Project # **IU20250110**

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Addendum No. 2

Project:	IU 20250110 - SB000A SITE - CREATION OF STUDENT RECREATION COURTS	**Date:**	May 12, 2026
To:	All Contractors and Sub-Contractors bidding on the above Project		
From:	Magdalena Aravena, PLA		

This Addendum forms a part of the contract documents. This Addendum is issued to clarify, expand, explain, supplement or supplant drawings and specifications. The items referred to in this Addendum are to govern in the work unless otherwise altered or revised by subsequent Addenda.

The following changes and/or additions shall be made to the contract drawings and specifications on the above-named Project and shall be considered a part thereof.

This addendum shall be listed on the bid form to acknowledge receipt and inclusion in the proposal amount.

PLAN

Sheet C3-100 (Revised)
This Sheet has been revised to correct missing keynotes. The diagrammatic placement of underground electrical conduit for Add Alternate 2 has also been added. Note that the connection shall be made at the closest common panel, which is panel HA in room 198 of Whitewater SB885A (building South of the quad). Final location to be coordinated with IU.

Sheet C5-100 (Revised)
This sheet has been revised to include the Asphalt Basketball Surface detail for Alternate No. 4; and the Concrete Basketball Surface detail has been revised to show acrylic surface on top of the concrete basketball surface to clarify the finish for the base bid concrete basketball surface.

SPECIFICATIONS

Specifications Division 26 – Electrical (Added)

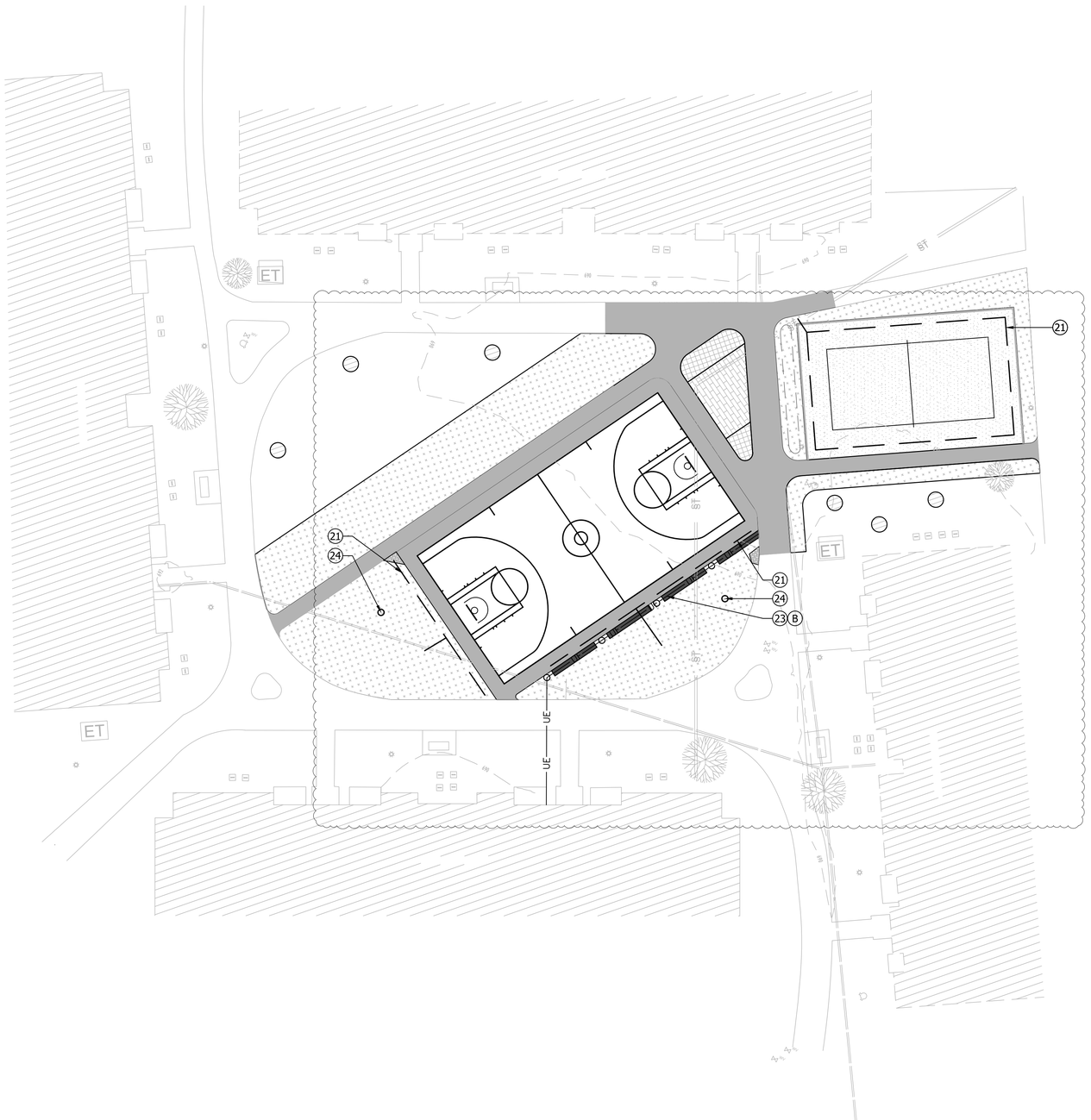
BIDDER QUESTIONS

- Q: Where is the electrical tie-in for the electrical pedestals shown in the drawings? What is to be included as part of that Add Alternate?
    - A: As described above, the connection shall be made at the closest common panel in room 198 of building Whitewater SB885A (South of the Quad). The associated costs with this electrical tie-in, including electrical engineering drawing and stamp, shall be added as a cost to Add Alternate Number 2.
- Q: Is there an existing irrigation system at this property? If so is there an as built of the system or any details that can be provided as to water supply location, controller location etc.
    - A: There is existing irrigation on site, however, the scope of this base bid is to include only irrigation sleeves where necessary due to the new hardscape, as well as the replacement of any equipment damaged during construction. Add alternate 1 shall include budget for the appropriate irrigation equipment to serve this new planting, to be installed as an addition/ replacement of the existing system equipment.
- Q: Can the limits of irrigation where the new irrigation system is to be installed be clearly defined on the plan.
    - A: See answer above.
- Q: Will you be providing a detail on the asphalt surface for the basketball court? I've pulled the specs per the American sports builders association. But it seems like there are a few different thicknesses this surface could be. The stone base should remain as 6" regardless of concrete or asphalt?
    - A: See Detail Sheet revised as attached to this addendum. Stone base shall be 6" regardless if concrete or asphalt as shown in the details.
- Q: Will the basketball court follow the rebar installation detail for sidewalks?
    - A: See Concrete Basketball Surface detail.
- Q: Would fiber in concrete mix be allowable in lieu of rebar for the sidewalks and basketball court?
    - A: That is not an acceptable substitution. All concrete sidewalks shall follow the sidewalk detail shown as this is required per IU standards.
- Q: Is there a final surface finish desired on the concrete for the basketball court? Should this concrete be sealed? This concrete should be the same IU beige color as the sidewalks?
    - A: The base bid surface finish for the concrete court pavement shall be an acrylic court surface, to be installed per manufacturer specifications.
- Q: Detail for sidewalk reinforcement is 24" OC where spec states 30" OC. Confirm which spacing is correct.
    - A: 24" O.C. as shown in the drawings is correct.
- Q: Should the concrete for the basketball court should be 4000psi to match sidewalks?
    - A: Yes.

- Q: Do we need any rebar in the flush curb?
    - A: No.
- Q: Bid form has lump sum and unit prices noted on it. What units should we provide for this breakout?
    - A: Unit prices shall be submitted for the materials as noted in the bid form, in addition to a bid base lump sum.
- Q: Sidewalk Width - Sheet C1-100 appears to show portions of new sidewalk at 5'-0" wide. Addendum #1 / Project Specifications Section 12 states that standard pedestrian sidewalks shall have a minimum width of 6'-0".
    - A: Sidewalks shown as 5’-0” are to remain as designed and approved by IU through our design review process.
- Q: Please confirm whether bidders should price the sidewalk widths as dimensioned on the drawings, including the 5'-0" walks shown, or whether all standard pedestrian sidewalks are to be increased to a minimum width of 6'-0".
    - A: Bidders should price per dimensions shown on the drawings.
- Q: Concrete Reinforcing Spacing - The drawings/details appear to indicate #4 rebar at 24" O.C. in some locations. Addendum #1 / Project Specifications Section 12 states required reinforcement for sidewalks and curbs is minimum #4 rebar at 30" O.C. both directions. Please confirm the required reinforcing spacing for the concrete sidewalks, concrete circulation pavement, and basketball court pavement.
    - A: 24” O.C. as shown in the drawings is correct.
- Q: Integral Color Concrete - Addendum #1 / Project Specifications Section 12 states that all site concrete will be IU Beige integral color unless otherwise specified. The sidewalk concrete appears to require IU Beige integral color. We do not see a separate callout confirming whether the base bid concrete basketball court pavement should also receive IU Beige integral color, especially since the basketball court is to receive acrylic SportMaster surfacing. Please confirm whether the concrete basketball court pavement is to be plain concrete below the acrylic surfacing system, or IU Beige integral color concrete.
    - A: Plain concrete below the acrylic surfacing system is acceptable. The manufacturer specifications for concrete shall be followed to ensure proper adhesion.
- Q: Basketball Court Surfacing Over Concrete - The pre-bid meeting confirmed that the base bid basketball court pavement is concrete, with Alternate #4 switching the court pavement to asphalt. Addendum #1 - Project Specifications Section 15 for Basketball Court Surfacing states to allow asphalt surface to cure 21 days prior to installation of surfacing. Please confirm the required cure period, surface preparation, and any moisture/pH testing requirements for installing the SportMaster acrylic surfacing system over the base bid concrete basketball court pavement.
    - A: Concrete curing for the specified SportsMaster surfacing is to be done per manufacturer specifications.
- Q: Groundwater / Dewatering / Unsuitable Soils - The project includes excavation, grading, concrete pavement, aggregate base, stormwater basins, perforated PVC

piping, drywell work, and volleyball court drainage. We have not located a geotechnical report, groundwater information, or specific dewatering criteria in the bid documents. Addendum #1 - Project Specifications and Division 01 include general requirements for site drainage, pumping, and maintaining excavations free from accumulated water. Please confirm whether a geotechnical report, soil borings, groundwater information, or other subsurface information is available for bidders. If not, please confirm the intended bid basis for dewatering, wet/soft subgrade remediation, and unsuitable soil removal/replacement.

- A: We are not requiring any geotechnical reports; While we don't foresee any groundwater issues, if a groundwater issue or unsuitable soil/subgrade is encountered, we will determine what remediation is necessary during construction. Contractors do not need to include dewatering or unexpected subsurface remediation in the bid.



GENERAL NOTES

1. Contractor Shall Call Indiana 811 at 811 or 800-382-5544 to Locate Utilities Before Any Excavation Work.
2. All Edges of Disturbed Pavement to be Saw Cut to Create Clean, Straight Lines Between Existing and New Pavement.
3. Protect Existing Pavement Not Marked for Demolition.
4. Field Verify All Existing Conditions.
5. Dispose of Removed Materials on a Continuous and Daily Basis as Needed. An Accumulation of Trash Debris Will Not Be Permitted.
6. Dumpster Location to be Reviewed with the Owner Prior to its Placement. Protect Owner's Buildings and Grounds; Repair to Original Condition if Damaged.
7. Contractor to Notify Owner's Representative Immediately if Suspected Hazardous Materials are Encountered. Owner will Test and Remove Hazardous Materials With a Separate Contractor. Do Not Remove Any Item Until the Hazardous Materials Have Been Removed as Indicated by the Owner's Representative.
8. Repair and/or Replace Any Existing Materials or Surfaces to Remain that Become Damaged Due to Construction Operations.
9. Contractor to Take Care Not to Disturb Adjacent Property.
10. All Utility Cuts are to Conform to City Standards.

UTILITY KEYNOTES

(21) Perforated PVC Pipe with 6" Sock
(22) Irrigation Sleeves
(23) Electrical Conduit & Wiring
(24) Basin Dry Well for Overflow Support

ALTERNATES

(A) ADD Alternate 1 - Plantings
(B) ADD Alternate 2 - Electrical for Seat Walls
(C) ADD Alternate 3 - Concrete Seat Walls
(D) DEDUCT Alternate 4 - Asphalt Pavement Basketball Court

0 20' 40'

NORTH

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REGISTERED
MAGDALENA ARAVENA GUTIERREZ
LA22100011
STATE OF INDIANA
LANDSCAPE ARCHITECT

SITE IMPROVEMENTS FOR
INDIANA UNIVERSITY
STUDENT REC COURTS
1700 E MISHAWAKA AVE
SOUTH BEND, INDIANA 46615

MARK	DATE	ISSUED FOR

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SCALE: 1:20

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PROJECT NUMBER 240085.0

SHEET TITLE
SITE UTILITIES PLAN

SHEET
C3-100

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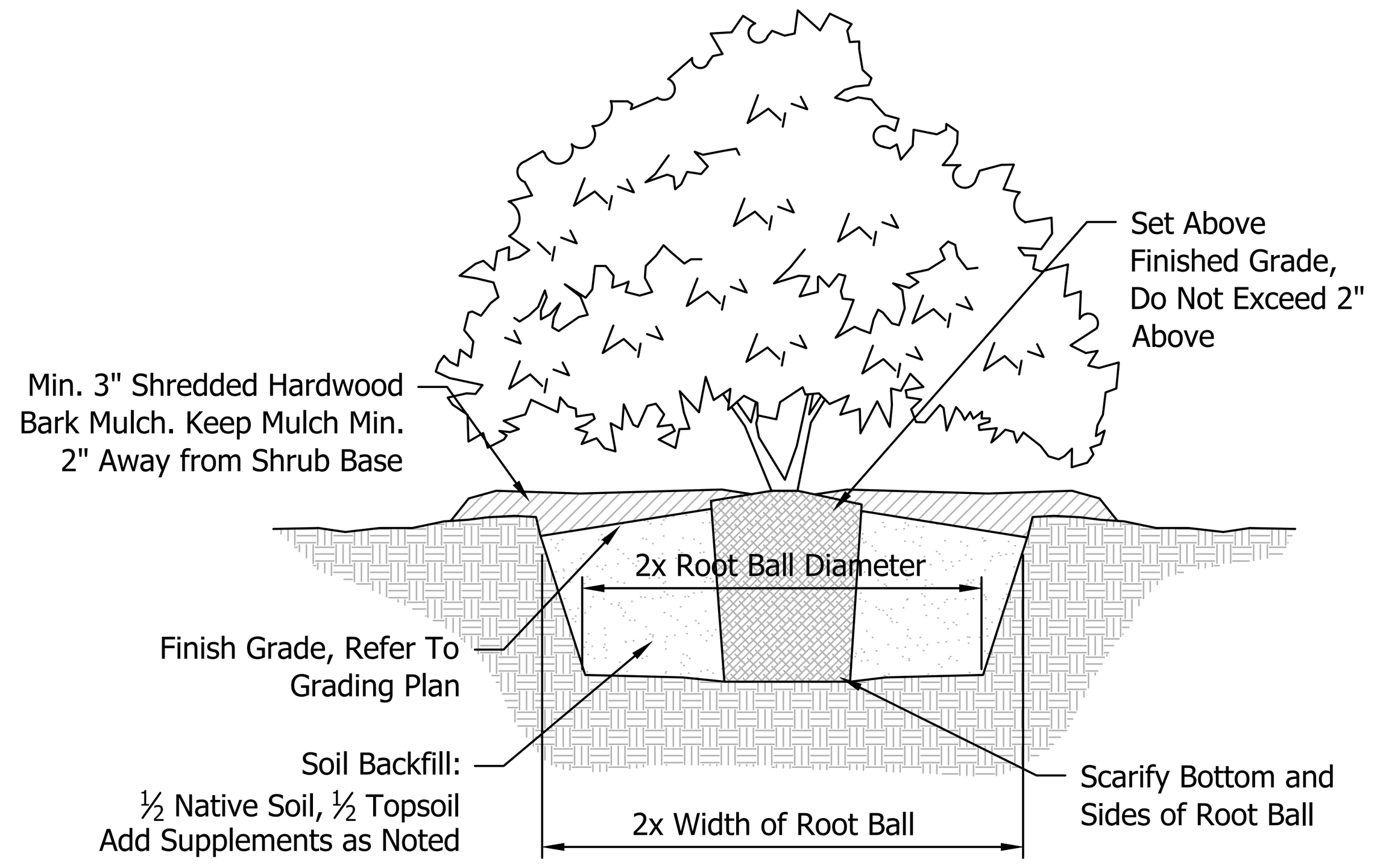

11 SHRUB PLANTING DETAIL

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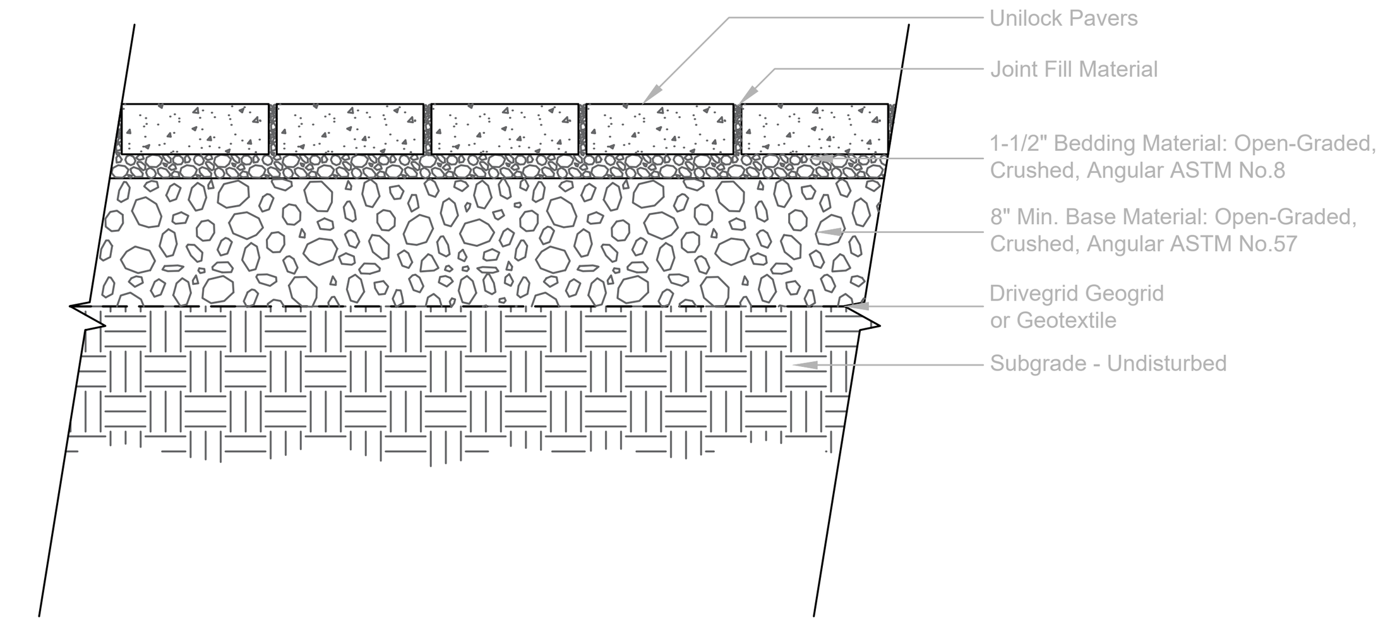
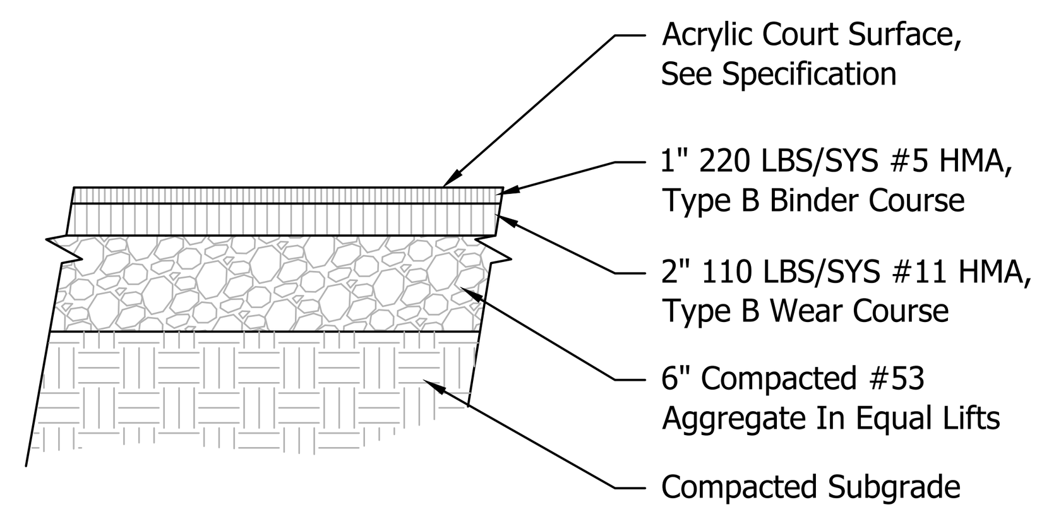


