duty oil tight labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight type and colour as indicated.

2.11 DC FULL VOLTAGE REVERSING STARTERS

- .1 DC full voltage non-reversing starters of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Contactor: single two pole solenoid operated type.
 - .2 Indirectly-heated, manual reset thermal overload relay.

- .2 Accessories:
 - .1 Pushbuttons: standard heavy duty oil tight labelled as indicated.
 - .2 Selector switches: standard heavy duty oil tight labelled as indicated.
 - .3 Indicating lights: standard heavy duty oil tight type and colour as indicated.

2.12 DC FULL VOLTAGE REVERSING STARTERS

- .1 Dc full voltage reversing starter of size, type, rating and enclosure type as indicated, with components as follows:
 - .1 Two contactors: single two pole solenoid operated type, mechanically and electrically interlocked.
 - .2 Indirectly-heated, manual reset thermal overload relay.
- .2 Accessories:
 - .1 Pushbutton Selector switches: standard heavy duty labelled as indicated.
 - .2 Indicating lights: standard heavy duty oil tight, type and colour as indicated.
 - .3 Auxiliary control devices as indicated.

2.13 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.14 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.15 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.16 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 5 engraved as indicated.

PART 3 **EXECUTION**

3.1 **INSTALLATION**

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses and overload devices elements installed.
- .4 Confirm motor nameplate and adjust overload device to suit

3.2 **FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
- .5 Factory representative must be present on site to complete set up for initial star-up and commissioning of variable frequency drives.

3.3 **CLEANING**

- .1 Clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION