

5.25.05 - COMMON WORK RESULTS FOR INTEGRATED AUTOMATION DESIGN AND CONSTRUCTION STANDARD

PART 1: GENERAL

1.01 Purpose:

- A. This standard is intended to provide useful information to the Professional Service Provider (PSP) to establish a basis of design. The responsibility of the engineer is to apply the principles of this section such that the University may achieve a level of quality and consistency in the design and construction of their facilities. Deviations from these guidelines must be justified through LCC analysis and submitted to the University for approval.

1.02 References:

- A. ASTM B 33 - Standard Specification for tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. ASTM B 88 – Standard Specification for Seamless Copper Water Tube.
- C. ICEA S-95-658 / NEMA WC70 – Nonshielded 0-2kV Cables.
- D. IEEE STD-802.3 - Carrier Sense Multiple Access with Collision Detection Access Method and Physical Layer Specifications.
- E. IEEE STD-1202 – Flame Testing of Cables for Use in Cable Tray In Industrial and Commercial Occupancies.
- F. NEMA 250 – Enclosures for Electrical Equipment (1000Volts Maximum).
- G. NEMA TC-7 - Smooth-Wall Coilable Polyethylene Electrical Plastic Conduit
NFPA 70 – National Electric Code.
- D. TIA/EIA-455-25B - Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies.
- E. TIA/EIA-455-41A - Compressive Loading Resistance of Fiber Optic Cables.
- F. TA/EIA-455-59 - Measurement of Fiber Point Defects Using an OTDR.
- G. TIA/EIA-455-104A - Fiber Optic Cable Cyclic Flexing Test.
- H. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard.

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- I. TIA/EIA-606 - Administrative Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - J. TIA/EIA Publication TSB67 - Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
 - K. UL-44 - Thermoset-Insulated Wires and Cables.
 - L. UL-1277 - Electrical Power and Cable Tray Cables with Optional Optic Fiber Members.
 - M. UL-2024 - Optical Fiber Cable Raceway.
- 1.03 Requirements:

- A. Provide cables and tubing suitable for the installed service conditions.
- B. Preferred configuration for instrumentation cables are home runs from instrument to final termination on an I/O nodule.
- C. Where there are numerous instruments in an area it will be permitted, at UT discretion, to group instruments and control circuit signals in a multiple pair (instruments) or conductor (control) cable.
- D. Provide instrument and control cables for multiple equipment with spare conductors or pairs. For example, for a control circuit that requires 5 conductors provide a 7 conductor cable; for a multiple instrument cable provide 6 pair if total number of installed instruments are 4.
- E. Provide identification labels for cable and individual conductors.
- F. Provide protection for materials during shipment and storage prior to installation.

PART 2: PRODUCTS

2.01 Instrument Cable

- A. 300 V or 600 V shielded multi-conductor cables shall be suitable for operation in instrument circuits carrying low level digital and analog signals.
- B. Sunlight resistant and suitable for installation in wet or dry locations, whether in tray, conduit or underground duct, both indoors and outdoors.

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- C. Conductor size of No. 18 AWG annealed copper with Class B stranding; tinned copper or alloy-coated as required to be compatible with material in contact with them.
- D. Insulation rated for 300 V or 600 V and continuous operation at a 90° C conductor temperature. Insulation shall be free stripping from the conductor material.
- E. Each pair or triad shall consist of individually insulated conductors twisted together with a drain wire and covered with a shield and jacket. Drain wire to be 20 AWG, Class B stranded tinned copper wire in accordance with ASTM B 33. Maximum lay of twist to be three inches.
- F. Shielding shall consist of a minimum 2 mil thick laminated, non-burning aluminum Mylar tape applied helically with the aluminum side in continuous contact with the drain wire. A minimum 15 percent overlap is required in the shield tape lay to ensure 100 percent coverage.
- G. Jacket material shall be suitable for installed service conditions and flame resistant, oil, heat, moisture, weathering, abrasion and chemical resistant
- H. Color coding to be as follows.
 - 1. Pairs: One conductor Black and one White.
 - 2. Triads: One conductor Black, one White and one Red.
- I. Individual conductors shall pass the VW-1 vertical wire flame test of UL 44. Completed cables shall pass the vertical tray flame propagation test in accordance with IEEE1202 or UT approved equal utilizing heat from a 70,000 BTU per hour burner

2.02 600V Control Cable

- A. The multi-conductor cable shall be suitable for operation in either 125 volt DC, 240 volt AC or 120 volt AC, 60 hertz, control and signaling circuits. Cables shall also be rated for potential and current transformer circuits.
- B. The cable shall be sunlight resistant and suitable for installation in wet or dry locations, whether in tray, conduit or underground duct, both indoors and outdoors.
- C. Cable materials, construction and testing shall meet or exceed the requirements of ICEA S-95-658.

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- D. Conductor material shall be No. 14, 12 or 10 AWG annealed copper with Class B stranding, as required based on current capacity. The conductors shall be tinned copper or alloy-coated as required to be compatible with material in contact with them.
- E. Insulation material shall be type XHHW, THHN, or THWN rated for 600 V.
- F. Jacket material shall be flame resistant, self extinguishing, heavy-duty, black, which is oil, heat, moisture, weathering, abrasion and chemical resistant.
- G. Cables shall consist of individually insulated conductors, bunched and filled to be round in cross section. All fillers and binder tape to be non-hygroscopic and flame retardant. Binder tape shall have a minimum 15 percent overlap.
- H. Conductor color-coding shall be in accordance with ICEA S- 95-658. White or Green conductors shall not be provided.
- I. Individual conductors shall pass the VW-1 vertical wire flame test of UL 44. Completed cables shall meet or exceed the requirements of UL 1277 and pass the vertical tray flame propagation test in accordance with utilizing heat from a 70,000 BTU per hour burner.
- J. The cable shall be surface printed or embossed on the overall jacket at regular intervals with, as a minimum, manufacturer's name, voltage rating, size and number of conductors, insulation and jacket type, temperature rating and sunlight resistance.

2.03 Telecommunications Cable

- A. Provide Category 6 unshielded twisted pair (UTP) cables that meet the criteria of TIA/EIA-568 and IEEE STD-802.3 standards for data and voice premise installations.
- B. Cable materials and construction:
 - 1. 24AWG or larger.
 - 2. 4 twisted pair.
 - 3. Unshielded.
 - 4. Solid conductor.
 - 5. Plenum rated.
 - 6. 100 ohm impedance.
 - 7. Color: Blue for data premise and white for voice premise cables.

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- C. Data and voice cables shall be bundled, routed, and terminated separately subject to approval by the UT.
 - D. Maximum cabling run is 90 meters (295 feet) including patch and drop cables in accordance with IEEE STD 802.3.
 - E. Identify and label cables in accordance with TIA/EIA-606 standard.
- 2.04 Fiber Optic Cables
- A. Strands: Coordinate with UT for specific application.
 - B. Material Structure: Silica.
 - C. Mode: Multimode or Single Mode (for long haul applications).
 - D. Core/Cladding Diameter: 62.5/125 micron.
 - E. Operating Temperature: -40°C to +85°C.
 - F. Maximum Attenuation: 3 dB/km at 850 nm and 1.0 dB/km at 1300 nm.
 - G. Jacket Material: Flame Retardant PVC (plenum) and high temp plenum fluoropolymer (riser), UL rated (OFNP, OFNR).
- 2.05 Terminations and Connectors
- A. Provide high conductivity ring or spade lugs as required for copper conductor termination at terminal blocks.
 - B. Provide RJ-45 connectors for data and RJ-11 connectors for voice UTP cables in accordance with TIA/EIA-568.
 - C. Provide type ST connectors in accordance with TIA/EIA-568:
 - 1. Insertion Loss (IL): 0.5dB max.
 - 2. Return Loss: 45dB typical.
 - 3. Repeatability of IL: 0.1dB.
 - 4. Body: Stainless Steel.
 - 5. Ferrule: Zirconia Ceramic.
 - 6. Service Life: 1000 mated/demate cycles.
 - 7. Operating Temp: Minus 40 to plus 85°C.