3 PERMEABLE PAVER SURFACE

Scale: 1:1



12 ASPHALT BASKETBALL SURFACE

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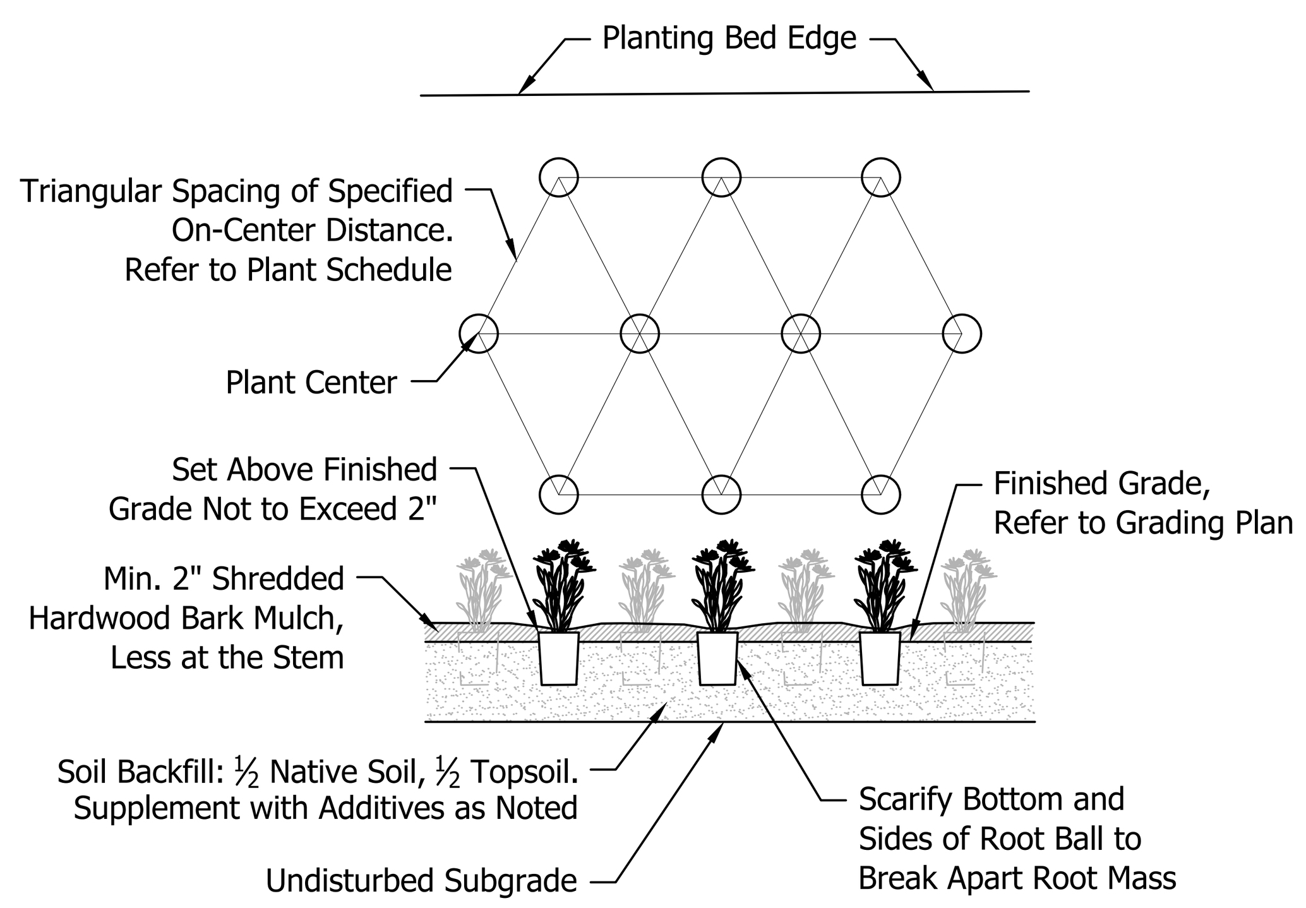

10 PERENNIAL PLANTING DETAIL

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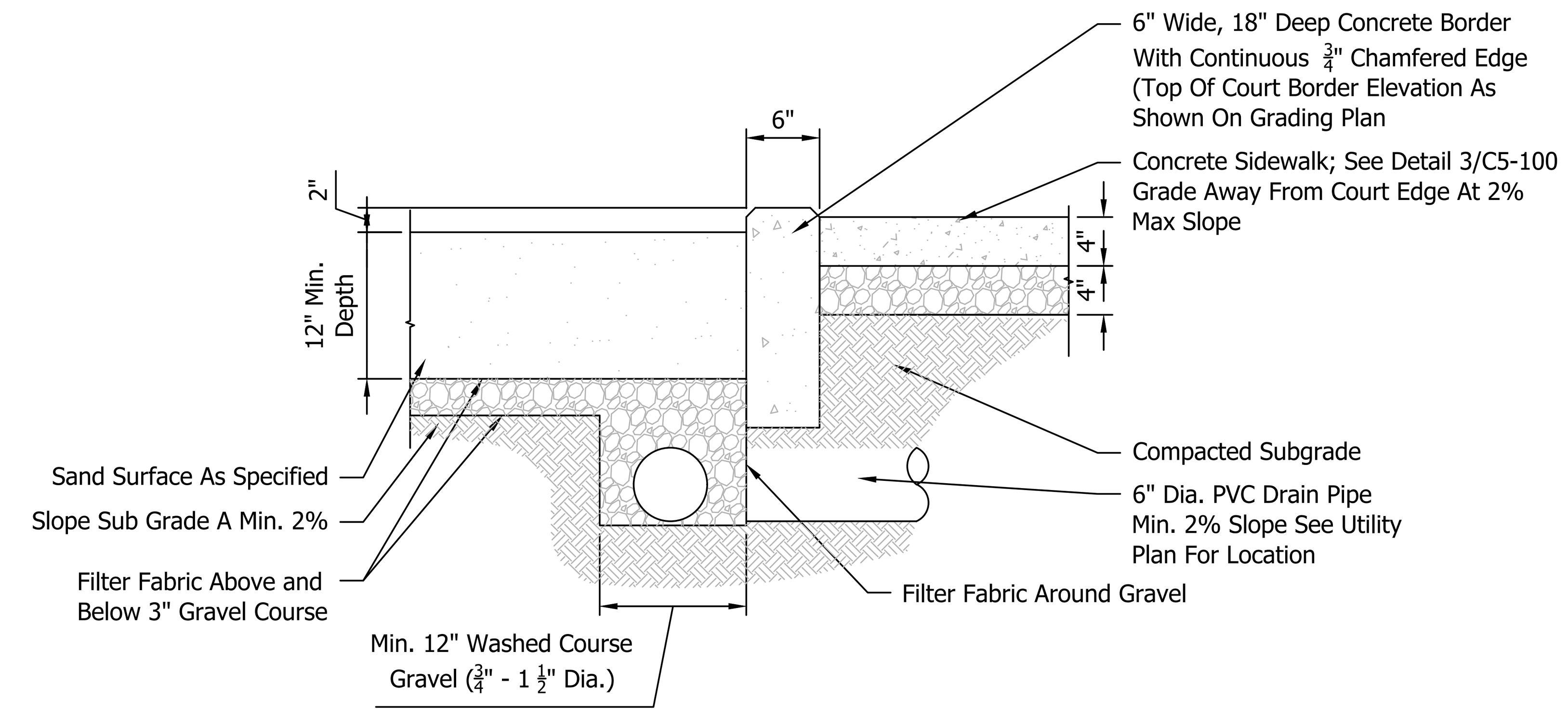

7 CONCRETE SIDEWALK @ SAND VOLLEYBALL EDGE DETAIL

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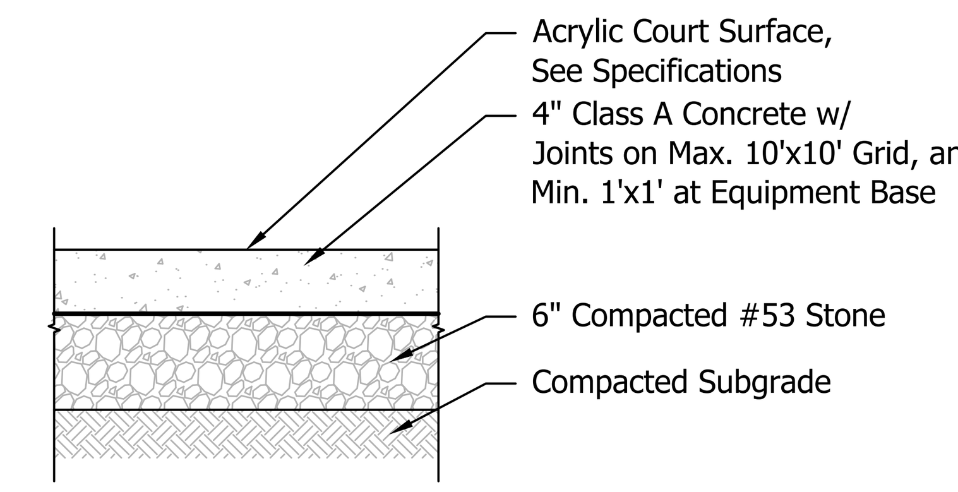
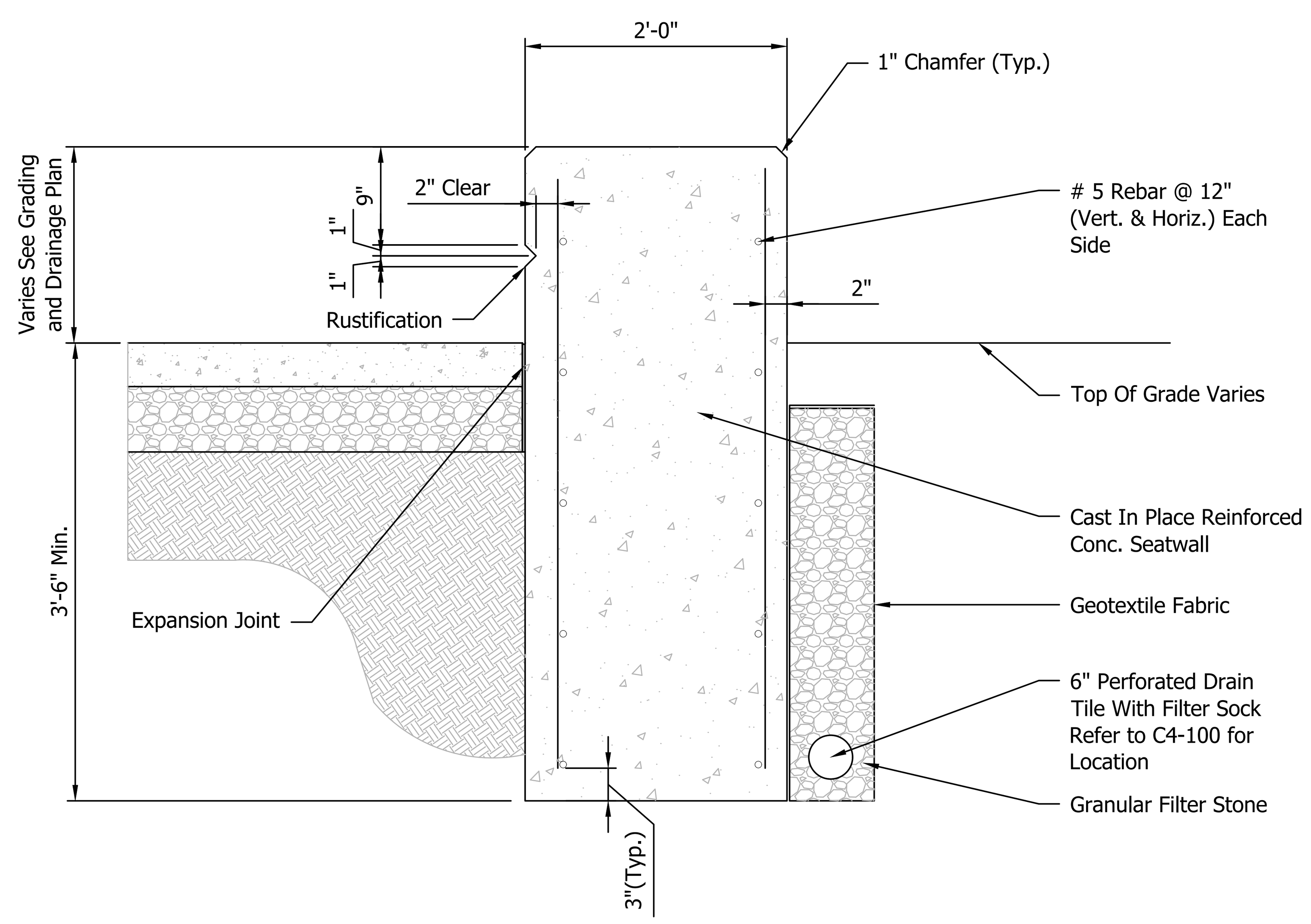


4 CONCRETE BASKETBALL SURFACE

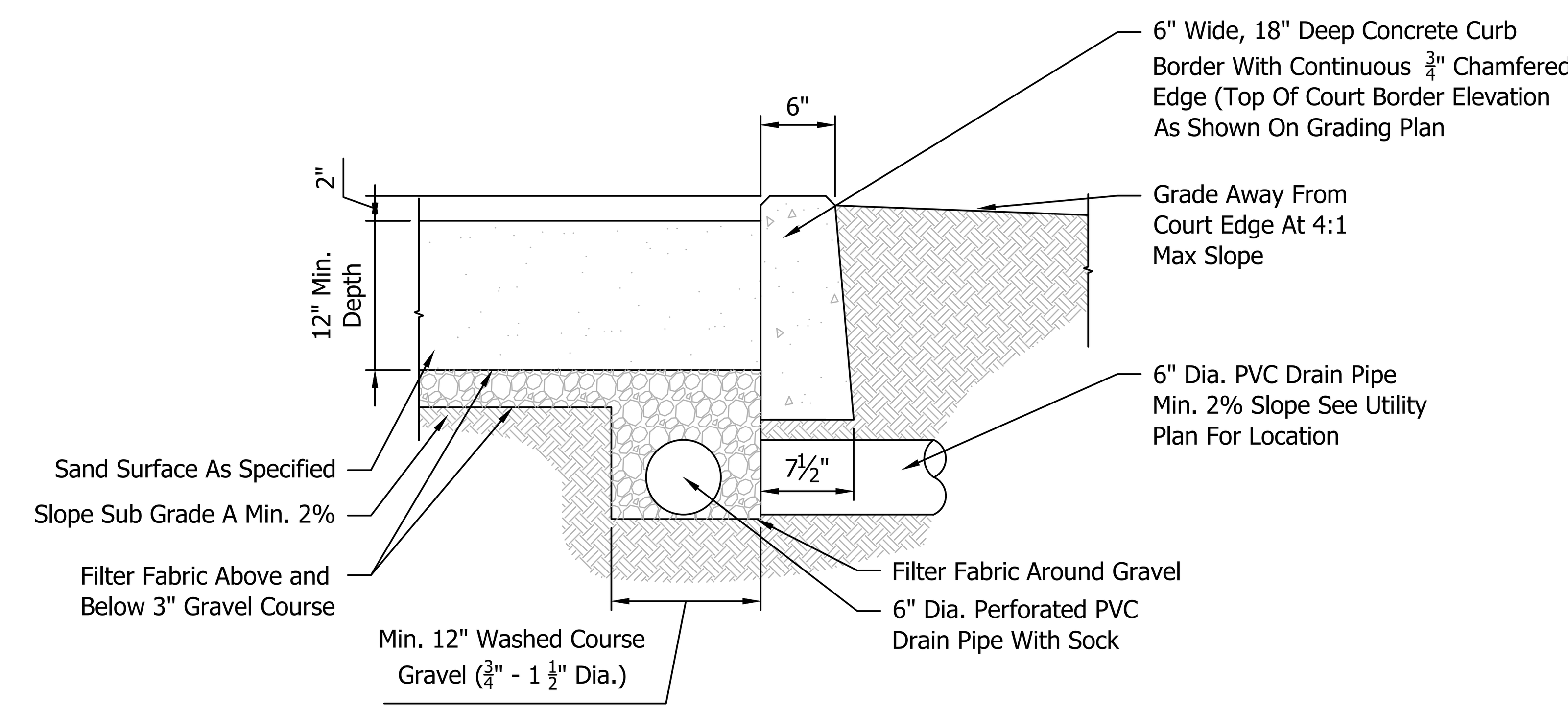
Scale: 1:1



Notes: Light Sandblast Fin. on all Exposed Surfaces.
Control Joints and Expansion Joints???

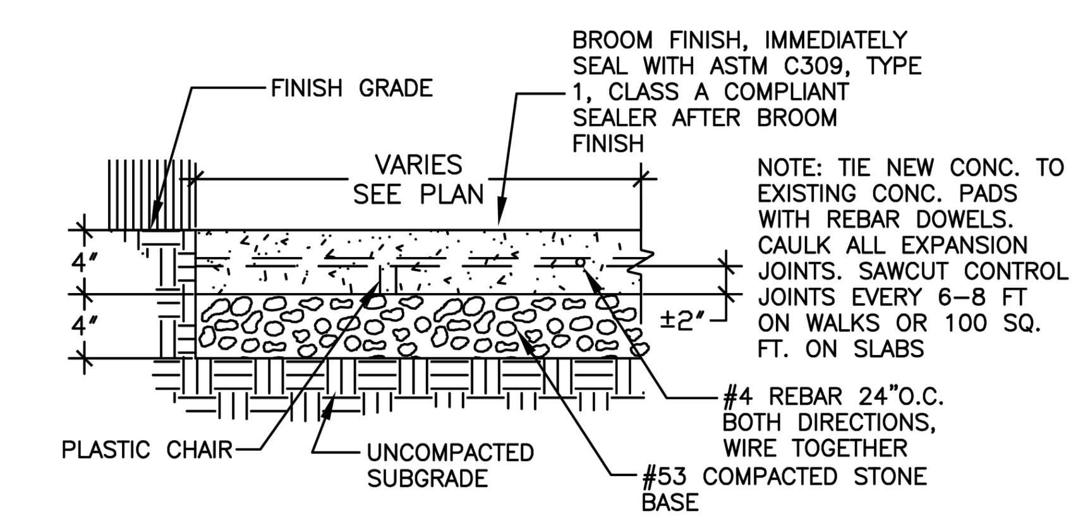
9 CONCRETE SEATWALL

Scale: 1/2 :1



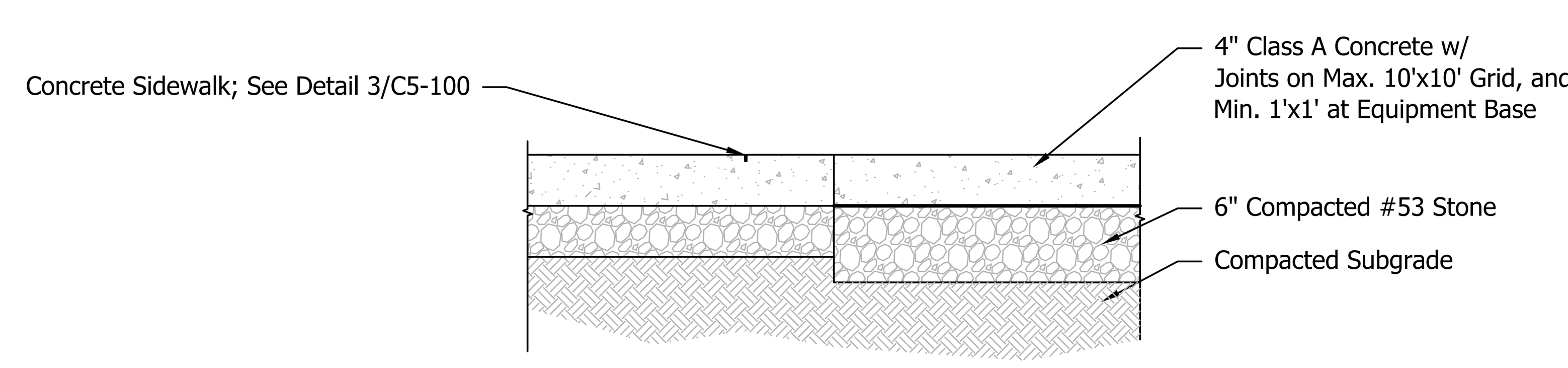
6 SAND VOLLEYBALL COURT EDGE DETAIL

Scale: 1:1



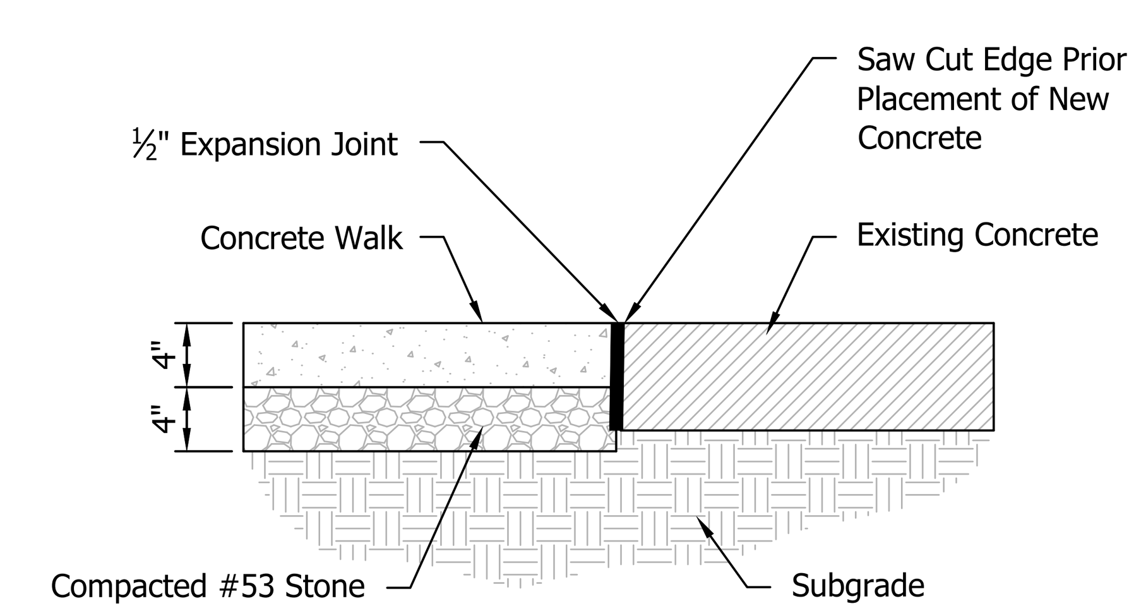
2 CONCRETE SIDEWALK

Scale: 1:1



5 CONCRETE BASKETBALL COURT SURFACE @ CONCRETE SIDEWALK DETAIL

Scale: 1:1



1 NEW CONCRETE @ EXIST. CONCRETE

Scale: 1:1

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MAGDALENA ARAVENA GUTIERREZ
REGISTERED LA22100011 STATE OF INDIANA LANDSCAPE ARCHITECT

