



APPENDIX NO. 3

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1. GENERAL.

- 1.1 This standard applies in the implementation of control , protection , supervisory, instrumentation and measuring circuits included in control systems, protection systems, switchgears, MCC's, control panels and other electrical cubicles of Power Stations and Substations. | HOLD
- 1.2 All Control Cubicles shall conform to this Standard Specification , except where overruled by specific requirements of the Project Specification.
- 1.3 This Standard shall also be read in conjunction with Standard EPD-5/2002 Rev.F: " CONTROL CUBICLES REQUIREMENTS " (or EPD –A.05 , to be issued in the future) .

2. WIRING MATERIALS AND REQUIREMENTS.

2.1 WIRING MATERIALS

- 2.1.1 The Israeli or European manufacturers shall use stranded copper conductors having halogen free insulation.
The wire shall be type HO7Z-K for 750V rated voltage, according to Standards CENELEC HD 22.1 and HD 22.9.
- 2.1.2 The American manufacturers shall use stranded copper switchboard wire , 90°C maximum operating temperature Heat – Resistant SIS Insulation , according to National Electrical Code (NFPA 70-1996) , table 310-13 , having 600V rated insulation .
- 2.1.3 Connections between fixed and hinged panels shall be made with stranded (extra-flexible) switchboard wire , having the same insulation as specified above .

2.2 CONTROL WIRING SIZE

- 2.2.1 For control circuits having a control voltage of 220 VDC or 230 VAC , wires sized 1.5 sq.mm (No. 16 AWG) shall be used .
- 2.2.2 For control and supervisory circuits in which the current is less than 0.2 A , wires sized 1.0 sq.mm (No. 18 AWG) , shall be used .
- 2.2.3 For control and supervisory circuits of European manufactured



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Control Systems (DCS) , in which the current is less than 0.2 A ,
wires sized 0.5 sq.mm (No. 20 AWG) can be used.

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2.3 POWER WIRING SIZE 2.3.1 This standard refers to the following power circuits : a. Primary and secondary connections of control transformers. b. Incoming power circuits. 2.3.2 The wiring of the above devices shall be made with similar wires as defined in paragraph 2.1 . The size of the wire shall be correlated with the control transformer primary and secondary currents , with the incoming power circuits currents and with the circuit protection . 2.4 CURRENT TRANSFORMER WIRING SIZE Current Transformer Circuits wiring shall be made with similar wires as defined in paragraph 2.1. The minimum wire size shall be 2.5 sq.mm (No. 14AWG). 2.5 INSTRUMENT WIRING SIZING (Low Level Signal Wiring) 2.5.1 Shielded instrumentation cable shall be used on all low level signal wiring. Unless otherwise specified in the Project Specification , the Contractor shall use twisted-pair No. 18 AWG , Class B stranded-tinned copper-wire , with minimum use 300V insulation over each conductor, aluminized mylar tape (with stranded-tinned copper drain wire) over both conductors , and an overall jacket . 2.5.2 If apparatus cannot accept conductors of sizes specified above , than the maximum size of conductors accepted by these apparatus can be used . 2.5.3 For Low Level Signal Wiring of European manufactured Control Systems (DCS) , shielded wires sized 0.5 sq.mm (No. 20 AWG), similar to those used for control wiring can be used , according to the manufacturer standard .			
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3. TERMINAL BLOCKS .

3.1 REQUIREMENTS FOR ISRAELI OR EUROPEAN MANUFACTURERS

3.1.1 The terminals shall comply with IEC 60947-7-1 , July 2002 Standard.

3.1.2 Type of terminals: screw type terminals .

3.1.3 The housing shall be made of thermosetting or thermoplastic materials having the following characteristics :

- a. Tracking resistance CTI : 600
- b. Continuous service temperature 100 °C
- c. Inflammability class..... UL94-VO
- d. Halogen and asbestos free
- e. Good tropical and termite resistance
- f. Contamination class 3

3.1.4 The metal parts (clamping parts and current carrying parts) shall be made of copper alloy to eliminate corrosion .
The screw clamping method shall be vibration resistant.

3.1.5 Mounting rail TS 32

3.1.6 Rated Voltage 800 V

3.1.7 Approved terminal blocks Manufacturers : Phoenix or Wiedmuller, as follows:

	<u>Phoenix</u>	Weidmuller
a. Control and Instrumentation wiring up to 1.5 sq.mm (No. 16 AWG) ...	UK 2.5 N	WDU 2.5 N
b. Control and Power wiring up to 6.0 sq.mm (No. 10 AWG)....	UK 6N	WDU 6N
c. Power wiring Up to 10 sq.mm (No. 4 AWG)	UK 16N	WDU 16N
d. Current transformer circuits *	UGSK/S	WTQ 6/1

* : Three (3) terminals shall be used for each current transformer.