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2.06 Raceways (Conduit or Cable Tray)

- A. Refer to Design and Construction Standard 5.26.05 section 2.03.
- B. Provide raceways for instrument and control cable/wiring where subject to mechanical damage and at levels below 10 feet in mechanical, electrical, or service rooms.
- C. Provide raceways sized and wire size and type selected in accordance with manufacturer's recommendations and NEC requirements.
- D. Provide rigid raceways with supports, reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings and according to code.
- E. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Liquid-tight flexible metal raceways shall be used in areas exposed to moisture including chiller and boiler rooms.

2.07 Instrument Tubing

- A. Process instrument tubing shall be hard temper seamless copper conforming to ASTM B-88.
- B. Provide 3/8-inch tubing for process input to pressure or flow transmitters, flow indicators, flow or pressure switches, pressure gauges, and analyzer sample lines.
- C. Provide Swagelok fittings for tubing.

2.08 Coaxial Cable

- A. Provide coaxial cable as required by the related equipment manufacturer's rating requirements.

2.09 Identification

- A. Provide type written, self laminating cable and wire markers using black characters on white background:
 - 1. Cables: Mark at both ends where cable designation is the origination – destination. For example, CHW-FT-0100 : CP1-TB2-15/16.s.
 - 2. Wire (conductors): Mark with final destination. For example, TB2-15.

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PART 3: EXECUTION

3.01 Installation

- A. Provide details for typical and special wiring installations on construction documents.
- B. Maintain equipment and cable separation between EMI/RFI emitter and EMI/RFI sensitive equipment as shown in the table:

EMI/RFI EMITTER OPERATING VOLTAGE	SEPARATION DISTANCE ⁽¹⁾	
	EQUIPMENT	CABLE
Greater than 125V	3 meters with no shielding;	0.6 meters if cable in cable tray;
	1 meter with shielded enclosure.	0.3 meters if cable in rigid steel conduit.
Less than or equal to 125V	None	0.1 meter if cable in tray (2);
		None if in conduit.
Notes: 1. Avoid separation distances that are equal to 1/4 wavelength of EMI. 2. Maintain separation distances at the back of equipment where 120 VAC or 125 VDC supply and signal lead connections are terminated.		

- C. Splice connections are not allowed unless shown on the Drawings or approved by UT.
- D. Leave 18 inches excess cable at each termination at system cabinets.
- E. Conduit, cable tray fill shall not exceed 50 percent of total cross-sectional area per NEC.

3.02 Testing

- A. Copper Wire and Cable:
 - 1. Perform continuity checks on conductors.
 - 2. Telecommunications Cable:
 - a. Perform continuity checks on conductors.
 - b. Perform attenuation tests and crosstalk measurements in accordance with TIA/EIA-568 and publication TIA/EIA TSB 67.
 - 3. Fiber Optic Cable:
 - a. Test cables on reels prior to installation with an Optical Time Domain

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Domain Reflectometer (OTDR) in accordance with TIA/EIA-455-59.
Test cable at 850nm and 1300 nm wavelength.

- b. Test cables after installation and termination with an OTDR in accordance with TIA/EIA-455-59 at 850nm and 1300nm wavelengths. Reject and replace cables if either condition exists:
 - 1) Attenuation exceeds factory specifications.
 - 2) Localized discontinuity exceeds 0.2dB.

B. Instrument Tubing Testing:

- 1. Perform pressure testing of air supply lines to 150% of process pressure.
- 2. Perform leak check for process instrument tube fittings during normal system operation.

END OF STANDARD