SITE IMPROVEMENTS FOR
INDIANA UNIVERSITY
STUDENT REC COURTS
1700 E MISHAWAKA AVE
SOUTH BEND, INDIANA 46615

MARK	DATE	ISSUED FOR

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PROJECT NUMBER 240085.0

SHEET TITLE
SITE DETAILS

SHEET
C5-100

Indiana University

Capital Planning and Facilities

Design Standards

PREFACE

The Design Standards are developed by IU Capital Planning and Facilities for use exclusively by IU's CPF staff and its consultants for the preparation of the design documents for new construction and renovation projects. They set forth IU's preferred design standards for its own building systems and are not intended to supersede any applicable regulations or codes, nor to represent industry standards. IU makes no express or implied warranties with respect to the fitness for any particular purpose or accuracy of information provided herein. Consultants are required to fulfill their legal and professional obligations and meet all applicable local, state, and federal codes and regulations when preparing design documents.

These standards are updated on a regular basis. Please refer to CPF Design Standards in zIUResources in eBuilder for the most recent edition. The revision date can be found in the top right header of this document.

THESE STANDARDS SHALL NOT BE COPIED AND USED AS SPECIFICATIONS.

MATERIAL CONTAINED HEREIN SHALL NOT BE COPIED VERBATIM IN SPECIFICATIONS OR IN NOTES ON THE DRAWINGS EXCEPT WHEN INSTRUCTED.

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25 05 01 – General Electric Design Considerations

February 2022

A. General

1. Follow all applicable codes. Indiana University is considered a State of Indiana entity. Please discuss with IU engineering regarding applicability of local codes. If any code variances are desired, please discuss in detail with IU team including Engineering Services. Please follow state of Indiana variance application and approval process.

2. Engineering Services may want to pursue aspects of codes that are newer than the state adopted code version. Discuss with Engineering Services at the start of a project.

3. At IU we have a large variety of occupancies – residential, office, laboratory, dining, sports venues, etc. It is impossible for our standards to address every situation that may come up. Our standards only address the most common subjects. It is therefore critical that discussions between the consulting team and Engineering Services start at the proposal development stage and close coordination continue thru-out the project to ensure the resulting design and construction meets IU goals for the project.

4. The Architect/Engineer of Record are responsible for reviewing submittals. Please forward all submittals to Engineering Services and CFS to assist in review of the submittals.

5. On many of the projects the university may furnish and/or install some of the electrical equipment, particularly low voltage equipment (Data/communications, access control systems, security cameras, etc.). In nearly all cases the contractors would still install the pathways. Include a responsibilities table in the project drawings to clearly communicate the projects intent. Below is a sample table. Items should be added or removed as needed for a specific project. Do not consider the sample matrix to be the universitie's default approach as it needs to be customized for each project.

LV Systems Scope of Work – Example Only							
Item	Cabling & Terminations		Raceways/Boxes/ Pathways		Equipment Devices		Notes
	Furnish	Install	Furnish	Install	Furnish	Install	
Fire Alarm	C	C	C	C	C	C	
Data	C	C	C	C	O	O	1.
Voice	C	C	C	C	O	O	
Wireless Access Points	C	C	C	C	O	O	2.
Intrusion Detection	C	C	C	C	O	O	
Video Surveillance	C	C	C	C	O	O	
Access Control	C	C	C	C	C	C	
Projectors	C	C	C	C	O	O	
Interactive Displays	C	C	C	C	O	O	
Sound Amplification	C	C	C	C	O	O	
Local Sound Systems	C	C	C	C	O	O	

General Notes:

A. Boxes marked with “C” indicates work included in this contract.
B. Boxes marked with “O” indicates work by the university or other’s on it’s behalf and is not included in this contract.

1. Owner furnishes Data Switches only – the balance of equipment in this contract.
2. Owner furnishes Wireless Access Points – the balance of equipment in this contract.

B. Electric Room Design Requirements

1. The building main electric room(s) shall be located on exterior walls with direct access via exterior doors.

2. Do not locate main electric rooms(s) below grade or in penthouses withoutEngineering Services approval.

3. The main electric rooms(s) construction shall be 2 hour fire rated and not be sprinklered as permitted by Indiana Fire Code Section 9.

4. In the other electrical rooms, electrical closets, MFD/IDF rooms, Security Rooms/closets and elevator machine rooms do not run sprinkler mains in these rooms. The only sprinkler piping allowed in the rooms shall be only for the sprinkler heads located in the rooms. Use of sidewall sprinkler heads is encouraged.

5. Do not install anything "Foreign" in electrical rooms/closets. This includes HVAC, plumbing, sprinkler mains, drains, etc.

6. Starting at schematic design check architectural plans for the floors above electrical rooms/closets to ensure no use is planned that would require drains (Restrooms, Break Areas, Kitchens, Labs, etc).

7. All electrical rooms and closets doors shall open outward. If doors must be open to provide code required working clearances coordinate with the Architects for proper door hardware.

8. All electrical rooms that contain medium voltage equipment, main electric service switchgear/panelboard and those that have electrical equipment rated 800A or greater doors shall be equipped with panic bars.

9. Provide Card Access to all electrical rooms/closets. Where rooms contain multiple doors, only provide card access on the main entry door. The other doors must have monitored door position switches.

10. All floor mounted equipment must be placed on housekeeping pads.

11. Do not locate electrical equipment in Mechanical Rooms unless it is directly associated with the mechanical equipment in the room. Examples of acceptable equipment to locate in Mechanical Rooms are MCC's, disconnect switches, ASD's, Temperature Control Panels, etc.

12. Work with your mechanical team members on the project to include the following on Div. 22 and Div. 23 drawings.

    i. On the fire protection drawings place hatching on the Main Electrical Room(s). The description for the hatching shall indicate the rooms are two hour fire rated and no sprinkler piping and heads shall be located in the rooms. Include elevator machine rooms if they are 2 hour fire rated.
    ii. For the other electrical rooms, electrical closets, MDF/IDF rooms, security rooms and elevator machine rooms (if not 2 hour fire rated) place a different type of hatching on the rooms. The description for this hatching type shall indicate the sprinkler piping in the rooms must only supply the sprinkler heads located in the room.
    iii. On the Plumbing and Mechanical (HVAC) drawings place a hatch over all the electrical rooms, electrical closets, MDF/IDF rooms, security rooms and elevator machine rooms no piping shall be located in these areas.
    iv. In mechanical rooms include hatching showing NEC required working spaces to help ensure no obstructions are located in these areas.

26 05 13 - Medium-Voltage Cables

February 2022

A. **5 KV and 15 KV Cables** - 5 KV and 15 KV cables shall be single conductor type rated MV-105, 133% (220mils at 15kV and 115mils at 5kV) insulation level composed of Class B compressed or compact stranded copper conductor, extruded semi-conductor shield, ethylene propylene (EPR) insulation complying with ICEA S-93-639, combination insulation shield and jacket consisting of 25% overlapped annealed copper tape ribbon (minimum 5mil thick) embedded in extruded non-conducting PVC or chlorinated polyethylene (CPE). Cable shall be sealed against longitudinal water penetration at 5 psi water pressure per ICEA T-31-610. Preferred manufacturers of medium voltage cable are General Cable, Prysmian Cables & Systems, Southwire and Okonite.

B. **Ground Conductor** - Required for all medium voltage circuits - See Section 26 05 26 – Grounding & Bonding for Electrical Systems for details.

C. **Pull Boxes** – Shall be sized per NEC Article 314 Section IV. (Pull and Junction Boxes for Use on Systems over 600 Volts, Nominal). Provide 2 handles on each removable cover.

D. **Pulling Calculations -** For all cable pulls over 200 feet or having multiple bends pulling calculations shall be performed. Results shall be submitted by the contractor and reviewed by the consultant (and Engineering Services or CFS) before the cables are pulled. Share results with Engineering Services or CFS shall review these calculations before the cables are pulled. The calculations shall be submitted with close out documentation.

E. **Installation** - Cables shall take the longest route around the manhole to allow slack for future use. In all cases, adequate slack for future splices shall be provided in the cable routing. Engineering Services or CFS shall approve final cable routing. When installing cable use pulling eyes connected to conductor in lieu of pulling “baskets” which grip the outer jacket of cable. Steel cable shall not be used to pull in cables. Cable shall be pulled in as a circuit off spools and not laid out on the ground. Cables shall be wrapped as a circuit with fire proofing tape in manholes and junction boxes. Where installed, modular tees shall not be fire taped. Scotch 77 fireproofing tape spirally overwrapped with Scotch 69 glass cloth electrical tape on 6” centers is approved for this use. Install labels identifying each cable in an underground vault or pull box. In the underground vault arrange labels, if possible, to be read without entering the vault. Use two UV stabilized wire ties to attach each label. Lettering on labels shall be at least one inch tall.

F. Terminations and Splicing

1. Utilize manufactured kits for termination and splicing of medium voltage cables. Only compression type sleeves and lugs, specifically listed for use on medium voltage systems, shall be used to splice or terminate conductors. Terminations and splices

shall be installed by journeyman electricians who have been trained by the manufacturer for the type of equipment installed.

2. Use 3M Scotch Cold Shrink QT-III 7620 Series termination kits for connecting to live front equipment.
3. Separable Insulated Connectors (IEEE Standard 386) – 600A deadbreak tees are to be used for splicing conductors. The separable connectors shall have test points. Use manufacturers whose kits require a use of a spanner wrench - Elastimold 600 Series or equivalent by Hubbell. Manufacturers (Cooper and 3M) kits that are tightened by use of Allen wrenches are not approved.
4. Where approved by Engineering Services or CFS Cold Shrink In-Line splice kits can be used. For shielded cables use 3M Scotch 5500 Series. For 5kV unshielded cables use 3M 5740 Series.
5. Feeders or circuit taps that are not terminated on equipment that remain energized because of project work use Separable Insulated T-Connector with insulated end caps. For temporary situations due to phasing of work, live end seal kits like Raychem HVES can be used with Engineering Services or CFS approval.
6. Use Elastimold or Hubbell 600A deadbreak elbows with test points for connecting cables to padmount transformers.

G. Testing

1. Except where noted below cable testing shall be performed by an independent, third party, approved testing agency. Testing agency shall submit qualifications of testing team for approval. The test report forms shall be included in the submittal.

2. Megger test new cables on reels at 5000VDC for one minute – Can be performed by contractor.

3. After the installation of new cables in conduit or ductbank, and prior to termination, cables shall again be megger tested at 5000VDC for one minute – Can be performed by contractor.

4. After termination and splice kits are installed the following tests shall be conducted according to current InterNational Electrical Testing Association (INETA) acceptancetest standards in the presence of the Owner's Engineering Services or CFS representative.
    a. Megger test cables at 5000VDC for one minute.
    b. The new cables shall be DC Hi-pot tested. Do not DC Hi-pot test existing cables. This test shall not to exceed 80% of factory test value. Maintain the final test voltage level applied to the cable for 10 minutes.
    c. The completed cable assembly (Old and New) shall be tested using the Tan Delta method.

5. Record and submit all test results to Engineering Services or CFS review after the consultant's review for approval prior to energization. The following information shall be included on test reports: date, project, circuit identification, cable manufacturer, insulation rating, conductor size, temperature, and humidity at time of test, voltage increments, stabilization time, leakage current at final test voltage after 10 minutes, test graphs, megohm meter readings, and names and mode numbers of instruments used. If any single conductor fails testing, all three conductors (plus ground) in the cable

segment system shall be replaced and then retested per the above requirements. During circuit upgrade/reconductoring projects, contractor shall be responsible for disconnection and reconnection of instrument transformers and lightning arrestors at existing equipment to facilitate acceptance testing.

26 05 19 - Low-Voltage Electrical Power Conductors and Cables

February 2022

A. 600 Volt and Below - Feeder and Branch Circuit Wires

1. Conductors shall be annealed copper with the following type of insulation for uses listed:
    a. Feeder (including ground) – THHN/THWN-2
    b. Branch Circuits (including ground) - THHN/THWN-2

2. Minimum wire size for feeders and branch circuits shall be #12 AWG.

3. Wire size #12 AWG shall be solid conductor. Wire sizes #10 AWG may be solid or stranded conductors. Wire size #8 AWG and larger shall be stranded conductor.

4. Preferred manufacturers
    a. Encore Wire Corporation.
    b. General Cable, A Brand of Prysmian Group.
    c. Republic Wire,Inc.
    d. Southwire Company.

5. Branch circuit conductors #10 AWG and smaller shall be spliced together using properly sized and listed twist-on spring type insulated connectors, i.e. wire nuts. Conductors #8 AWG and larger shall be spliced using a non-insulated compression type sleeve or mechanical type connectors. Install taped covering on sleeves to maintain insulation level of system. Polaris type connectors can also be utilized when approved by Engineering Services or CFS. Split-bolts are not permitted.

6. Where not provided with equipment use mechanical type lugs (allen-head screw type) to terminate wire.

7. All feeder and branch circuit wiring shall be installed in raceway.

8. Homerun conductors shall be installed unspliced from panelboard source to first device.

9. Multiwire branch circuits are not acceptable. Each branch circuit requiring a neutral conductor shall be installed with a full-sized, dedicated neutral conductor. Special care must be taken when coordinating power feeds to systems furniture to avoid multiwire branch circuits.

10. In remodeling of former residential (Houses) structures repurposed for commercial use the use of non-metallic sheathed cable for branch circuits may be permitted. Verify the acceptance of using non-metallic sheathed cable with Engineering Services or CFS prior to designing around this type of cable system. Any installation of this cable shall be designed and specified to meet the requirements of Article 336 of the National Electrical Code.
11. Megger tests shall be performed on all feeders and three phase motor branch circuit conductors to motors 20HP and larger. Do not megger check solid state equipment.

12. Conductors shall be color coded per the following table. The preferred method of color coding is to use conductors with permanently colored insulation. If field applied color coding is required, use pressure sensitive vinyl tape like Scotch 35. Tape shall be applied in half-lapped turns for a distance of 6” from the terminal point and in boxes where splices or taps are made. The last two laps of tape shall be applied with no tension to prevent possible unwinding. If colored tape is applied, do not obliterate cable identification marking.

LOW-VOLTAGE CONDUCTOR COLOR CODING TABLE		
CONDUCTOR	**480 / 277 VOLT SYSTEM**	**208 / 120 VOLT SYSTEM**
A Phase	Brown	Black
B Phase	Orange	Red
C Phase	Yellow	Blue
Neutral	Grey	White
Ground	Green with Yellow Stripe	Green

13. Conductors shall be labeled at each end with circuit information; e.g. panel label and circuit number. Labeling shall also be attached to each conductor at each pull or junction box the conductor passes through.

B. Control and Signal Wires

1. Motor control and relaying wiring shall be no smaller than #14 AWG stranded copper conductor type THWN, or MTW, installed in conduit and shall not be run with feeder or branch circuits.

2. Fire alarm and door access control system wiring shall be installed in a raceway system. Fire alarm wiring shall be stranded.

3. Class 2 Temperature control cables, occupancy sensor wiring, LED lighting dimming wiring and other low-voltage control cables are to be installed in a raceway system. However, these cables may be installed in open air providing the following criteria is satisfied.
    a. Cables are not installed above inaccessible ceilings.
    b. Cables are not subject to damage.
    c. Cables are provided with plenum rated jackets.
    d. Cables are properly supported by J-hooks and/or bridle rings.

4. Telecommunications System Wiring: Refer to the latest version of *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS) for telecommunication system wiring requirements. These standards can be found on the IU Capital Planning & Facilities web site.

26 05 26 - Grounding and Bonding for Electrical Systems

February 2022

A. Medium Voltage Distribution System

The following medium voltage distribution systems are present on the Indiana University Campuses:

1. IU Bloomington: 4,160 volt and 12,470 volt
2. IU Purdue University Indianapolis: 4,160 volt and 13,800 volt
3. IU Northwest: 12,470 volt
4. IU South Bend: 12,470 volt

In general, all systems are solidly grounded; verify system configuration at Campus locations. Distribution consists of phase conductors plus an insulated ground cable. This ground cable should be a 600 volt THW or THWN-2 insulated cable. The existing system ground while not perfect is one of the best grounds available. This system ground should be extended to ground buses in the medium voltage switchgear and bonded to the other grounding electrodes used in the building. The size of the system ground cable shall be the smaller of #4/0 AWG or the size of the phase conductors or another size as approved by Engineering Services or CFS.

B. Service Entrance

1. Simply referring to the National Electrical Code Article 250 on Grounding is not acceptable. The NEC is not a design manual and while we must meet the requirements of the NEC, additional information on the installation of the grounding system is the responsibility of the Consulting Engineer. The installation of ground mats, connection to water service, building steel, footing grounds, etc. should be shown on the drawings and included in specifications.

2. A readily accessible ground bar connected to the grounding electrode conductor shall be installed in each main electrical equipment room. The ground bar shall be copper or tinned copper material, minimum 1/4" thick X 4" wide X 20" long. In lieu of a ground bar a ground loop may be installed. The ground loop shall consist of a #4/0 AWG bare copper conductor installed around the entire perimeter of the electrical room. Bond all metal items in the electrical rooms to ground. Using a ground bar inside equipment is not an acceptable substitute.

3. Grounding Electrode:
    a. Utilize building steel where available
    b. Metal underground piping shall be used. Natural gas piping shall not be used.
    c. A building footing ground shall be installed per NEC Article 250.52(A)(3)
    d. A ground mat consisting of at least three driven ground rods (8'-0" long X 3/4" diameter copper clad steel) 10 foot on center shall be installed.
4. The maximum acceptable impedance to ground at the building service entrance is 5 ohms and the grounding system should be designed accordingly. The project specifications shall require testing and documentation of this ground impedance testing. Testing shall be performed by an independent, third party, approved testing agency in according to current InterNational Electrical Testing Association (INETA) acceptance test standards. Test results shall be included in project record documents.

5. All Grounding electrode systems shall be bonded together at the service entrance (Main Electrical Room/Vault) ground bar. No independent grounding electrode systems are allowed.

C. Feeders: Feeders shall have a separate insulated equipment grounding conductor installed.

D. Branch Circuits: Receptacle, lighting, power utilization equipment, etc., shall have separate insulated equipment ground conductors installed.

E. Telecommunication System: The telecommunication systems installed shall be grounded in accordance with the latest version of the *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS) for telecommunication system wiring requirements. These standards can be found on the IU Capital Planning & Facilities website.