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3.1.8 The insulation material of terminal blocks shall not be adversely affected by abnormal heat and fire .
Compliance to this requirement shall be checked by the needle flame test , according to Standard IEC 60695-2-2 .

3.1.9 Performance Requirements.

3.1.9.1 Temperature Rise.

The terminal blocks shall be tested in accordance with Standard IEC 60947-1-1, item 8.4.5.

The temperature rise of terminals shall not exceed 45°C.

3.1.9.2 Rated Short-time Withstand Capability.

The terminal blocks shall be capable of withstanding for 1 sec. the rated short-time withstanding current which corresponds to 120A/mm² of its rated cross-section , according to Standard IEC 60947-1-1, item 8.4.6.

3.1.10 For European manufactured equipment Maxi-Termi-Point terminals , according to DIN/VDE 0815 Standard can be used .

3.2 REQUIREMENTS FOR AMERICAN MANUFACTURERS

3.2.1 The terminals shall comply with the NEMA Standard Publication No. ICS 4 /2000 and shall be UL approved .

3.2.2 Molded thermoset phenolic base – rated 150°C.

3.2.3 Suitable for connection of copper conductors.

3.2.4 Washer head screw contacts.

3.2.5 The metal parts (clamping parts and current carrying parts) shall be made of copper alloy to eliminate corrosion .

3.2.6 Rated insulation voltage :

-- For control and instrumentation circuits less than 120V :

U_i = 300 V

-- For control and instrumentation circuits above 120V :

U_i = 600 V



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3.2.7 The following terminal blocks are accepted :

- a. For control circuits 120 V and above :
Series 1500 or Series 1600 , Marathon Special Products Co. ,or Catalogue No. 2B112 Buchanan .
- b. For control circuits less than 120 V and instrumentation :
Series 300 Marathon Special Products Co. , or Type CR151B – General Electric .

4. ARRANGEMENT OF WIRING

- 4.1 Wire and wire groups extending from terminal blocks to instruments or devices on cubicles , or from one cubicle to another , shall be installed in halogen free ducts or troughs and packed in neatly formed bundles securely clamped or tied together and supported from the cubicle framework.
Plastic cable ties (Halogen free or EPR) shall be used to bundle wires outside of ducts or troughs .
No more than 30 wires shall be bundled together in wire hinge loops.
- 4.2 When wiring is installed in wire ducts or troughs , the edges of the cut-outs troughs which the wires pass shall be provided with suitable protection of the insulation from cuts or nicks .
- 4.3 Shielded instrument cables carrying low level signals shall be in separate bundles or wire-ways .
- 4.4 Drain wires and shield tapes shall be fully insulated and terminated at terminal blocks .
Grounding of shielded wires shall be as defined in the Project Specification or drawings.
- 4.5 Wire extensions from wire-ways or bundles to instruments shall be neatly formed, attached and secured to the cubicles with wire cleats.
Bends in the wiring shall be carefully made in such a manner that the insulation or cover is not damaged.
Care shall be used in removing insulation from the wire , so that the wire will not be cut or nicked.



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- 4.6 All wiring shall be installed exactly as shown on the wiring diagrams.
- 4.7 The maximum number of conductors connected to any one terminal point on a terminal block shall be two (2).
- 4.8 Spare contacts from each device (circuit breaker , auxiliary relay , control switch, etc) shall be wired to terminal blocks , as per specific Project Specification requirements.
- 4.9 Both ends of each wire shall be tagged with appropriate plastic markers.
Mylar wire markers such as Brady Type SLFW or similar as agreed upon, should be used .
- 4.10 Internal wiring color coding shall be according to Appendix 1 of this standard specification.
- 4.11 The wires marking shall be made as follows :
-- The terminal block end of each wire will be tagged with the terminal number.
-- The instrument or device end of the wire will be tagged with the respective instrument or device designation and terminal number, according to the wiring diagram.
- 4.12 All internal wiring of control circuits will preferable be terminated by the Contractor at the terminal blocks , rather than between devices within the cubicle.
- 4.13 All the alarm circuits should be connected to adjacent terminal block points , to facilitate Purchaser's field wiring.
- 4.14 In bench-board type control cubicles applications , switches , lights and other instruments shall be loop wired.
Sufficient wire length shall be included in the loop to permit complete removal of all connected devices through the face of the bench-board, to permit maintenance of the device from the front of the cubicle, without disconnecting any wires.
- 4.15 Wiring shall be routed in such a manner that it will not prevent blank cubicle (spare) from being used for the addition of future equipment.