F. Terminations: Terminations of grounding system conductors shall be done using listed lugs and fittings specifically made for the use intended. Any ground connections in wet or damp locations shall be by Cadwelding or irreversible Compression Fittings – using Mechanical connectors is not acceptable. Using sheet metal bolts with lock washers and Sta-Con connections on the wire is not acceptable.

G. Inspection: The Consulting Engineer and Engineering Services shall jointly inspect the main distribution equipment to verify that the main bonding jumper between the system ground and the grounded conductor (neutral in most cases) has been installed before the equipment is energized. The main bonding jumpers at separately derived systems and at the generator shall also be jointly inspected. Engineering Services has found several installations where this jumper was not properly installed resulting in an unsafe working condition.

H. Underground Electrical Vaults: All metal parts, e.g. lid, ring, frame and support, ladder, and etc., shall be bonded to ground rod and ductbank ground conductor with a minimum #6 THW or THWN-2 conductor.

I. Ductbanks: Refer to Section 26 05 43 - Underground Site and Electrical Utilities (located in ES – 26 05 33 – Raceways and Boxes for Electrical Systems) for ground conductor requirements in ductbanks.

J. Underground Outdoor Lighting Circuits Hand Holes: Ground connections shall be by Cadweld or Irreversible compression fittings. Use of wire nuts or other mechanical type connectors are not permitted.

26 05 33 - Raceway and Boxes for Electrical Systems

February 2022

A. Raceway

1. General Requirements
    a. Where multiple conduit/tubing types are listed as acceptable select the type appropriate for your project/application. Listing of all types in your specification is not acceptable – we expect the designer to choose, not the contractor.
    b. For rigid metal conduit (RMC), intermediate metal conduit (IMC) and electrical metallic tubing (EMT) use galvanized steel type. Stainless steel and aluminum may be used for special applications – discuss with Engineering Services or CFS before specifying.
    c. Use of RMC, IMC and EMT with integral couplings or fittings is not permitted.
    d. Conduit shall be installed with NO MORE THAN the equivalent of THREE 90-DEGREE BENDS in any conduit run. Pull boxes, properly sized to the latest requirements of the NEC, shall be installed if more than the equivalent of three 90-degree bends are needed in a conduit run. The location of the box shall be such that it eliminates a 90-degree bend in the conduit run.
    e. Minimum conduit size shall be 3/4”; 1/2” conduit is allowed for lighting switch legs.
    f. All conduit shall be labeled every 25 feet (Minimum one label per conduit) in accordance with the following.

1. Normal Power: Black lettering on White background identifying voltage of conductors.
2. Emergency Power: Red lettering on White background identifying voltage of conductors.
3. Fire Alarm: White letters on Red background – “FIRE ALARM”.
4. Telecommunications: Black letters on White background – “TELECOMMUNICATIONS”.
5. Temperature Control: Black letters on White background – “TEMPERATURE CONTROL”.
6. Security Systems: Black letters on White background – “SECURITY”.
7. Audio / Visual: Black letters on White background – “AUDIO / VISUAL”
8. Consult with Engineering Services or CFS on how to label conduit for other systems.

2. Power Feeder Conduit
    a. Interior exposed conduit shall be RMC or IMC.
    b. Interior concealed conduit 2" trade size and larger shall be RMC or IMC.
    c. Interior concealed conduit 1-1/2" trade size and smaller may be RMC, IMC, or EMT.
    d. Interior conduits for Medium Voltage Cables shall be RMC.
    e. DO NOT install power feeder conduits within concrete floor slabs.
    f. Installation of power feeder conduits below on-grade concrete floor slabs is not desired and exceptions other than for conduits from pad mounted transformer secondaries must be approved by Engineering Services or CFS.
    g. Below grade conduit refer to Section E - Underground Site and Electrical Utilities (Section 26 05 43).
    h. Exterior conduit shall be RMC or IMC.
    i. Connection to Equipment: The use of flexible metal conduit (FMC) or liquid-tight flexible metal conduit (LFMC), not less than 12” nor more than 6’ in length, may be allowed for terminations of feeder runs serving low- voltage (less than 600 volt) equipment with inherent vibration, e.g. dry type transformer, motor terminal box, and etc. In Mechanical Rooms only use LFMC. The use of flexible conduit shall be reviewed with Engineering Services or CFS. FMC shall be UL-1 listed and LFMC shall be UL-360 listed.
    j. In Mechanical Rooms with Steam use only RMC.

3. Branch Circuit and Control Conduit
    a. Interior exposed conduit shall be RMC or IMC.
    b. Temperature control conduit in Mechanical and Electrical equipment rooms may be EMT.
    c. Interior exposed conduit in electrical closets containing only branch circuit panelboards, EMT may be used.
    d. Interior concealed conduit 2" trade size and larger shall be RMC or IMC.
    e. Interior concealed conduit 1-1/2" trade size and smaller may be RMC, IMC or EMT.
    f. Branch circuit and control conduit installed in or under concrete slabs is not preferred. Coordinate any conduit installed in concrete slab with Engineering Services or CFS.
        1) If installed under on grade concrete slabs use RMC, RNC 40, or RNC 80.

2) If installed in concrete slab use RMC, RNC 40, or RNC 80. In addition, conduit installed in a concrete slab shall not exceed 1" trade size and must be installed in middle 1/3 of concrete slab.

g. In existing buildings where conduits cannot be concealed, cut and channel walls and ceilings or install surface raceway where specifically directed by Engineering Services or CFS.
h. Below grade conduit refer to Section E - Underground Site and Electrical Utilities (Section 26 05 43).
i. Exterior conduit shall be RMC or IMC. Where conduits transition from below grade directly up to a junction / pull box located within 18 inches of the ground they can be RNC 80 to match the below grade conduit.
j. Connection to Equipment: Flexible metal conduit (FMC) or liquid-tight flexible metal conduit (LFMC), not less than 12" nor more than 6' in length, as required by environment, shall be used for terminating at recessed light fixtures or vibrating equipment. In Mechanical Rooms only use LFMC. Coordinate any other proposed uses with Engineering Services or CFS. FMC shall be UL-1 listed and LFMC shall be UL-360 listed.
k. On the IUPUI campus for exterior lighting circuits use PVC coated RMC – See 26 56 00 Exterior Lighting Section C.5.

4. Conduit for Bare Grounding/Bonding Conductors for physical protection.
   a. Generally use GRC or IMC with ground bushings. In accordance with NEC requirements the jumper from the ground bushings to the grounding system shall be the same size as the conductor located in the conduit.
   b. RNC 40 or RNC 80 can be used with Engineering Services or CFS approval when not subject to damage.
   c. Bare Grounding/Bonding Conductor conduit may be installed under concrete slabs. Coordinate with Engineering Services or CFS. Use RMC, RNC 40, or RNC 80.

5. Telecommunication System Conduit
   a. Refer to the latest version of *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS) for telecommunication system conduit requirements. These standards can be found on the IU Capital Planning & Facilities website.
   b. General requirements for telecommunication system conduit include, but are not limited to the following:
      1. Sleeves through floors shall be RMC or IMC.
      2. Risers, home runs, and station cabling shall be installed in RMC, IMC, or EMT, as directed by Engineering Services or CFS.

6. Fire Alarm System Conduit
   a. Interior concealed dry spaces
      1. Use RMC, IMC, or EMT
      2. Where conduit cannot be installed, and with Engineering Services or CFS approval, plenum rated, MC type cable specifically manufactured for use with Fire Alarm Systems may also be used in interior concealed dry spaces (MC-FPLP). Jacket is to have red coloring.
   b. Interior exposed use RMC, IMC, or EMT.
   c. In moist locations use RMC or IMC.
   d. The conduit system including junction boxes shall be painted red.

7. Other Low-Voltage System Conduit
    a. Interior concealed dry spaces
        1. Use EMT.
        2. Where conduit cannot be installed, and with Engineering Services or CFS approval, low-voltage system cabling may be installed in open air providing the following criteria is satisfied.
            a. Cables are not subject to damage.
            b. Cables are provided with plenum rated jackets.
            c. Cables are properly supported by J-hooks and/or bridle rings.
    b. Interior exposed use RMC or IMC.
    c. In moist locations use RMC or IMC.

8. Couplings and Fittings for Conduits
    a. The University is concerned with the quality of materials used and the workmanship expended on the installation of conduit couplings and fittings. Poor materials and improper installation can and have resulted in hazardous conditions due to the loss of the ground return path. The consultant is urged to address this issue in detail in the project documents.
    b. The minimum standards for material are:
        1. RMC and IMC conduit: threaded, corrosion resistant, malleable iron conduit bodies.
        2. No threadless fittings for RMC or IMC shall be used.
        3. EMT: steel compression type for 2" and smaller; steel set-screw type for larger than 2".
        4. No cast or indent type couplings shall be specified.
        5. Use manufacturer's recommended solvent cement for RNC and manufacturer's standard fittings and accessories.
9. Surface Raceway
    a. In general the University does not accept the installation of surface raceways in new building construction. Possible areas where this equipment might besuitable are computer cluster rooms, shop areas, and laboratories. Remodeling of existing buildings will sometimes necessitate using surface raceways, however, this should be kept to a minimum. Verify the acceptance of using surface raceways with Engineering Services or CFS prior to designing around this type of system.
    b. Where surface raceway is allowed to be used it may be of metallic or non-metallic construction; utilize smallest surface raceway available to accomplishthe job. Paint surface raceway to match walls after installation. Where making vertical drops, install in room corners. Install a separate equipment grounding conductor within surface raceway. Use manufacturers standard fittings and accessories.
    c. Where single channel surface raceways are used for branch circuits and control wiring use Wiremold 700 as the minimum size metallic raceway solution, and Panduit LD10 as the minimum size non-metallic raceway solution.
    d. Where single channel surface raceways are used for telecommunications wiring use Wiremold V2100 as the minimum size metallic raceway solution, andPanduit LD10 as the minimum size non- metallic raceway solution. Use extra deep 2-gang outlet boxes.

e. Where multiple outlet assemblies of the same type, e.g. all duplex receptacles, all UITS data outlets, are required use Wiremold 3000 as the minimum size metallic raceway solution, and Panduit T-70 as the minimum size non-metallic raceway solution
f. Where multiple outlet assemblies are installed in a divided raceway use surface raceway with two covers, one for each channel. Install devices under separate covers. Use Wiremold DS4000 as the minimum size metallic raceway solution, and Wiremold 5400 as the minimum size non- metallic raceway solution.
g. For laboratory installations utilize Wiremold Isoduct AL4320 extruded anodized aluminum raceway.

10. Firestopping

Raceways penetrating a fire wall or other fire rated barriers shall have rating of fire barriers restored using approved methods. Drawings shall detail locations and techniques used.

B. Boxes

1. Wall and Ceiling Outlet Boxes
   a. In general wall outlet boxes shall be galvanized steel, 4" square with depth as required by devices or conduits. Specify partitioned multi- ganged switch boxes where voltage between conductors exceeds 300 volts. Plaster rings shall be used for single gang devices. In exterior or damp locations use cast metallic boxes type FD or FS.
   b. Telecommunication outlets shall be per latest version of *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS)
   c. Ceiling outlet boxes shall be galvanized steel and rated and installed to support fixture or equipment weight.
   d. Wall boxes shall not be installed in any "through wall" manner. This includes back-to-back installation, and back-to-back with nipple connections. Preference is to have a stud located between boxes serving spaces on opposite sides of the wall.

2. Floor Boxes
   a. Cast-in-place type floor boxes shall be fully adjustable style cast metal where used at or below grade and fully adjustable style formed steel above grade level.
   b. Preferred cast-in-place floor box style will have devices mounted in a vertical plane, e.g. Legrand/Wiremold RFB or Evolution style.
   c. Poke through type floor boxes are acceptable for use in existing construction. Location of poke through floor boxes shall be carefully selected to not degrade the structural integrity of the existing floor.
   d. Preferred poke through floor box is Legrand/Wiremold 6AT or 8AT.

3. Pull and Junction Boxes
   a. Where installed indoors use galvanized sheet steel NEMA I enclosure with baked enamel finish. Boxes shall have screw cover.
   b. Where installed outdoors or in damp or wet locations use NEMA type 3R or 4 gasketed enclosure with screw cover.
   c. Where cast outlet boxes are installed use cast metal surface mounted pullbox.
   d. Consultant shall size all pull boxes indicated on the drawings.

e. Any pull box covers with a dimension greater than 18 inches shall have one or more handles installed to facilitate installation and removal.

4. Identification
    a. Pull and outlet boxes located in ceiling spaces and in unfinished areas of building shall be legibly identified on exterior with permanent markers indicating the circuits contained within and panel serving circuits.

C. Cabletray (Section 26 05 36)

1. Cabletray shall be used to carry telecommunication cables, data cables, control system cables, other low-voltage system cables, and in rare instances power cables in accessible areas or locations without ceilings. Preferred style is wire basket.
    a. Refer to the latest version of *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS) for telecommunication system cabletray requirements. These standards can be found on the IU Capital Planning & Facilities website.

2. Install cable tray as low as possible above accessible ceilings and secure to side wall with an "L" shaped bracket wherever possible. Use 4" EMT (quantity determined by cable tray width) to transition above inaccessible ceilings. Install tray at 9'-0" in areas without ceilings. Stem mount supports from structure where side walls cannot be utilized. Stem mount supports shall be attached to the sides of the cable tray. To allow for future use an 18" minimum clearance shall be maintained on the free side(s) of cable trays and a minimum of 18" clearance shall be maintained above trays. Turns in tray shall be made by using two (2) 45 degree turns in lieu of one (1) 90 degree turn where possible.

D. Underfloor Duct (Section 26 05 39)

1. In areas of buildings with a known high concentration of power and telecommunication needs which cannot be served by wall outlets an underfloor duct system may be considered for use. The system shall be compartmentalized into three (3) separate raceways: one for power wiring, one for telecommunication wiring, and one for future cabling. The system must be coordinated with the architectural and structural design of the building.

2. Preferred manufacturers, subject to specific system requirements, are Legrand/Walkerduct and Square D.

3. Details of system design and installation shall be coordinated with Engineering Services or CFS. Specific concerns will include how duct system is interfaced with telecommunication's equipment rooms, electric panelboards, floor finishes, and etc.

E. Underground Site and Electrical Utilities (Section 26 05 43)

1. Below Grade Low Voltage Power Feeder and Branch Circuits (See Section E.2 for padmount transformer secondary conductors and exterior emergency feeders).
    a. Below grade power feeder, branch circuit and control conduit are to be installed a minimum of 2’-6” below grade. Slope conduits away from building where possible. Install a magnetically detectable red plastic marking tape 1 foot above top of conduit.
    b. Power feeder conduit shall be sand or concrete encased RMC, or concrete encased RNC 40 or concrete encased RNC 80. Below grade power feeder

conduit shall be installed in a 3” sand or concrete envelope. Where RNC is used, transition to RMC for penetrating building footings or elbows up through floor slabs. RNC conduit shall not be installed within building interiors. Minimum conduit size is 1”.

c. Branch circuit and control conduit shall be RMC, RNC 40 or RNC 80. Below grade branch circuit and control conduit shall be installed in 3” sand envelope (concrete encasement is also acceptable). Where RNC is used and penetrates building footing or elbows up through floor slab RMC or RNC 80 shall be used. RNC shall not be installed within building. Minimum conduit size is 3/4”.
d. Junction boxes and covers for branch circuits shall be constructed of cast iron or cast aluminum with neoprene gaskets and stainless steel screws. This type of junction box has problems associated with maintenance and accessibility. Use should be kept to a minimum.
e. Below grade power feeder, branch circuit and control conduit may be installed using horizontal directional drilling (HDD) methods. If HDD is used, conduit shall be UL Listed for use as an electrical conduit Schedule 80, High Density Polyethylene (HDPE). Preferred manufacturers are: Carlon and Blue Diamond Industries.

2. Low and Medium Voltage Ductbanks and Service Entrance Feeders
    a. The system shall consist of concrete encased RMC, RNC 40 or RNC 80. Minimum conduit size is 5 inches for Medium Voltage and 4 inches for Low Voltage. Provide 100% spare conduits on Medium Voltage and 25% (Minimum of 2) spare conduits for Pad Mounted Transformer secondaries. Spacing between conduits shall be 2" minimum and the concrete envelope shall be minimum 3" thick. Use end bell fittings where conduits terminate in underground electrical vaults or building walls. Conduits shall terminate in underground electrical vaults or building walls at a right angle. Plastic conduit spacers shall be used to support conduits and to maintain proper spacing. Install polyethylene plugs on unused conduits. The top of ductbanks shall be minimum of 2'-6" below grade and shall be sloped to drain away from buildings. Install a magnetically detectable red plastic marking tape 1 foot above top of ductbank. For Ductbanks over 30 inches wide install two tapes over the outside edges of the Ductbank. Bends in ductbanks shall be Long Radius Sweeps (30" minimum radius). All Medium Voltage Ductbanks and Low Voltage Ductbanks that go under roads/parking lots (Continuous between end points) shall utilize #4 reinforcing bar in all four corners with #2 crossties secured with tie wire every two feet along entire ductbank length. Where reinforced ductbanks connects to a building or manhole, dowel the #4 rebar one-half thickness into the wall using a suitable epoxy adhesive. Transition to RMC at 5'-0" from building foundation/wall if RNC is used in duct bank. At completion of construction of ductbank pull a mandrel and brush or pig through all conduits in presence of Engineering Services or CFS to verify accessibility and cleanliness of conduit system. Pull strings shall be installed in all spare conduits.
    b. A plan profile for each Ductbank must be included in the construction drawings.
    c. Install a #4/0 AWG bare copper ground wire within the ductbank. Bond to ground rod at manholes, equipment ground bar, or room ground bar at each end ofwire.
    d. Install a 2” conduit within ductbanks for metering purposes.
    e. Padmount transformer secondary conductors and exterior emergency feeders shall be installed in ductbanks.

3. Low and Medium Voltage Underground Electrical Vaults
    a. Underground electrical vaults shall be pre-cast concrete. A 12 inch by 12 inch sump shall be located in the corner of the floor. On the IUPUI Campus and other campuses as appropriate, the sump shall have a suitable drain opening and stone fill to a minimum depth of 18”. On the Bloomington Campus a 3 inch gravity drain line with a backwater valve shall be installed if a storm sewer line is within reasonable distance and proper slope can be maintained. All vaults shall meet AASHO-H-20 truck loading with 20% impact rating. Vault shall have pull-in irons located opposite each ductbank entrance. Sidewalls shall have heavy duty non-metallic (Underground Devices, Inc. or owner approved equivalent) cable supports on 24" to 30" centers. Manhole covers and frames shall be heavy duty cast iron 30" diameter clear opening. Manhole cover shall be marked "ELECTRIC" and have an identification number attached. Manholes shall have pick holes in lieu of "dropped handles". Where vaults are installed in planting areas install a 10" high frame for manhole lid. Minimum inside dimensions for manholes are 6 feet (W) x 10 feet (L) x 7 feet (H). Install a 5/8" x 8' long ground rod in each vault and connect to all non-current carrying metal parts (lid, frame, ladder, and etc.). Seal and grout around all penetrations to minimize entrance of any water. Vaults shall be spaced no farther than 325 feet apart or 150 feet from building.

4. Low Voltage Handholes
    a. Precast concrete handholes may be used for underground low voltage power feeders. Requirements shall meet that of underground electric vaults except maximum size shall be 4 feet x 4 feet x 4 feet.
    b. Other materials may be used for low voltage handholes, e.g. High Density Polyethylene (like PenCell), or polymer concrete (like Quazite). Use ANSI Tier 8 in soil/grass areas, Tier 15 in pedestrian pavement areas, and in parking lots use Tier 22. Coordinate the use of these products with Engineering Services or CFS.

5. Telecommunication System
    a. Refer to the latest version of *Telecomm Design Guidelines* and *Communications Systems - Structured Cabling* prepared by IU University Information Technology Services (UITS) for telecommunication system ductbank requirements. These standards can be found on the IU Capital Planning & Facilities website.

SCHEDULE OF RACEWAY APPLICATIONS

APPLICATION			RMC	IMC	EMT	FMC	LFMC	RNC 40	RNC 80	HDPE 80	MC FPLP	IU STD
POWER FEEDER	INTERIOR	CONCEALED 2" AND LARGER OR EXPOSED	- * -	- * -								A.2 a, b
		CONCEALED 1-1/2" AND SMALLER	- * -	- * -	- * -							A.2.c
	EXTERIOR	ABOVE GRADE	- * -	- * -								A.2.h
		BELOW GRADE	- * -					- * -	- * -	- * -		E.1 b, e
	CONNECTION TO VIBRATING EQUIPMENT					- * -	- * -					A.2.i
BRANCH CIRCUIT	INTERIOR	CONCEALED 2" AND LARGER OR EXPOSED	- * -	- * -								A.3 a, d
		CONCEALED 1-1/2" AND SMALLER OR EXPOSED IN ELECTRICAL CLOSET	- * -	- * -	- * -							A.3 b, e
		IN OR BELOW CONCRETE SLAB	- * -					- * -	- * -			A.3.f
	EXTERIOR	ABOVE GRADE	- * -	- * -								A.3.i
		BELOW GRADE	- * -					- * -	- * -	- * -		E.1 c, e
	CONNECTION TO VIBRATING EQUIPMENT					- * -	- * -					A.3.j
DUCTBANKS FOR ELECTRICAL UTILITY DISTRIBUTION			IN DUCT BANK					IN DUCT BANK	IN DUCT BANK			E.2
INTERIOR MEDIUM VOLTAGE / MECHANICAL ROOMS WITH STEAM			- * -									A.2.d A.2.j
TELECOMMUNICATION SLEEVES THROUGH FLOORS			- * -	- * -								A.5 b.1)
TELECOMMUNICATION RISERS, HOME RUNS, AND STATIONS			- * -	- * -	- * -							A.5 b.2)
TELECOMMUNICATION BELOW GRADE									IN DUCT BANK	- * -		E.5
FIRE ALARM CIRCUITS CONCEALED AND IN DRY LOCATIONS			- * -	- * -	- * -						- * -	A.6
FIRE ALARM CIRCUITS EXPOSED OR IN MOIST LOCATIONS			- * -	- * -								A.6
TEMPERATURE CONTROL / LV WIRING			- * -	- * -	- * -							A.3.b & 7

General notes:

1) Refer to the listed sections for more details and limitations.
2) The symbol -*- indicates approved type.

Abbreviations:

RMC – Rigid Metallic Conduit
IMC – Intermediate Metallic Conduit
EMT – Electrical Metallic Tubing
FMC – Flexible Metallic Conduit
LFMC – Liquid Tight Metallic Conduit

RNC 40 – Rigid Nonmetallic Conduit, Schedule 40
RNC 80 – Rigid Nonmetallic Conduit, Schedule 80
HDPE 80 – High Density Polyethylene, Schedule 80
MC-FPLP – Plenum rated, Type MC – FPLP, with red jacket

Rev: February 2022

END OF 26 05 33

26 05 73 - Power System Studies

February 2022

A. Power System Studies

1. The following power system studies shall be completed by the consultant as an integral part of their Electrical System Engineering Design services.
    a. A load analysis shall be conducted to size all new equipment and to confirm adding loads to existing equipment will not result in overloaded equipment. The consultant will utilize appropriate load and diversity factors to develop peak expected demands.
    b. The consultant shall conduct short circuit calculations to specify short circuit ratings for all new equipment and to confirm existing equipment is properly rated. On new equipment rated 480V and below the short circuit rating shall be at least 10% higher than available fault levels to allow future increases in fault levels. Note for all circuit breakers rated 480V and lower the minimum acceptable short circuit rating is 22kA.
    c. The consultant shall consider in their design the coordination of protective device characteristics and achieve selective coordination wherever possible. Selective coordination must be achieved where required by the Indiana Electric Code.
    d. Indiana University would like arc flash incident energies below 1.2 Cal/cm^2 for all electrical equipment. Arc flash incident energies up to 8 Cal/cm^2 for equipment are acceptable where the 1.2 Cal/cm^2 criteria cannot be reasonably met, but must be minimized. Notify IU Engineering Services (CFS at IUPUI) where arc flash incident energies over 8 Cal/cm2 are expected during the design phase of the project and provide recommendations on possible solutions for consideration.

2. The above investigations can be conducted by any commercially available electrical analysis software, but use of Easy Power (SKM for IUPUI only) is encouraged. The consultant will supply backup documentation when requested to IU Engineering Services (CFS at IUPUI) regarding the above design studies.

3. System studies shall comply with the latest editions of all applicable national and local standards, codes, and laws including but not limited to:
    a. OSHA – CFR 1910
    b. NFPA 70 – National Electrical Code
    c. NFPA 70E – Standard for Electrical Safety in the Workplace
    d. ANSI Z535 – Product Safety Signs and Labels
    e. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations
    f. IEEE C37.010 – Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI).
    g. IEEE C37.20.1 – IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear (ANSI).
    h. IEEE C37.46 – American National Standard Specifications for Power Fuses and Fuse Disconnecting (ANSI).

i. IEEE C57.12.00 – General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers (ANSI).
j. IEEE C57.96 – Guide for Loading Dry-Type Distribution and Power Transformers (ANSI).
k. ICEA P-32-382 - Short-Circuit Characteristics of Insulated Cable.
l. NEMA MG1 – Motors and Generators
m. IEEE 3000 Standards Collection for Industrial & Commercial Power Systems

4. Contact Engineering Services (CFS at IUPUI) for access to existing building models or available utility fault levels for new buildings. Field data will need to be collected to augment and/or confirm existing information.

5. For construction projects an as-built short circuit analysis, protective device coordination study, Arc Flash Analysis and labels shall be included in each construction bid package utilizing an IU provided Specification Section (26 05 73 - Power System Studies). This specification requires these studies to be preliminarily completed and submitted as part of the shop drawings submittals for the electrical equipment approval process. The studies will be updated to as-built status by substantial completion and submitted in Easy Power (SKM for IUPUI only) software for review. After acceptance of the as-built study arc flash labels can then be printed and installed. The design consultant shall review all submittals specified in the specifications for completeness and compliance with the specification before forwarding to the IU's Engineering Services (CFS at IUPUI) forreview.
    a. If the design consultant has the Easy Power (SKM for IUPUI only) software and has full time employee's qualified to conduct the studies they can seek IU Engineering Services (CFS at IUPUI) approval for conducting this work provided it is included in the negotiated design fees for the project.
    b. For smaller projects (typically less than 10 labels) IU Engineering Services (CFS at IUPUI) may perform the above analysis in-house and work with the consultant to develop a note to add to the drawings specifying the Contractor's involvement in the process and responsibilities. Prior confirmation with IU Engineering Services is required.
    c. Engineering Services (CFS at IUPUI) will provide the Power System Studies Specification Section (26 05 73) that shall be utilized in all work that is not performed in-house. Ask for a new Specification Section for each project – do not reuse one furnished for a previous project.

26 10 00 - Medium-Voltage Electrical Distribution

February 2022

A. General

1. The following medium voltage distribution systems are present on the Indiana University Campuses:
    a. IU Bloomington: 4,160 volt and 12,470 volt
    b. IU Purdue University Indianapolis: 4,160 volt and 13,800 volt
    c. IU Northwest: 12,470 volt
    d. IU South Bend: 12,470 volt

2. The medium voltage utility systems are operated and maintained by university personnel. Operations include switching to isolate portions of circuits and live- line paralleling (closed-transition switching) of circuits to move loads for maintenance work or during conditions caused by system problems. The requirements of the medium voltage system have been developed over years of operating the system. The consultant shall work with Engineering Services or CFS to determine the quantities and type of switchgear to be provided.

3. The University is concerned with proper access to and clearances around all medium voltage equipment. The requirements of the National Electrical Code will be viewed as an absolute minimum and the Consultant must consider how replacement of transformers, cables, and switchgear will be accomplished after the building has been constructed. The consultant shall provide equipment layout, with access, accordingly on the bid documents.

4. A suggested sequence of work shall be prepared for all projects involving medium voltage equipment and placed on the project drawings. This helps ensure a buildable design has been provided, demonstrates any need for temporary provisions to the contractor, and all costs are anticipated.

5. Address in the project drawings any needs for temporary power. The contractor shall furnish any temporary generators and associated fuel, including refueling the university's permanently installed generators.

6. Medium voltage switchgear should be located at grade level wherever possible. Such equipment should only be located in penthouses or below grade with permission of Engineering Services or CFS.

7. All lighting in medium-voltage equipment rooms shall be on emergency power if available. If emergency power is not available provide some fixtures with emergency ballasts or wall-mounted, battery operated emergency lighting.

8. All 120V receptacles in medium-voltage equipment rooms shall be on emergency power if available.

9. Double doors (6'-0" W X 7'-0" H) should be provided into switchgear rooms. Access to the room shall allow for removal of largest equipment item.

10. Assume a Type 2 condition in NEC Table 110.34(A) for minimum clearances.

11. Provide electrical metering on all mains and feeders at utility service points or where directed by Engineering Service or CFS. Electric meter shall be Schneider Electric PowerLogic ION 9000 Series or equivalent ION meter under another company's brand (Siemens, etc) as approved by Engineering Services or CFS, and shall be installed in a separate, arc flash resistant compartment. Electric meter shall have the following features and accessories. a. Meter shall have minimum 10Base-T and/or 10Base-FX Ethernet option as specified by Engineering Services or CFS.
    a. Provide ANSI Accuracy Class 0.3 current transformers. CT range shall be selected appropriately for the load and shall not exceed the load by more than 50%.
    b. Provide CT shorting block and/or test switches.
    c. Provide voltage transformers on the line side (Utility) of the Main Breaker and on the switchgear main bus at main utility service points.
    d. Provide an analog voltmeter and switch monitoring the line side (Utility Service points) of the Main Breaker.
    e. Meters shall have fuse protection for voltage and power supply inputs.
    f. For each electronic meter, supply a data jack at the metering enclosure, connected to the campus Ethernet.

12. There shall be no foreign systems installed in medium voltage electrical rooms unless they are associated with the room function.

B. 15 KV Switchgear (Section 26 13 00)

1. Switchgear shall be fusible, or relay protected for overcurrent protection of transformers or feeder cables. Fuses shall be Class E rated and shall utilize an S & C Electric Corporation SM-5 or SM-4 fuseholder (consult Engineering Services or CFS). Fuse size shall be per ANSI C37 & C57 recommendations for transformer or cable protection. The "SM" fuse holder may be special order equipment for some switchgear manufacturers but can be provided if specified. Non-fused interrupter switches shall be used for loop circuit entrance and exit into switchgear lineups. One set of spare fuses shall be provided for each fusible switch.

2. Equipment shall meet or exceed all requirements of ANSI/NFPA 70, ANSI/IEEE C2, and ANSI/IEEE C37.

3. Switchgear shall be rated 15 KV nominal (includes equipment applied to Bloomington's 4160V systems), 600 amp or 1200 amp main bus, 25kA or 40kA 3-phase symmetrical short circuit interrupting, 95 KV BIL. Fused switches shall be rated 200 amp or 400 amp depending on fuse requirement.

4. Switchgear shall be deadfront type completely metal enclosed with freestanding, self supporting enclosure. Switchgear assemblies comprised of numerous cubicles shall be group mounted with an 11-gauge steel full length barrier between adjacent sections. The enclosure shall be completely front accessible allowing the rear of the equipment to be placed against walls.

5. Switchgear shall be key interlocked to prevent doors from being opened when the switch is in the closed position.

6. Fused switch cubicles shall have an inner door secured by bolts to prevent access to the fuses with only the outer door opened.

7. Switchgear shall have copper bus with silver-to-silver connections at main-bus sections, main bus to tap bus, and between ground bus sections. A copper ground bus shall be installed the full length of switchgear.

8. Phasing of incoming cables shall be such that circuits may be paralleled within the switchgear.

9. Provide analog voltmeters on medium voltage switches which are not part of the building's main switchgear lineup.

10. Compact switchgear is not acceptable.

11. All switches shall have auxiliary contacts that match the switches position. One normally open contact for switch shall be connected to a digital input on the IONMeter.

12. For outdoor pad mounted equipment evaluate cable bending radius inside the gear based on your pad design and specify spacers for the equipment as needed – do not automatically specify them. This design shall not be delegated to the contractor. We expect a detail to be prepared.

13. Preferred manufacturer shall be S & C Electric Co.

C. 5 KV Switchgear (Section 26 13 00)

1. 5 KV switchgear shall meet all requirements of 12.47 KV (15 KV) switchgear except as modified hereafter.

2. Switchgear shall be rated 5 KV nominal, 600 amp main bus, 25kA 3-phase symmetrical short circuit interrupting, 60 KV BIL.

3. Switchgear shall be completely front accessible when located with rear against walls, however, equipment may be located in room so as to provide rear access. The consultant is cautioned to review NEC clearance requirements when arranging equipment in this manner.

4. Compact switchgear is not acceptable.

5. Preferred manufacturers are S & C Electric Co.

D. Unit Substations and Transformers (Sections 26 11 13 and 26 12 00)

1. Transformers 1000 KVA and smaller may be dry type or liquid filled. Dry type transformers shall be vacuum-pressure impregnated type with copper or aluminum windings, 80 degree C rise.

2. Transformers larger than 1000 KVA may be dry type or liquid filled. Dry type transformers shall be cast coil type with either copper or aluminum windings, 80 degree

C rise. Both primary and secondary windings shall be cast in a stabilized epoxy resin or totally encapsulated in epoxy resin.

3. Liquid filled transformers shall have Envirotemp FR-3 coolant. Coordinate outdoor locations with Engineering Services or CFS. Where directed or required, provide containment large enough to confine the liquid of a ruptured transformer tank.

4. Dry type transformers shall be installed in environmentally conditioned spaces. The transformer room shall not use outside air for the sole source of cooling or heating. Provide temperature sensors connected to the campus energy management system when requested by Engineering Services or CFS. These sensors will be used to monitor room conditions.

5. In buildings with major research programs or other critical loads the electrical substation shall be of double ended construction with transformers sized so that either unit could carry the building load in the event of a failure.

    a. Transformers shall be equipped with fans to increase kVA rating to 133% of base rating.
    b. Transformer fan rating shall exceed 60% of the NEC calculated demand load on the substation. Note our experience shows actual loading typically experienced is 30 – 40% of NEC calculated demand load – this allows each transformer to carry the maximum expected load plus room for future growth.
    c. At IUPUI campus the low voltage Switchgear shall be designed toautomatically open main breaker where voltage is lost and close tie in the event of primary voltage loss. When normal power is restored, the system shall return to normal operating position without additional power interruptions (closed transition). Contact Engineering Services or CFS for details on how to implement the system.
    d. Circuits shall be phased in Engineering Services or CFS presence during startup.
    e. Gear shall include an indicating light to show circuits are in phase.
    f. Transformers shall have a winding temperature monitor powered from unit sub control circuit.
    g. Over temperature alarm and trip functions shall be supplied.
    h. Provide an analog voltmeter and switch that is connected to the voltage transformers on the line side of the main breaker.

6. The incoming line section of unit substations shall consist of either a fused or relay protected switch cubicle or an air terminal compartment if switchgear is separate from substation but located in same room. Section shall be complete with bushings for terminating cables and a NEMA two-hole ground pad. One additional set of spare fuses shall be supplied per fused switch.

7. Transformers shall have provisions for forced air fan cooling. Transformer core and coils shall meet the requirements of ANSI C57.

8. It is anticipated that transformers will be installed inside buildings. Where equipment is to be located outdoors see Item 16, Pad Mounted Transformers.

9. Transformers shall meet Department of Energy 2016 efficiency requirements.

10. Equipment Manufacturer's representative shall be required for checkout, startup, and training of university personnel prior to energization of unit substations.

11. Factory test results shall be provided as part of the record documents.

12. Preferred vendors for unit substations are Eaton (Cutler-Hammer), Siemens, Schneider Electric (Square D), or ABB/General Electric. Only transformers manufactured by a preferred vendor shall be acceptable.

13. Transformer Ratings
    a. The following ratings are minimum requirements for transformers:
        1) Temperature: 80 degree C rise with an insulation system hot spot capability of 140 degrees C for dry type and 65 degree C rise over 40 degree C ambient for liquid filled type.
        2) BIL: Units with 12.47 or 13.8 KV primary voltage shall have 95 KV BIL; 4.16 KV primary units shall have 60 KV BIL; secondary (600V or less) BIL rating shall be 10 KV unless noted otherwise.
        3) Taps: 2 - 2.5% above and below normal primary voltage (unless directed otherwise by Engineering Services or CFS) suitable for operation when de-energized.

14. Transformer Accessories
    a. Transformers shall have the following accessories as applicable:
        1) Coolant temperature (liquid type) or winding temperature (dry type)with indicating gauge to show highest reading.
        2) Distribution class lightning arresters; Based on solidly grounded systems the anticipated ratings are 3 KV on 4.16 KV system, 9 KV on 12.47 KV system, and 10 KV on 13.8 KV system. Locate lightning arresters in switchgear or air terminal compartment.
        3) Liquid level indicator gauge.
        4) Pressure-vacuum gauge with pressure relief and valved fill port, as sampling port, and bottom drain with sampling valve for liquid type.
        5) Upper and lower filter press connections on liquid type units larger than 333 KVA.
        6) Fan cooling or provision for fan cooling per Engineering Services or CFS directions.
        7) Transformer accessories requiring power shall be powered from a control power transformer located inside the transformer enclosure and not external panelboards.

15. Outgoing Termination Equipment
    a. See Section 26 20 00 - Low-Voltage Electrical Distribution.
    b. The enclosure for outgoing termination equipment shall consist of a dead-front metal type matching the transformer enclosure.

16. Pad Mounted Transformers
    a. Where approval has been obtained from Engineering Services or CFS, pad mounted transformers may be installed. Location of transformers shall meet FM recommendations for liquid used and building construction rating. Protective and/or decorative screening and possibly a custom color will be needed at outdoor equipment locations – coordinate with the architects.

b. Pad mounted transformers shall have applicable accessories as detailed in previous sections and the following additional features:
    1. Dead front construction with 600A bushings for 600A dead break elbows. Include parking standoff plugs for mounting of elbows when disconnected from bushings.
    2. Bay-o-net, oil-immersed, in series with under the oil current- limiting fuses when applicable for overload and short-circuit protection. Bay-o-net fuses shall be accessible from the front of the high-voltage compartment.
    3. Arrangement for loop feed with 3 of the terminations used for incoming cable terminations and 3 of the terminations used for connecting to deadfront M.O.V. elbow arresters.
    4. Oil-immersed OFF-ON loadbreak, gang operated switch rated 600A. Switch shall allow paralleling (closed transition switching) of 2 different circuits (same source) at each transformer. Two switches are acceptable to allow paralleling provided both may be closed and/or open at the same time. Switch shall have a handle with eye suitable for operation with a hot stick. Locate switch(s) in the high voltage compartment. Verify with switches have adequate ratings for the application. Switch rating data shall be included on transformer nameplate or separate nameplate next to transformer nameplate.
    5. Compartmental type construction with metal barrier between high voltage and low voltage sections. Sealed tank construction with sufficient strength to withstand 7 psi without permanent distortion.
    6. NEMA two-hole ground pads in each compartment.
    7. Low Voltage spades shall be sized to accommodate twice the number of cables that will be terminated at installation.
    8. At the Bloomington campus transformers that will be applied to the 4160V system shall have dual voltage primaries (4160V and 12470V) with a dual voltage switch in the high voltage compartment to allow future conversion to 12470V. The high voltage winding shall be 95kV BIL.
    9. Provide baseline oil sample analysis.
    10. Preferred manufacturers for pad mounted transformers are Eaton (Cooper Power Systems), General Electric, and Asea Brown Boveri.

E. Equipment Rooms Below Grade – Not preferred

1. Provide access to equipment rooms for future maintenance and removal of equipment. Access path must accommodate largest piece of electrical equipment to be moved into or out of the equipment room.

2. Provide water detection alarms in each equipment room below grade. System to notify Campus Operations Center via energy management system. Water detection alarms shall be the responsibility of the building controls installation contractor.

26 20 00 - Low-Voltage Electrical Distribution

February 2022

A. General

1. The University does not accept “Series-Rated” equipment for power distribution switchboards, distribution panels and branch circuit panelboards. Equipment must be “fully-rated” to minimum short circuit ratings specified.

2. For replacement of electrical services or other major equipment prepare a Proposed Sequence of work to include on the drawings. This helps ensure a buildable design has been provided and demonstrates any need for temporary power to the contractor.

3. Prepare panel schedules for all new switchgear, switchboards, distributionpanels, panelboards and motor control centers. Prepare panel schedules for all existing equipment that circuits are being added or removed.

4. Provide electrical metering on the incoming service for the building and elsewhere as directed by Engineering Service or CFS.

   Electric Meters shall be as follows:

   a. Research Buildings and other buildings with Critical Loads: Schneider Electric PowerLogic ION 9000 Series
   b. Classroom Buildings, Office Buildings, Residence Halls, Athletic Facilities, Museums, etc: Schneider Electric PowerLogic ION PM5563. At the IUPUI campus use PowerLogic PM8000.
   c. Equivalent ION meters sold under another company’s brand (Siemens, etc) as approved by Engineering Services or CFS.
   d. On the Bloomington Campus for buildings less than 10,000 sq ft: Sensus (Electric Utility Socket type) Meter – Engineering Services will provide information.