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5. TERMINATIONS.

- 5.1 Compression type (solder-less) lugs or ferrules shall be applied on the ends of all stranded wires for connection to terminal blocks or to instruments. For connection to screw type terminals , isolated fork type terminal lugs should be used.
The lugs should be tin plated to resist corrosion.
- 5.2 The wire insulation shall be removed for the lug application without nicking the conductor.
The wire shall be firmly inserted into the lug and crimped with the specified tool , recommended by the lug manufacturer.
Devices having compression clamps, push-on, etc type terminals will be wired accordingly.
- 5.3 All solder and push-on type connections shall have snug fittings insulated sleeves which cover the entire lug and extend 1/4 inch (6mm) over the insulation.
- 5.4 Terminal blocks shall be provided for terminating all wiring entering and leaving the cubicles , except the leads from thermocouples and other temperature detecting devices , and devices connected with prefabricated cables , that may be field run directly to the terminals in the instrument cases.
- 5.5 Thermocouple extension wire and other solid wire terminations shall be made without the use of lugs.
- 5.6 The arrangement of terminal blocks for Purchaser's connections shall permit convenient cable installation.
Cable supports shall be provided for Purchaser's wiring.
Wiring troughs shall be provided in areas requiring a high density of such cables.
Routing paths of all such cables shall be shown on Contractor's cubicle wiring diagrams.
Adhesive-backed wire bundle grips are not accepted for supporting wire extensions.
- 5.7 Terminal blocks shall be arranged with terminals in vertical or horizontal rows.
Terminal blocks shall have each point identified indelibly.



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One side of the terminal blocks shall be left free for Purchaser's connections. All jumpers between terminals shall be made on the internal wiring side. Terminals associated with individual items of equipment shall be grouped together for convenient cable connections. 5.8 The terminal blocks shall not be mounted closer than 7 inches (180 mm) from the control cubicle walls and at least 10 inches (250 mm) from the cable entrance . Central line distance between terminal blocks shall be a minimum of 8 inches (200 mm). Where terminal blocks for Purchaser's connections are mounted on vertical wire-ways , the inside area of said wire-ways shall be reserved exclusively for Purchaser's incoming cables. 5.9 All incoming power terminals shall be clearly identified in a manner distinctly different from all other terminations , for safety in maintenance. It is recommended to group the terminals as follows : 5.9.1 Power 5.9.2 Control AC / DC (120 V/ 220 V) 5.9.3 Control DC circuits 24 VDC , 48 VDC , 60 VDC 5.9.4 Instrumentation 5.10 Where bottom cable entry is used , the vertical wire-ways shall be located over floor openings , to allow Purchaser's cable to have a clear run directly to the terminal blocks. 6. <u>MISCELLANEOUS</u> If any component is not available at the time of shipment , Contractor shall provide wooden templates complete with accurate terminal arrangement and all wiring terminated. The plate shall closely resemble the configuration of the missing component, so that the cubicle wiring can be bundled and identified for easy substitution of the missing device in field.			



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Where cubicles are shipped in sections for connecting together in field, the wiring between sections shall be factory made , to be connected in field. Identically tagged terminal blocks shall be provided on each side of the shipping unit.

Jumpers shall be provided for convenient connection in field.

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7. WIRING TESTS.

The wiring shall be capable of withstanding a one (1) minute field test at 1500 VAC , all parts to ground (except the wiring for electronic equipment).

The factory tests shall demonstrate freedom from grounds and accuracy of the wiring.

Point-to-point continuity tests and electrical insulation tests shall be factory made.

Megger or other high voltage tests shall not be applied to any coaxial shielded or solid-state components.

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8. APPENDIX 1 – INTERNAL WIRING COLOR CODING .

The following color coding is required for the internal wiring of control cubicles :

8.1 AC CIRCUITS .

- 8.1.1 Protective earth : Yellow - Green (mandatory)
- 8.1.2 Neutral : Blue

8.2 AC POWER CIRCUITS .

- 8.2.1 One (1) phase : Brown
- 8.2.2 Three (3) phase :
 - Phase L1 : Brown (preferred) , or
Brown + L1 marking / sleeve
 - Phase L2 : Brown – Orange (brown with one orange
strip on the whole wire length -preferred) ,
or
Brown + L2 marking / sleeve
 - Phase L3 : Brown – Black (brown with one black
strip on the whole wire length- preferred) ,
or
Brown + L3 marking / sleeve

8.3 DC POWER CIRCUITS .



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8.3.1 (+) : Brown
8.3.2 (-) : Blue

8.4 CONTROL CIRCUITS . : Grey (preferred) , or Black .

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