   The ION meters shall be installed in a separate, arc flash resistant compartment. They shall have the following features and accessories.

   a. Meter shall have minimum 10Base-T and/or 10Base-FX Ethernet option as specified by Engineering Services or CFS.
   b. Provide ANSI Accuracy Class 0.3 current transformers. CT range shall be selected appropriately for the load and shall not exceed the load by more than 50%.
   c. Provide CT shorting block and/or test switches.
   d. Provide voltage transformers as necessary.
   e. On double-ended substations provide analog volt meters and switch on the line side of the Main Breakers.
   f. Meters shall have fuse protection for voltage and power supply inputs.
   g. For each meter, supply a data jack in at the metering enclosure, connected to the campus Ethernet.

5. Lock Out Tag Out (LOTO)
   a. Refer to latest version of Indiana University Building Design Standards, Section 01 92 14 for LOTO procedures.

6. For buildings greater than approximately 10,000 square feet per floor, consider the use of multiple power distribution risers to limit the number of branch circuits over 100 feet long. If the floor plan is such that two telecommunications risers would be required to limit any run to less than 300 feet, then the use of multiple power distribution risers in separate closets shall also be provided.

7. There shall be no foreign systems installed in low voltage electrical rooms unless approved by Engineering Services.

8. On Emergency Power Distribution System equipment include the following sign
   i. "Emergency Power System. Load Additions must be approved by Engineering Services".

9. Receptacle circuits (20A, 120V) shall be generally designed as follows (Does not include dedicated circuits for technology):
   a. Offices – Two per circuit
   b. Administrator Offices (Dean/Director or higher) – One or more dedicated circuits.
   c. Modular furniture systems – Three cubicles per circuit is preferred.
   d. Class Rooms – One or more dedicated circuits.
   e. Conference Rooms – One or more dedicated circuits.
   f. Residence Hall Bedrooms – One per bed.
   g. Lounges/Informal Learning Areas – One or more dedicated circuits.
   h. Lobbies – One or more dedicated circuits.

B. Unit Substations (Section 26 11 16)

1. The secondary section of unit substations shall utilize copper bussing and Low Voltage Power Circuit Breakers (ANSI C37). Device hoists for drawout type devices shall be unit mounted. In some instances, insulated case or molded case breakers (UL489) may be acceptable; coordinate with Engineering Services or CFS.

2. Unless directed otherwise the outgoing equipment shall consist of a single main circuit breaker with separate feeder devices. Metering and ground fault protective schemes shall be as detailed below in "Power Distribution Switchboards" section.

3. Low Voltage Power Circuit Breakers (ANSI C37) shall be drawout type with stored energy, manual operation.

4. Circuit breaker type overcurrent devices shall utilize solid state trip units.

5. The interrupting rating for circuit breakers shall be specified by the consulting engineer. Engineering Services or CFS will provide the available fault current on the primary distribution system at a point nearest to the building when structure is served by the campus distribution system. If served directly from the local utility coordinate contacting the utility with Engineering Services to obtain this information.

C. Power Distribution Switchboards (Section 26 24 13)

1. Power Distribution Switchboards (PDS) shall be specified with copper bus and shall have bus extensions provided at ends where future sections can be added.

2. On 277/480 volt systems that require the installation of Ground Fault Protection (GFP) both the main circuit breaker and the feeder circuit breakers shall have GFP. The GFP system shall utilize a zone interlock technique.

3. The PDS shall have a copper equipment ground bus installed for its entire length.

4. A 100% capacity neutral bus shall be provided.

5. Where applicable, the PDS shall be listed suitable for use as service entrance equipment.

6. Provide space for at least additional 4 circuit breakers. Discuss with Engineering Services or CFS the number and size of spares to include.

7. The minimum interrupting rating of overcurrent devices and bus bar bracing of the PDS shall be determined by calculations made by the consulting engineer. These ratings shall be specified in the construction documents.

8. Care should be used in locating the PDS. At minimum the location should meet requirements of NEC Table 110.26(A)(1) for a Type 2 condition. The exclusively dedicated space requirements of NEC Article 110.26(F) shall be strictly enforced. Additional space for maintenance, future extensions, and possible replacement should be factored into the location selected. The consultant shall work with the Engineering Services or CFS in locating this equipment.

9. Preferred equipment suppliers for Power Distribution Switchboards
   a. Eaton (Cutler-Hammer)
   b. ABB/General Electric
   c. Schneider Electric (Square D)
   d. Siemens

D. Motor and Circuit Disconnects (Section 26 28 16)

1. Motor and circuit disconnects shall be provided at all motor and equipment locations. Utilizing the “lock-out” feature on remotely located motor controllers is not acceptable as a disconnecting means. The University has dedicated maintenance crews who do such things as oil and grease bearings and replace belts on equipment. These personnel are not expected to be familiar with the location of starting equipment for the device being serviced. A disconnect (adequately rated for the available fault level) switch shall be provided on or adjacent to equipment for maintenance personnel use. Integral disconnect switches on VFD’s are not acceptable for this function – a separate disconnect switch must be installed. Avoid installing multiple disconnects on motor circuits.

2. Heavy-duty type disconnects shall be specified with NEMA enclosure suitable for the environment to be encountered.

3. Preferred manufacturers for motor and circuit disconnects
   a. Eaton (Cutler-Hammer)

b. ABB/General Electric
c. Schneider Electric (Square D)
d. Siemens

E. Dry Type Transformers (Section 26 22 13)

1. Dry type transformers shall be specified with temperature rating of 150 degree C rise above a 40 degree C ambient. Units 30 KVA and larger shall be floor mounted only. Stacking of transformers is not acceptable. Taps to adjust the secondary voltage, 2 – 2.5% above and 2 – 2.5% below nominal shall be provided.

2. Where variable frequency drives 100HP and larger are used, a drive isolation transformer or reactor shall be installed ahead of each unit. These transformers shall be specifically designed for the application and shall include symmetrically placed taps and added coil bracing. Locate the transformers adjacent to the drive.

3. Shielded isolation transformers shall be utilized where load requires such enhanced protection. These units shall have copper shielding with appropriate connections for grounding the shield.

4. Secondary feeder conductors from transformers shall have overcurrent protection installed within 10 feet of transformer.

5. Care shall be used in locating dry type transformers. Adequate clearances around units shall be provided and minimum clearances from walls, how conduits will enter the enclosure with respect to working clearance for other equipment needs to be considered and etc. should be specified in the contract documents. Consideration should be given for how the units would be replaced in event of failure. Where units are installed adjacent to offices, library areas, or other noise sensitive locations, consideration shall be given to specifying “quiet” rated transformers. An excellent reference standard for use by the consulting engineer is the ANSI C57.X series.

6. Transformers shall meet Department of Energy 2016 efficiency requirements.

7. Preferred manufacturers for dry type transformers
   a. Eaton (Cutler-Hammer)
   b. ABB/General Electric
   c. Schneider Electric (Square D)
   d. Siemens

F. Feeder and Plug-In Busway (Section 26 25 00)

1. Bus material shall be copper with full capacity neutral, separate equipment ground bus, and standard impedance. Enclosure shall be non-ventilated type. Splice plates and all component contacts shall be silver plated.

2. Design shall minimize the use of elbows/offsets and other non-standard components due to long delivery time for non-standard replacement components.

3. Arrange vertical plug-in busways so that at least three plug openings per floor can receive bus plugs that will have NEC required working clearance in front of them.

4. Busways equal to and less than 1200A shall not be directly connected to electrical distribution equipment. A cable tap box and cables shall be used to make the connection.

5. Floor Penetrations.
   a. Where busways penetrate walls or floors specify an integral fire stop as a part of the system.
   b. NEC required curbs shall be cast-in-place concrete that are formed as an integral part of the floor.

6. Plug-in units shall be fusible type.

7. Preferred manufacturers of bus ways
   a. Eaton (Cutler-Hammer)
   b. ABB/General Electric
   c. Schneider Electric (Square D)
   d. Siemens

G. Distribution Panelboards (Section 26 24 16)

1. Distribution panelboards shall have copper bus with full capacity neutral and equipment ground bus. Circuit breaker style distribution panelboards shall have a minimum interrupting rating of 35,000 amps symmetrical. Include a main breaker unless the source is located in the same room. If a distribution panel board must be located in an area of a building which may be accessed by the general public (must be approved by Engineering Services or CFS) it shall have a full cover door over all overcurrent devices. Exposed switch or circuit breaker handles in areas accessible to the public are not allowed.

2. Preferred manufacturers for distribution panelboards
   a. Eaton (Cutler-Hammer)
   b. ABB/General Electric
   c. Schneider Electric (Square D)
   d. Siemens

H. Branch Circuit Panelboards (Section 26 24 16)

1. Branch circuit panelboards shall have copper bus, full capacity neutral, and equipment ground bus. Circuit breakers shall be bolt-on type with a minimum interrupting rating of 22,000 amps symmetrical at 240 volt and 14,000 amps symmetrical at 480 volt. Specify a panelboard with a concealed trim and recessed lock. Where isolated ground devices are connected to panel specify a separate insulated equipment ground bus in panel. Provide minimum 20% spare breaker position capacity in panelboards.

2. Specify multi-pole circuit breakers that have one (1) operating handle. Using circuit breakers with handle ties is not acceptable.

3. Hinged Covers or Door-in-Door covers are to be used. Bolted on covers arenot acceptable.

4. Provide a Main Breaker in all panelboards. Main breakers may be omitted if the panelboard source is located in the same rooms and Engineering Services or CFS approves.

5. Panelboard cabinets in general shall be limited to 42 overcurrent devices as counted by the NEC. Exceptions for a larger number of devices may be permitted by Engineering Services or CFS if a specific installation detail is prepared for each panelboard cabinet showing how the conduits will exit the panelboard.

6. Panelboards located in area's accessible to the public are to be specified with Best Locks – See Architectural Standards for details on requirements. Cylinders will be supplied by the IU Lock shop.

7. Use of GFCI circuit breakers is generally not desired as building staff does not have access to the panelboards to reset them. Upon Engineering Services or CFS approval they can be used for branch circuits going to dedicated loads.

8. Where panelboards are flush mounted specify a minimum of (3) 1" spare conduits to be installed from panelboard to ceiling space for future use.

9. In new buildings and existing buildings undergoing a major renovation, panelboards shall be labeled as "Panel - floor/source/voltage/riser/panel" according to the following code.
   a. floor = building floor per architectural drawings
   b. source = N for normal, LS for Life Safety, LR for Legally Required and OS for Optional Standby.
   c. voltage = H for 480V or 480/277V, L for 120/208V
   d. riser = number risers consecutively beginning with 1
   e. panel = number panels by floor beginning with 1

10. In existing buildings, match existing panel nomenclature when adding small quantity of panelboards.

11. When existing panelboards are being retained in existing buildings undergoing a major renovation do not rename these panelboards to be consistent with Item 9 naming scheme.

12. Preferred manufacturers for branch circuit panelboards
    a. Eaton (Cutler-Hammer)
    b. ABB/General Electric
    c. Schneider Electric (Square D)
    d. Siemens

26 27 26 - Wiring Devices

February 2022

A. Wiring Devices

1. Wall Switches
   a. TOGGLE SWITCHES: Toggle switches shall be back and side wired, heavyduty, specification grade, AC only, quiet-type, quick make, quick break, 20 ampere, 120/277 volt. Use of modular connectors is not approved.
   b. WALL BOX DIMMERS: Refer to Section 26 09 63 - Architectural Lighting Controls for wall box dimmer requirements.

2. Receptacles
   a. CONVENIENCE RECEPTACLES: Convenience receptacles shall be back and side wired, heavy duty, specification grade, parallel blade, U- grounding slot, 20 ampere, 125 volt, NEMA configuration 5-20R, with a one-piece brass or brass alloy plated backstrap and single ground strap with integral ground contacts.
   b. SURGE SUPRESSOR RECEPTACLES: Surge suppressor receptacles (SSR) shall be specification grade grounding type duplex receptacle with integral protection from line to ground, line to neutral, and neutral to ground surges that meet or exceed the standards published in the latest edition of UL Standards 1449 and 498. SSR shall have visible and audible surge protection status indicators. The audible indicator shall sound continuously when surge protection is no loger functioning and shall continue until the device is replaced. The audible alarm shall be capable of being muted without removing coverplate. SSR shall be rated 20 amperes, 125 volts, NEMA configuration 5-20R.
   c. GROUND FAULT CURRENT INTERRUPTING RECEPTACLES: Ground fault current interrupting (GFCI) receptacles shall be specification grade grounding type duplex receptacle with integral ground fault circuit interrupter UL listed to standard 498 and 943 Class GFCI receptacles shall be rated 20 amperes, 125 volts, NEMA configuration 5- 20R. GFCI receptacles shall be installed in accordance with the latest published version of the NEC. Downstream protection feature of GFCI receptacles shall not be utilized except where approved by Engineering Services or CFS.
   d. USB COMBINATION RECEPTACLES: USB combination type receptacles, i.e. single device with USB charger ports and tamper- resistant convenience receptacle, shall be considered for use in student lounges, informal learning areas, and similar areas where students congregate. USB combination receptacles shall contain both Type A and Type C USB charger ports.
   e. Only install controlled receptacles as required for LEED or other energy codes. They shall be controlled via occupancy sensors. The controlled receptacles and cover plates shall be marked in accordance with the latest version of the NEC. Do not use time clocks to control the receptacles.
   f. In damp or wet locations use listed weather-resistant type receptacles.
   g. Use tamper-resistant receptacles as required by the latest version of the NEC.
   h. Use of modular connectors is not permitted.

3. Device Color

a. Wall switch and receptacle color shall be white.
b. Where wall coverings are dark or wood use brown colored devices.
c. In historical buildings or other special spaces IU interiors should be consulted for the color to use.
d. For receptacles that are on the emergency power system they shall be red colored.

4. Device Coverplates
   a. Device coverplates in interior spaces shall be brushed stainless steel (302/304), satin smooth finish.
   b. Where brown colored devices are used, use brass coverplates.
   c. Where specifically required by Architects/Interior Designers, heavy duty thermoplastic plates may be used in some areas. It is anticipated that the reason for using plastic device plates will be to obtain a unique color.
   d. In historical buildings or other special spaces IU interiors should be consulted for the color to use.
   e. WEATHERPROOF COVERS
      1) Receptacle covers shall be listed as “extra-duty” while in use style. Both the box and cover shall be metal.
      2) Switch covers shall be high impact polycarbonate lever style, like Carlon E98TSCN. Also acceptable switch covers are clear silicon bubble plate style, like Hubbell HBL1795.

5. Preferred Manufacturers for Wiring Devices
   a. Eaton (Cooper Wiring Devices – Arrow Hart)
   b. Hubbell Inc.
   c. Legrand - Pass & Seymour
   d. Leviton
   e. Lutron

B. Floor Boxes: Floor box service fittings shall be coordinated with Engineering Services or CFS for specific application.

C. Occupancy Sensors (For control of lighting)

1. Occupancy sensors shall be installed in classrooms, offices, storage rooms, restrooms, and etc. to meet the requirements found in the Indiana Energy Conservation Code and ASHRAE 90.1. Closely coordinate application and sensor technology with Engineering Services or CFS.

2. Occupancy sensors shall be low voltage, ceiling (preferred) or wall mounted, dual technology (both ultra-sonic and infrared sensing) type. Use manufacturer’s standard power pack / relay device to provide power to occupancy sensor, to provide on/off control to switched lighting circuit, and to provide auxiliary contact closure for use with HVAC control systems and controlled receptacles.
   a. Some types of lab animals are sensitive to ultra-sonic frequencies. In areas where lab animals will be present, including adjoining areas, and hallways they will transit do not use ultra-sonic type occupancy sensors. Coordinate with University Laboratory Animal Resources (LAR) staff on areas to include.

3. The use of combination wall switch / occupancy sensor are not preferred and shall be used if approved by Engineering Services or CFS. Where this type of device is used, it shall be dual technology (both ultra-sonic and infrared sensing) type.

4. Occupancy sensors shall not be used in mechanical and electrical equipment rooms general lighting circuits. Standard toggle switches are required. The use of night lights (constant on) to clearly mark the egress from mechanical and electrical equipment rooms is preferred.

5. For safety reasons occupancy sensors generally should not be used in the following types of areas:

    a. Laboratories
    b. Laboratory Prep Areas
    c. Chemical Storerooms
    d. Animal Rooms
    e. Surgical Suites

6. Preferred Manufacturers for Occupancy Sensors
    a. Watt-Stopper
    b. Hubbell
    c. Leviton
    d. Lutron

26 29 00 - Low-Voltage Controllers

February 2022

A. Motor Controller Applications

1. All campuses of Indiana University have a pre-purchase agreement with Johnson Controls and Siemens Automation. This agreement provides for the design and delivery of all HVAC controls including motor controllers. Motor controllers provided as part of this agreement must be specified to be installed by the Electrical Contractor. Coordinate with Engineering Services or CFS for all HVAC motor controllers.
    a. In general, motor controllers are not provided as part of the pre-purchase agreement on the IUPUI campus. Coordinate with CFS

2. For motor controllers that are not part of the pre-purchase agreement, the following shall apply.
    a. Due to current practice of utilizing Adjustable Speed Drives (ASD) on almost all motors, Motor Control Centers (MCC) should not be utilized, unless approved by Engineering Services.
    b. Utilize individual motor controllers.
    c. Preferred manufacturers for motor controllers are Allen-Bradley, Cutler- Hammer, General Electric, Siemens, and Square D.

B. Individual Motor Controllers (Three Phase)

1. Individual 3 phase motor controllers shall be combination type with fusible disconnects. The controllers shall have the following features:
   a. Individual control transformer with fused primary and secondary, 120 volt secondary output, and 50VA spare capacity.
   b. Manual reset overloads.
   c. Hand-Off-Auto selector switch unless noted otherwise.
   d. LED pilot lights to indicate unit is in the run condition. Where multi-speed motors are served provide separate pilot lights for each speed.
   e. Phase reversal/phase loss relays.
   f. NEMA Size "0" minimum.
   g. NEMA rated contacts - IEC rated contacts are not acceptable.
   h. Two (2) auxiliary contacts convertible from N.O. to N.C.
   i. NEMA rated enclosure for the environment present, usually NEMA 1 for interiorsand NEMA 3R for exteriors.

2. Controllers for motors 20 horsepower and smaller at 208 volts, and 50 horsepower and smaller at 480 volts, shall be full voltage non-reversing. Star- delta, closed transition, or solid state “soft-start” reduced voltage type controllers shall be used for motors 25 HP and larger at 208 volt, and 60 HP and larger at 480 volt.

C. Individual Motor Controllers (Single Phase)

1. Single phase manual starters for fractional horsepower motors shall consist of a quick-make, quick-break toggle switch with one piece melting alloy type thermal overloads. Where applicable, pilot lights shall be LED.

2. Where fractional horsepower motors are to be automatically started, use starters meeting the requirements of the paragraph above.

D. Motor Control Centers (Section 26 24 19) – Obtain approval from Engineering Services before using**.**

1. General
   a. Bus bar shall be copper and a separate ground bus shall be included throughout.
   b. Wiring shall be NEMA Class 1, Type B-T.
   c. Enclosure shall be NEMA 1 gasketed for interior and NEMA 3R gasketed for exterior installations. MCC’s shall be floor mounted and set upon a 4” concrete housekeeping pad.
   d. Provisions for future addition of sections shall be included so that matching sections of the same current rating can be added without the use of transition sections.
   e. Adequate horizontal and vertical wireways shall be provided. In general 12" at top, 6" at bottom, and 6" vertical shall be specified.
   f. The main horizontal bus shall be enclosed in an isolated compartment to prevent accidental contact with other equipment or wiring. Compartment shall have removable barriers to permit access for maintenance purposes.
   g. Minimum starter size shall be NEMA 1. Starters shall meet the requirements of paragraph B above. All cubicles shall have minimum 3" extension for control relays.
   h. All cover doors (front and rear) shall be hinged type. Where adequate space for motor control centers is a problem consideration may be given to back-to-back construction.
   i. Minimum gauge steel used on doors shall be #14.

j. Care should be used in locating the MCC. At minimum the location should meet NEC requirements of Table 110.26(A)(1) - Condition 2. The exclusively dedicated space requirements of NEC Article 110.26 shall be strictly enforced. Additional space for maintenance, future extensions, and possible replacement should be factored into the location selected. The consultant shall work with the Engineering Services or CFS in locating this equipment.
k. Where motor control centers are rated 600 amps or greater provide with amain disconnect. Disconnect may be a molded case circuit breaker.
l. Each motor control center shall have a minimum of two (2) spare cubicles fully equipped for a future motor load and two (2) spaces for future starters.

2. Fault Withstand Capability
   a. The motor control center shall be suitable for operation at the maximum available fault current. The unit shall be labeled by the manufacturer to indicate themaximum fault current rating taking into account the structure, bussing, main feed, starter cubicles, and devices within the motor control center. Do not use bus bar bracing or rating of the main disconnect as the maximum available fault current rating for the motor control center.
   b. The consulting engineer shall specify the interrupting rating of the motor control center equipment.

3. Preferred MCC Manufacturers
   a. Allen Bradley
   b. Eaton (Cutler-Hammer)
   c. ABB/GE
   d. Siemens
   e. Schneider Electric (Square D)

E. Adjustable Speed Drive (Section 26 29 23)

1. Adjustable Speed Drive (ASD) shall convert incoming three phase, 60 hertz power to an adjustable voltage and frequency for controlling motor speed. Speed range shall be from 10% to 110%. The ASD shall use full digital pulse width modulation using insulated gate bipolar transistors (IGBT) for speed control and shall include the following:
   a. Minimum efficiency at full load of 95 percent.
   b. Power Factor of 1.0 to 0.95 lagging over entire operating range.
   c. Total harmonic voltage distortion shall not exceed 5% as measured on the line side of the drive input.
   d. Power outage ride through capability of 2 seconds with no disruption of output. This is to allow for operating times of utility system circuit breakers. In order to achieve the 2 second ride through, it may be necessary to add a UPS.
   e. Adjustable auto restart with selection of number of restart attempts and time interval between restarts.
   f. Ability to start (or restart) into a rotating motor without component failure or faulting of the drive. Drive shall employ “start on the fly” method.
   g. Integral fused switch on line side of drive for circuit disconnecting means.
   h. Where directed by Engineering Services or CFS, include manual by- pass feature with magnetic contactors.

2. Product Features
   a. Solid state circuit protection incorporating voltage rate-of-change and current rate-of-change protection for IGBTs.
   b. Instantaneous electric trip protection for the following occurrences:

1) 110% of drive maximum sine wave current rating is exceeded.
2) Output phase-to-phase short circuit condition and output phase- to-ground short circuit condition.
3) High and low input voltage and loss of phase input current.

c. LCD display, 2 line, 40 character minimum. Display shall indicate operating parameters with English descriptors.
d. Keypad adjustment controls for the following shall be provided:
1) Maximum (15 to 66 Hz) and minimum (3 to 60 Hz) frequency.
2) Acceleration and deceleration times (1 to 360 seconds).
3) Voltage/Hz ratio and voltage offset boost.
4) Current limit (50% to 110%).
5) Three critical frequency avoidance bands.
6) Switching frequency adjustment (2 to 8 kHz, set to 3 kHz).
e. In general, the control signal for the drive will be 4-20mA or a 0-10V DC signal from a Digital System Controller in the building's temperature control system.

3. Installation
a. Location of ASD shall be selected to allow for adequate clearances for service, maintenance, and replacement. Distance from load served shall be as short as practical and under no circumstances to exceed manufacturer'srecommendations.
b. Where specified, drive isolation transformers shall be located adjacent to the ASD. Secondary conductors shall not exceed 10'-0" without overcurrent protection.
c. Electrical noise shall not exceed IEEE Std. 519, with "Point of Common Coupling" defined as the line side of the isolation transformer and assuming the values for "General Systems" in chapter 10, "Recommended Practices for Individual Consumers".
d. Use insulated tap connectors like Polaris IT Series to make wiring connections inside the motor termination box. Do not use insulated twist-on spring type connectors, i.e. wire nuts.
e. During manufacturer start-up and/or training, provide copy of actual field programming to Owner's representative. Include copy of program in O&M manuals.

4. Preferred Manufacturers of ASD
a. Allen-Bradley
b. Asea Brown Boveri
c. Danfoss Graham
d. Eaton - IUPUI Only
e. Toshiba - IUPUI Only
f. Siemens

F. Power Factor Correction (Section 26 35 33)

1. Power factor correction capacitors shall be specified for motors 10 horsepower and larger which do not use a variable frequency drive.

2. Capacitors shall be connected to the motor controller on the load side of the contactor and ahead of the starter overloads. Locate capacitor adjacent to or above motor controller.

3. Capacitors shall utilize non-flammable, NFPA III B impregnant. Units shall have current limiting fuse in each phase and shall have blown fuse indicator pilot lights on front of enclosure.

4. Preferred Manufacturers for Power Factor Correction Equipment
   a. Aerovox
   b. General Electric
   c. Myron Zucker
   d. Commonwealth Sprague
   e. Schneider Electric (Square D Company)
   f. Northeast Power Systems, Inc. (NEPSI) - medium voltage only
   g. Controllix - medium voltage only

5. Consultant shall evaluate harmonic loading of the system and provide documentation to Engineering Services or CFS for evaluation. Specify filtered capacitors where required.

26 32 00 - Packaged Generator Assemblies

February 2022

A. Standby Engine/Generator Systems

1. Installations of stationary engine/generator (E/G) systems shall be designed in strict accordance with ANSI/NFPA 70 - National Electrical Code, NFPA 37 - Stationary Combustion Engines and Gas Turbines and NFPA 110 - Emergency and Standby Power Systems. Products incorporated into systems shall be U.L. (2200) listed and labeled and F.M. approved.

2. Design Features
   a. Engine/Generator (E/G) Sizing and Selection
      1) Loads to be connected to the emergency power distribution system shall include the following:
         a) Fire pump
         b) Fire detection and alarm system
         c) Smoke removal system
         d) Egress lighting
         e) Energy management system control panel(s)
         f) Control air compressors
         g) Condensate and Sewage Pumps
         h) Lighting and receptacles in the locations listed below:
            (1) Transformer vault / Substation
            (2) Mechanical / Electrical room/closet
            (3) Telephone / Data communication room/closet
            (4) E/G room / Enclosure

i) HVAC equipment serving E/G room / Enclosure
j) Walk-in Freezers and Coolers associated with Kitchens/Dining Facilities
k) CBord Card Access Systems in Residence Halls
l) Exterior “Blue Light” Phones
m) Lighting in Hazardous Material Accumulation Areas
n) Special equipment or where directed
o) Research Loads - This will vary by building, but in general the following research loads require emergency power:
-Freezers for storing research samples.
-Fans for Hazardous Exhaust (Fume Hoods, Bio safety Cabinets, etc.)
-Lab Animal Research Areas (HVAC, Animal Housing Equipment, Card -Access, etc.)
-Other identified research equipment approved by Engineering Services.

2) Standby E/G systems installed to provide emergency power to non-linear loads, such as uninterruptable power supplies or variable frequency drives, shall be sized in accordance with E/G manufacturers recommendations and actual equipment to be installed. Increased loading of the E/G system due to equipment efficiencies, UPS battery recharging, harmonic distortion, etc. shall be thoroughly investigated.
3) New installations of standby E/G systems shall provide a minimum of 20 percent growth capacity. Contact Engineering Services or CFS to determine if this is adequate.
4) The E/G system shall be a standard production model in commercial use for the past five years and capable of satisfactory performance on a commercial grade of distilled petroleum such as DF-2.
5) The alternator shall be capable of providing 3X rated output for at least 10 seconds to allow downstream protective devices to operate.
6) The University performs monthly testing of generators. In order to facilitate testing, provide a permanently installed load bank sized at 50% of generator capacity. Generator control system shall switch from load bank to automatic transfer switch loads in the event of a power outage during testing. The load bank shall be cooled by the generator radiator fan and be completely (including controls) located inside the generator enclosure. To facilitate this specify the load banks controls are to be separately mounted. Where space doesn’t allow, or as directed by Engineering Services or CFS, provide required switches, etc. to allow a portable load bank to be easily connected to the generator.
7) For generators located indoors an emergency stop button shall be located just outside the main entrance for the generator room. If the location is accessible to the public, it must be of a break glass type. For generators located outdoors the emergency stop button shall be located on the generator enclosure and it must be of a break glass type.

b. Fuel Tanks and Piping
1) In general, underground fuel tanks are not acceptable. In extremely rare circumstances, and only with Engineering Services or CFS approval will underground fuel storage tanks even be considered.
2) Above ground fuel tanks shall be double wall welded steel construction and sized to provide the E/G system with fuel for a minimum of **24** hours operating at continuous full-load power output. Above ground fuel tanks may be sub-base mounted or remote located as appropriate for the application and shall be

provided with a rupture basin. Interstitial monitoring and “fuel in basin” alarms shall be provided.

3) Day tanks shall be installed where applicable or required. Construction shall be same as fuel tank.
4) Fuel piping shall be double wall construction.
5) Provide fuel fill location outside of building if the generator is installed indoors. Provide fuel tank level gauge and overfill alarm at this location. Overfill alarm shall be set at 90% of fuel tank capacity.

c. Monitoring and Alarms
   1) Standby E/G systems shall be self-monitoring. A local annunciator shall display the status, "normal, "trouble" and "alarm", of E/G system components. The following signals shall also be monitored and displayed by the local annunciator.
      a) Generator running
      b) Generator system alarm or trouble
      c) Leak detection system alarm
      d) Fuel tank level
      e) Fuel overfill alarm
      f) E/G main circuit breaker position
   2) Regarding the low fuel alarm, it shall indicate a “low fuel” when the tank is at less than 25% of capacity.
   3) The generator should automatically shut down before the fuel level drops low enough to require “repriming”.
   4) The E/G system status and signals listed above shall also be monitored by the energy management system. The energy management system will forward any E/G system "trouble" or "alarm" signals to the campus control Operations Center.
   5) The E/G system shall be provided with a remote annunciator that displays the status and signals listed above. The remote annunciator shall be located next to the Life Safety ATS or in the Fire Command Center if the building has one. Provide a data connection to the generator controller to allow remote interfacing with the E/G controller.
d. Standby E/G systems shall be provided with jacket water heaters. The jacket water heater shall be connected to the emergency power distribution system.
e. Enclosures
   1) Indoors: E/G systems installed inside a building shall be located in a room, preferably along an outside wall, that is dedicated to only the E/G and ancillary equipment. E/G system designers shall pay particular attention to the following requirements:
      a) Provide adequate access into the generator room from outdoors for maintenance, replacement or removal of any and all equipment housed in the room.
      b) Provide adequate means of cooling and ventilating the E/G room. HVAC equipment and any other "space" equipment shall be connected to the emergency power distribution system.
      c) Provide adequate insulation so that E/G running noise levels are not obtrusive to building occupants.
      d) Coolant lines to extension heat exchangers shall be protected from freezing and mechanical damage.
   2) Outdoors: E/G systems installed outdoors shall be housed in a steel, heated, free standing, weather tight enclosure that has a Level 2 sound rating. The enclosure shall be constructed upon a skid base that shall have sufficient stiffness to allow

transportation and handling of the entire package with all equipment mounted and ready for operation. Wall framing, dampers, shutters and bird screens shall be aluminum. Provide lockable, access doors on both sides of enclosure. Where E/G controls are too high to be readily accessible from ground level, provide a catwalk around enclosure to facilitate maintenance and testing. The enclosures and fuel tanks shall be painted a color specified by the Architect and approved by owner. There shall not be any manufacturer names or logos on the outside of the enclosure.

f. Provide an engineered exhaust system for engine exhaust. Insulate all piping. Mufflers shall be installed on E/G exhaust systems. They shall be "critical" sound rated to provide maximum noise attenuation. Install muffler and exhaust wrap systems where applicable or required to augment exhaust system sound attenuation. Locate engine exhaust so it does not infiltrate building.
g. E/G systems shall be completely factory tested prior to installation. In addition, E/G systems shall be completely field tested by manufacturers representative using load banks, INETA Acceptance Testing Specifications, and, if applicable, NFPA 110 to ensure proper installation and operation.
h. Installing contractor shall provide fuel for field testing and top off fuel tank at substantial completion/beneficial occupancy. Specify the fuel used shall be biodeisel free (BZero). Biodeisel fuel can support fungal growth and result in expensive repairs to the generator.

3. Submit design calculations (using computer software) for E/G system, whether a new system or an existing system being modified, for review by Engineering Services or CFS.

4. Preferred Manufacturers
   a. Caterpillar
   b. Cummins
   c. Kohler
   d. Tognum America (MTU Detroit Diesel)
   e. Generac

B. Automatic Transfer Switch (ATS) (Section 26 36 23)

1. Automatic transfer switches shall conform to the requirements of ANSI/NFPA 70 - National Electrical Code, NEMA Standard ICS 2-447 and UL 1008. ATS shall be UL listed and labeled for intended purpose.

2. The ATS shall be tested in accordance with INETA Acceptance Testing Specifications (NFPA 110 as applicable) to ensure a completely coordinated system.

3. Design Features
   a. The ATS shall consist of a power transfer module and a microprocessor control module interconnected to provide complete automatic operation. The power transfer module shall be mechanically held and electrically operated by a single solenoid mechanism momentarily energized from the source to which the load is to be transferred. The control module shall have solid-state sensing and control logic. Interfacing relays shall be industrial control grade. The ATS shall include a microprocessor- based metering device that provides real time measurements of single and three phase power system. The following shall be measured: current per phase, real, reactive, and apparent power, and bi-directional energy.

b. The ATS shall be inherently double throw and mechanically interlocked to ensure only two positions: normal or emergency.
c. The ATS shall be rated for continuous duty and braced to withstand the rms symmetrical short circuit current available at the ATS terminals.
d. Utilize by-pass isolation type ATS.
e. ATS shall be closed transition type.
f. ATS for elevator shall have delayed transition feature to deenergize elevator controller when switching from emergency to normal source. Function of the building elevator controller with ATS functionality shall be verified with the elevator controller manufacturer.
g. Specify the Inphase Monitor is to be enabled on all ATS's. The delay for transferring from generator power to normal power after normal power is restored be shall set at 15 minutes for buildings served by the campus main distribution system at the Bloomington, IUPUI, Gary and South Bend Campuses.

h. Specify the transfer switch with the following accessories (Assumes ASCO 7000 series – provide similar from other manufacturers):
   1) 150A Tech Package (135L ASCO Digital Power Meter, 1PS1 Extended Control Power Ride Thru, 72EE2 Ethernet Monitoring)
   2) 77CC3 (Load Side Surge Protection) for Research Load ATS
   3) 31BG (Status Relay Bundle – 18B Emergency Source Present Contacts, 18G Normal Source Present Contact and 31Z Selective Load Disconnect – For interfacing with elevator controllers)
   4) 30A (Load-shed circuit) for Research Load ATS.

i. Provide a data cable to each ATS to allow remote connection to the ATS controller.
j. Generally, the neutral shall be switched – confirm with Engineering Services or CFS.

4. Preferred Manufacturers
   a. Automatic Switch Company (ASCO) - Model 7000
   b. Russelectric and Eaton may also be acceptable – Confirm with Engineering Services.

26 41 00 – Facility Lightning Protection

February 2022

A. Lightning Protection Systems

1. This is an optional system that should be evaluated for inclusion in new construction or major renovation projects. Evaluation shall be made in accordance with guidelines set forth in the latest edition of NFPA 780, Standard for the Installation of Lightning Protection systems, Appendix H, Risk Assessment Guide. Submit copies of the evaluation for review by Engineering Services or CFS.

2. The LPS shall be comprised of air terminals, down conductors, ground terminals, counterpoised ground conductor, interconnecting conductors, arresters and other connectors or fittings required to complete the system. The lightning protection ground components shall be connected to the electrical service ground. System design shall be in accordance with the latest edition of the following.
   a. NFPA 70, National Electrical Code
   b. NFPA 780, Standard for the Installation of Lightning Protection Systems
   c. LPI-175, Lightning Protection Institute (LPI), Standard of Practice
   d. UL 96A, Underwriters Laboratories, Installation Requirements for Lightning Protection Systems

3. If an LPS is to be installed, it must be fully coordinated with any surge protective devices (SPDs) installed for equipment protection. Both the LPS and SPDs must be properly installed in accordance with the above referenced standards. The use of an experienced electrical designer who is well versed in such systems is strongly encouraged.

4. Installation of the LPS and/or SPDs must be by an installer that is listed with Underwriters Laboratories (UL) and capable of furnishing a UL Master Label. The installer must use LPI certified journeymen who are directly supervised by LPI certified Master Installers for the installation.

5. During design of the LPS, contact Engineering Services or CFS for the actual level of certification required, e.g. installer verified code compliant LPS, UL Letter of Finding,or UL Master Label Certified LPS.

6. The LPS shall be tested and certified in accordance with the latest LPI standards. Submit testing data, certified report, and LPI certification with O&M Manuals.

A. Surge Suppression Systems (Section 26 43 00)

1. Integrate surge protective devices (SPDs) into the electrical distribution equipment for the protection of AC electrical circuits and equipment from the effects of lightning induced currents, substation switching transients, and internally generated transients resulting from inductive and/or capacitive load switching and other electronic equipment. Selection of SPDs shall be based upon the latest edition of ANSI/UL 1449, Standard for Safety for Surge Protective Devices.

2. The surge suppression system shall be comprised of Types 1, 2, & 3 SPDs that are listed and labeled for their intended installation. System design shall be in accordance with the latest edition of the following.
   a. NFPA 70, National Electrical Code
   b. ANSI/UL 1449, Standard for Safety for Surge Protective Devices
   c. ANSI/IEEE C62.41.1, Guide on the Surge Environment in Low Voltage ACPower Circuits
   d. ANSI/IEEE C62.41.2, Recommended Practice on Characterization of Surges in Low Voltage AC Power Circuits
   e. ANSI/IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits

f. IEEE C62.62, Test Specifications for Surge Protective Devices for Low Voltage AC Power Circuits
g. IEEE C62.72, Guide for the Application of Surge-Protective Devices for Low-Voltage AC Power Circuits

3. Type 4 SPD assemblies are allowed provided they have been investigated by UL for Type 1, 2, or 3 locations and are approved as suitable for use within the specified electrical panel or gear. SPDs shall not require additional UL testing or field investigation to maintain equipment's UL listing.

4. The SPDs used in the design of a surge suppression system shall be installed at all levels of the distribution system (cascaded) to optimize the level of suppression throughout the system.

5. Use only SPDs with the following characteristics.
   a. Nominal Discharge Current Rating (In)
      1) Type 1 & 2 devices - 20 kA
      2) Type 3 devices - 3 kA
   b. Short Circuit-Current Rating (SCCR) shall be no less than 200 kA.
   c. Maximum Continuous Operating Voltage (MCOV) shall be identified and shall be the actual tested value. It is expected that the MCOV shall be no less than 15% and no more than 25% of normal system operating voltage.
   d. Voltage Protection Rating (VPR)
      1) 120/208 volt system - minimum ratings shall be 700 Volts L-N, and 1200 Volts L-L
      2) 277/480 volt system - minimum ratings shall be 1200 Volts L-N, and 2000 Volts L-L

26 51 00 - Interior Lighting

February 2022

A. General

1. Lighting systems shall conform to the requirements, standards and recommendations found in the latest edition of the following:
   a. ANSI/NFPA 70 - National Electrical Code, with Indiana Amendments.
   b. ASHRAE/IES 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
   c. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
   d. Illumination Engineering Society (IES) Handbook.
   e. International Energy Conservation Code (IECC).

2. All lighting systems and components shall be classified by Underwriter's Laboratories, Inc. (UL) as suitable for purpose specified and shown and shall bear an appropriate "UL" label.

3. Lighting designers shall employ IES standards for the selection of proper illumination levels for any given area or activity.

4. During the design process and prior to completion of construction documents, provide point-by-point photometric calculations of lighting design to Engineering Services or CFS for review and comment.

5. The use of Energy Star compliant lighting solutions is encouraged.

6. In general, loading of lighting system power circuits shall not exceed 80 percent of the maximum allowed by the National Electrical Code. To accomplish this, the lighting designer shall not exceed 13 amps connected load on a branch circuit utilizing a 20 amp overcurrent protective device.

7. To minimize outages while lighting is being repaired use two circuits in hallways and alternate connection of circuits to fixtures. Place no more than ten offices on a circuit. Conference rooms shall be on their own circuit.

8. Lighting in stairwells shall be installed so maintenance can be performed from a 6' stepladder. The use of dual technology motion sensors (infra-red and ultra- sonic) and/or day-light sensors to automatically control the light levels in the stairwell are strongly encouraged.

9. Light fixtures shall be supported independently from ceilings.

10. Provide separate non-switched night light circuits in mechanical equipment rooms, electrical equipment rooms and corridors. In buildings where emergency power is available, connect night lights to emergency power circuit.

11. Use occupancy sensors, timers and/or day-light sensors to meet the requirements found in the referenced standards. In general, the use of stand- alone devices is preferred over building wide systems. Contact Engineering Services or CFS prior to designing around a building wide lighting control system.
    a. Refer to 26 27 26 Wiring Devices Item C – Occupancy Sensors for preferred features.

12. For new buildings or large renovations specify the lighting controls supplier provide a one page (two if needed) summary of how the lighting controls work in the varioustype of spaces (Office, classroom, conference room, etc.) to explain how the new advance lighting controls work for the occupants. Include controlled receptacles if applicable.

B. Interior Lighting Fixtures

1. Interior lighting fixtures shall be LED type.

2. The use of fluorescent, incandescent, high intensity discharge, or other lamps is allowed for specialty applications. Contact Engineering Services or CFS prior to using any light source other than LED for approval.

3. When available, fixtures shall be painted after fabrication.

4. Areas of computer usage shall utilize light fixtures specifically designed for glare control. Where feasible, the use of indirect and direct/indirect systems shall be considered.

5. Wherever practical or directed, provide dimming controls for LED lighting. Coordinate dimming zones with Engineering Services or CFS. The use of 0- 10V dimming controls is strongly encouraged.

6. In non-accessible ceilings “can type” down lights shall have a minimum diameter of 6 inches to facilitate maintenance.

7. Where applicable or directed, interior lighting fixtures are to be "heat removal" type. Do not utilize lighting fixtures for HVAC systems (air supply or return), unless directed by Engineering Services or CFS.

C. Lamps

1. Lamps shall be selected to mate with lighting fixtures selected.

2. Incandescent
   a. In general, incandescent lamps shall not be used in the lighting design.
   b. The use of incandescent lamps shall be for special applications and only as directed by Engineering Services or CFS.
   c. Where used, incandescent lamps shall be 130 volt rated.
   d. Incandescent lamps used in conjunction with dimming systems shall utilize filaments recognized by the dimming system manufacturer to reduce "ringing" and "chatter" of the lamp.

3. Fluorescent
   a. In general, fluorescent lamps shall not be used in the lighting design.
   b. The use of fluorescent lamps shall be for special applications and only as directed by Engineering Services or CFS.
   c. In general, fluorescent lamps shall be four-foot, 25 watt, T8 type with medium bi-pin base and 2400 initial lumens minimum. The use of T5 type lamps is also acceptable.
   d. Lamp color shall be at the discretion of the designer. The University standard is 3500 Kelvin correlated color temperature. Care shall be taken to utilize only one lamp color in any given space and to provide uniform color rendering throughout a project.
   e. Conform to ANSI standards, C78 series and C82 series as applicable to each type of lamp.
   f. Preferred manufacturers
      1) General Electric Co.
      2) North American Philips Lighting Corp.
      3) Osram Sylvania, Inc.

4. Light Emitting Diode (LED)
   a. As a minimum, LED lighting must provide the following:
      1) Color Temperature: The University standard is 3500 Kelvin correlated color temperature. Care shall be taken to utilize only one lamp color in any given space and to provide uniform color rendering throughout a project.

2) Color Rendering Index (CRI): minimum acceptable CRI = 0.85.
    i. Where multiple LEDs are used in a fixture, they shall be installed as easily replaceable assemblies.

4. Drivers and Ballasts

1. Specify that the contractor is to provide 10% spare materials (Minimum 2) for each type driver/ballast used on project. These drivers/ballasts shall be delivered to location specified by the University. These spare units shall not be used for warranty uses.

2. Fluorescent - Electronic Type
    a. Fluorescent electronic ballasts shall be low-energy, solid-state, full-light output, capable of operating one, two, three or four T8 lamps as required. All ballasts shall be high power factor, Class P thermally protected, sound-rated A, long life and low weight. All ballasts shall comply with the following ratings:
        1) Minimum Power Factor: 98 percent.
        2) Minimum Ballast Factor: 84 percent.
        3) Maximum Crest Factor: 1.70.
        4) Maximum Total Harmonic Distortion: 10 percent.
        5) Maximum Third Harmonic Distortion: 10 percent.
    b. Fluorescent electronic ballasts shall conform to the following requirements:
        1) FCC Regulations, Part 15, Subpart J for electromagnetic interference.
        2) IEEE C62.41, "Guide for Surge Voltages in Low-Voltage AC Power Circuits", Category A, for resistance to voltage surges for normal and common modes.
        3) UL 935, "Fluorescent Lamp Ballasts".
        4) The standards of the Certified Ballast Manufacturers' Association (CBM).
    c. Unless otherwise directed by Engineering Servicer or CFS, the type of fluorescent ballast (Instant Start, Rapid Start or Programmed Rapid Start) shall be left to the discretion of the lighting designer. However, programmed rapid start ballasts are preferred when using occupancy sensors.
    d. Preferred manufacturers
        1) Philips Advance
        2) Universal Lighting Technologies
        3) General Electric

3. High Intensity Discharge
    a. High intensity discharge ballasts shall be core and coil construction, constant wattage autotransformer type, with integral automatically reset thermal overload protection and high power factor. HID ballasts located indoors shall be "quiet" type.
    b. Preferred manufacturers
        1) Philips Advance
        2) Universal Lighting Technologies
        3) General Electric

4. Light Emitting Diode (LED) Driver
    a. LED drivers shall be Underwriters Laboratories, Inc. (UL) listed and labeled for intended purpose.

5. Dimming Systems (Sections 26 09 63 and 26 27 26)

1. Single Station
    a. General

1) Single station (wall box) dimming switches shall have an easily accessible and operable on/off switch that is independent of the dimming function. “Slide to off” or “rotate to off” type switches are not acceptable.
2) Installing multiple single station dimming switches in a common wall box and under a common cover plate (ganging) is acceptable. Follow manufacturers’ written instructions concerning de-rating of ganged single station dimming switches. Do not gang more than three (3) single station dimming switches. If more than three (3) single station dimming switches are required, use a multi-station or Architectural dimming system solution.

b. Light Emitting Diode (LED) Type - Any single station dimming switch used to control LED lighting shall be fully tested, approved, and listed by the switch manufacturer for the specific LED light fixture/driver installation.
c. Preferred manufacturers
1) Lutron Electronics Co., Inc.
2) Leviton Manufacturing Co., Inc.

2. Multi-Station
a. Use a room controller type lighting control system, like Lutron Grafik- Eye, when the lighting design has more than three (3) dimming/control zones in a single room, or where an interconnection to an auxiliary system such as an AV system or window shade control system are required. Small classrooms and conference rooms are likely candidates for room controller type lighting control systems.
b. Preferred manufacturers
1) Lutron Electronics Co., Inc.
2) Leviton Manufacturing Co., Inc.
3) Crestron Electronics, Inc.

3. Architectural Dimming Systems
a. Use an architectural dimming system when the lighting design has more than eight (8) dimming/control zones in a single room, or where a shared dimming rack can/must be utilized to serve more than one (1) room or partition.
b. Architectural dimming systems will typically be employed in large classrooms, large assembly spaces, and large multi-function spaces.
c. In general, the architectural dimming system equipment rack will be installed in an equipment room immediately adjacent to the space served. The main system controller / microprocessor will be housed in the dimming equipment rack. Provide a user interface at or near the dimming rack for system modifications and updates. The use of universal type dimming modules is strongly encouraged.
d. Use low-voltage push button control stations at entries.
e. Use low-voltage master manual slide type dimming control stations atinstructor stations. A minimum of eight (8) presets buttons shall also be located at the instructor station. The preset buttons may be part of the master controlstation.
f. Provide other low-voltage dimming control stations, preset control stations,room partition stations, and audio/visual interface controls as required.
g. Preferred manufacturers
1) Electronic Theater Controls, Inc. (ETC)

F. Emergency Lighting (Section 26 52 00)

1. Provide emergency lighting as required by referenced standards or where directed. The main function of emergency lighting is to direct building occupants safely out of building in the event of an emergency.

2. Connect emergency lighting to emergency power distribution systems where new emergency power (generator source) distribution systems are a part of design.

3. Connect emergency lighting to existing emergency power distribution systems only after a complete load study of existing distribution system to verify sufficient capacity or where directed by Engineering Services or CFS.

4. Where emergency power distribution systems are not present use central inverter systems. The units shall be designed for the environment they are installed. Central inverter systems shall be self-testing and generate output reports to satisfy yearly testing requirements. Provide for manufacturer startup testing.

    a) Preferred manufacturers:
        1) Evenlite LiteMinder
        2) Dual Lite D Series

5. Integral battery power for emergency lighting should only be used in existing buildings that already have similar fixtures and where only a few fixtures are being installed and it does not make sense to install a central inverter system. Approval must be obtained from Engineering Services or CFS. Batteries shall have a minimum 5 year guarantee.
    a. Emergency battery power supply shall be suitable for installation remote from or in driver/ballast compartment of luminaire. Unit shall be capable of providing normal fixture operation in a switched fixture. Include "TEST" switch and "AC ON" indicator light capable of installation in luminaire or remote from luminaire. Power supply shall have self-test diagnostic feature. Test shall be performed at minimum of 30 seconds every 30 days and 90 minutes once year.
    b. Preferred manufacturers:
        1) Philips Bodine
        2) Dual-Lite

G. Exit Signs (Section 26 53 00)

1. Preferred exit signs shall have cast aluminum housings and stencil faces with matte black finish. Letters shall be red. However, in buildings with existing exit signs to remain and having green colored letters, new exit signs shall also have green colored letters pursuant to the Indiana Building Code. Light source shall be light emitting diodes (LED). Exit signs shall employ a diffuser lens for even illumination of letters. Products that exhibit “dots” or “hot spots” shall not be acceptable.
2. Preferred Manufacturers:
    a. Lithonia – “Signature LRE” Series
    b. Sure-Lites – “CAX” Series
    c. Emergi-Lite – “Preceptor” Series

H. Regulated Waste Disposal

1. Fluorescent Lamps and Ballasts – Contact IU Environmental Health and Safety Department (EH&S) to find out latest requirements.

26 56 00 - Exterior Lighting

February 2022

A. General

1. Exterior lighting systems shall conform to the requirements, standards and recommendations found in the latest edition of the following:
   a. ANSI/NFPA 70 - National Electrical Code, with Indiana Amendments.
   b. ASHRAE/IES 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.
   c. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
   d. Illumination Engineering Society (IES) Handbook.
   e. International Energy Conservation Code (IECC).

2. All exterior lighting systems and components shall be classified by Underwriter's Laboratories, Inc. (UL) as suitable for purpose specified and shown and shall bear an appropriate "UL" label.

3. Lighting designers shall employ IES standards for the selection of proper illumination levels for any given area or activity.

4. The University has established campus standards regarding exterior site lighting fixture styles. Contact Engineering Services or CFS for approved site lighting fixtures to be utilized in specific areas.

5. The use of Energy Star compliant lighting solutions is encouraged.

6. The use of dark sky friendly light fixtures approved by the International Dark Sky Association (darksky.org) is encouraged. On the IUPUI campus, this isrequired.

7. During the design process and prior to completion of construction documents, provide point-by-point photometric calculations of lighting design to Engineering Services or CFS for review and comment.

8. Exterior lighting shall include, but is not limited to the following.
   a. Exterior area and walkways
   b. Security
   c. Roadway (May be by the local municipality)
   d. Portal and informational signs
   e. Parking lot lighting

9. To allow the University the ability to add future exterior light fixtures to a branch circuit, loading of exterior lighting system power circuits shall not exceed 80 percent of the maximum allowed by the National Electrical Code. To accomplish this, thelighting

designer shall not exceed 13 amps connected load on a branch circuit utilizing a 20 amp overcurrent protective device.

10. Light Emitting Diode (LED) lamps are to be used in exterior light fixtures. Other lamps / lighting sources may be used on the various IU campuses. Verify permitted lamp types with Engineering Services or CFS.

11. Exterior Lighting Fixtures shall be generally applied at 277V or less, utilizing thehighest voltage readily available. Where offered by the manufacturer universal (120 - 277V) drivers shall be used. Check with Engineering Services or CFS to see if there are campus specific requirements.

12. Control of exterior lighting shall be by photocell, photocell and lighting contactor, or Sensus wireless control module (Bloomington and South East Campuses), asapplicable for the installation. The use of time clocks are not allowed.

13. Concrete light pole bases shall be designed with 4,000 PSI concrete and properly sized re-bar necessary to support light fixture to withstand wind load for typical regional weather.
    a. Base diameter and depth below grade will vary with the light fixture to be supported and actual underground conditions. The diameter of the concrete base shall be a minimum of 2” larger than the base of the light fixture.
    b. Base height above grade will vary with the light fixture location. In grassy areas and alongside of walkways, the height above grade is to be a minimum of 6”. In parking lots and along roadways, the height above grade is to be a minimum of 36”.
    c. Top edge of base shall have continuous 1-inch, 45° chamfer.
    d. Exposed concrete shall have hand rubbed finish.
    e. Reference 26 05 26 – Grounding and Bonding for Electrical Systems for grounding requirements on outdoor lighting circuits.

14. Exterior lighting fixtures shall be finished in Dark Architectural Bronze baked enamel unless otherwise specified.

15. Stand-alone lighting bollards shall not be used. However, lighting bollards utilized as architectural lighting integral in building railings or architectural features may be acceptable. Verify with Engineering Services or CFS prior to designing around this type of fixture.

16. Light fixtures imbedded in masonry walls or concrete slabs are maintenance intensive and should not be used unless approved by Engineering Services or CFS.

17. Lighted stairway handrails should not be used unless approved by Engineering Services or CFS.

18. Use of multicolor lighting systems are generally not desired and must by approved by IU Landscape Architect.

B. IUB (Bloomington) Specific Exterior Lighting Requirements

1. Exterior light levels are to be 1 foot-candle minimum, maintained.

2. Voltage Source: Unless directed otherwise by Engineering Services or CFS, all power sources shall originate in campus buildings.

3. Verify with Engineering Services quantity of spare fixtures to be included in each project.

4. Walkway light fixture

a. Washington style – This style is being retired - only use if directed by Engineering Services.
    1) Fixture shall be Spring City 118 Refractive Globe with cast iron Bryn Mawr style casing with factory applied iron oxide red prime paint. Globe shall be heavy duty, injection molded refractive prismatic polycarbonate (“Acorn” type). Lamp shall be LED. Use NEMA Type III or V light distribution. Provide with gold colored finial where directed by Engineering Services.
    2) Pole shall be Spring City Washington Pedestrian, round, fluted, 11’ tall, one-piece heavy wall cast iron with access door in base. Provide with factoryapplied iron oxide red prime paint.
    3) Finish of metal components shall be minimum two coats of Rust- O-Lastic #074-679 Foliage Green.

b. Arcadian style
    1) Fixture shall be Spring City William & Mary. Cast aluminum housing with 3/16” pebbled finish polycarbonate panels. Lamp shall be LED with 4500°K color temperature, 4375 minimum lumen output, and 0-10V full range dimming capabilities. Use NEMA Type III or V light distribution. Provide with factory applied Rust-O-Lastic #074-679 Foliage Green paint.
    2) Pole shall be Spring City Arcadian, octagonal, 12’ tall, one-piece heavy wall cast iron with access door in base. Provide with factory applied iron oxide red prime paint.
    3) Finish of metal components shall be minimum two coats of Rust- O-Lastic #074-679 Foliage Green. The use of powder coating is acceptable.
    4) Sternberg is also an acceptable manufacturer of the Arcadian style fixtureand pole. Note the Sternberg pole is cast aluminum, not cast iron.
    5) Provide each fixture complete with a 7-pin receptacle mounted internally. The receptacle shall be compatible with a Sensus wireless control module. Each fixture shall be furnished with a shorting cap for the receptacle. Sensus control modules will be furnished and installed by IU Utilities. Cost associated with furnishing and installation on the Sensus control modules must be included in the IU cost model as a “below the line” item.

c. Solitaire style
    1) Fixture shall be Kim “Solitaire” SRSP2 style. Die-cast aluminum housing elements with clear Lexan lens. Fixture shall be fully gasketed and shall use stainless steel hardware. Fixture shall attach directly to pole; use type “FM”(flush mount) mounting feature. Light source shall be LED with 4000°K color temperature, 6000 minimum lumen output, and 0-10V full range dimming capabilities. Provide with appropriate NEMA distribution pattern(s), as determined by calculations, to provide proper walkway illumination.
    2) Pole shall be Kim Type PRA, 4” round, non-tapered, seamless 6063-T6 alloy extruded aluminum shaft welded to a 356 alloy cast aluminum base. Pole shall be 12’ tall. Provide complete with hand-hole and base cover.
    3) Finish of fixture shall be Dark Bronze Gloss Smooth polyester powder coat paint. Finish of pole shall be factory applied Dark Bronze anodized finish to match fixture.

4) Provide each fixture complete with a 7-pin receptacle mounted on top of fixture. The receptacle shall be compatible with a Sensus wireless control module. Each fixture shall be furnished with a shorting cap for the receptacle. Sensus control modules will be furnished and installed by IU Utilities. Cost associated with furnishing and installation on the Sensus control modules must be included in the IU cost model as a “below the line” item.

d. Square Linear Element style
   1) Fixture shall be Bega “Linear Element – Square”. Fixture and pole shall be integrated to appear as single 8-5/8” square column comprised of a “solid” base section, a four (4) post open-air center section, and a “solid” top section. Construction of this fixture/pole shall be cast and extruded aluminum components. Fixture/pole shall be fully gasketed and shall use stainless steel hardware. Mounting base (anchorage unit) shall be made of galvanized steel. Lamp shall be LED.
   2) Finish of fixture and pole shall be Dark Bronze polyester powder coat paint.

5. Roadway / parking lot light fixture
   a. Archetype style
      1) Fixture shall be Kim “Archetype”, Model AR. One-piece cast aluminum housing and lens frame, completely gasketed with 3/16” thick clear tempered glass lens. Support arm shall be one-piece extruded aluminum with internal bolt guides. All hardware shall be stainless steel. Light source shall be LED (PicoPrism style) with 4200°K color temperature, 9162 minimum lumen output using 80 LED’s 35 mA, and 0-10V full range dimming capabilities. Provide with appropriate NEMA distribution pattern(s), as determined by calculations, to provide proper illumination for area being lit.
      2) Pole shall be Kim Type PRA, 6” round, non-tapered, seamless 6063-T6 alloy extruded aluminum shaft welded to a 356 alloy cast aluminum base. Pole shall be 25’ or 30’ tall, as required by project. Provide complete with hand-hole and base cover. Poles shall have a factory installed pendulum vibration dampener. Vibration dampener shall be internally mounted with stainless steel hardware, finished to match pole.
      3) Finish of fixture shall be Dark Bronze polyester powder coat paint. Finish of pole shall be factory applied Dark Bronze anodized finish to match fixture.
      4) Provide each fixture complete with a 7-pin receptacle mounted on top of pole. The receptacle shall be compatible with a Sensus wireless control module. Each fixture shall be furnished with a shorting cap for the receptacle. Sensus control modules will be furnished and installed by IU Utilities. Cost associated with furnishing and installation on the Sensus control modules must be included in the IU cost model as a “below the line” item.

C. IUPUI (Indianapolis) Specific Exterior Lighting Requirements

1. Exterior light levels are to be in the 1 to 5 foot-candle range with a target of 2 to 3 foot-candles and a minimum at any one point of 0.9 fc. Grass areas are not expected to belit unless there is a landscape feature.

2. Voltage Source: Exterior lighting shall utilize 120V source wherever possible. New lighting systems and those to be connected to existing, or upgrades of existing, shall utilize 120V source. This may require conversion of existing lights to new voltage source

and replacement of wiring, ballasts and lamps or the addition of transformers or use of multi-tap ballasts. All power sources shall originate in Campus buildings. Parking lot lighting, if fed from a building, shall be supplied from a separate metered source. Consult IUPUI CFS Utilities for metering requirements.

3. Controls: Outside lighting circuits shall be controlled by dedicated photo cell and contactor arrangement. Time clocks shall not be used. Where upgrade to existing lighting circuits or controls is required, contact CFS Utilities.

4. Spare Parts/Fixtures – Confirm with Engineering Service or CFS.
   a. New construction or upgrade projects shall provide three (3) complete spare light pole and fixture assemblies including lamps.
   b. Where parking lot lighting is included in the project, two (2) spare pole and fixture assemblies shall be provided including lamps. In addition, light assemblies shall be chosen from manufacturers that maintain adequate spare parts inventories for no less than 10 years from date of purchase.

5. Conduit & Wiring: All lighting circuits shall be placed in PVC coated rigid steel conduit or continuous HDPE (UL listed for use as electrical conduit), at minimum depth of 30". Circuit conductors shall be sized to minimize voltage drop and maximize light fixtures per circuit. #8 AWG copper protected by a 20 Amp circuit breaker is preferred. Wire insulation shall be rated THWN. Outside lighting circuits shall be dedicated sharing no other loads.

6. Walkway Lighting
   a. Fixture shall be Visionaire Lighting Aria-1 Array Model: ARI-1-L XX YY 4K UNV AM BZ WSC-20 RPP4 DIM with XX= Optics Type and YY = Lumens (Generally 6L)
   b. Pole shall be Valmont part number: RNTA-4RS-.125-14'-9.25BC-HING- 317-AS1-BZ-HHC-VD (140040404SH-1VDA) Hand Hole Vibration Dampner with the following features.
      1) Aluminum, non-tapered, 4" outside diameter
      2) Hinged base
      3) Hand-hole
      4) 9" bolt circle
      5) Have adequate wind load withstand capability for typical regional weather
      6) Drilled for the Visionaire fixture
      7) Fixture mount shall be capable of 90° and 180° rotation in relation to hinged base opening to allow mounting next to obstacles such as buildings, trees, etc. An adapter is acceptable as long as overall height limit maintained.
      8) 14 feet overall height
   c. Fixture and pole color shall be matching bronze, powder coated finish.
   d. Concrete light pole base requirements shall comply with general requirements with the following modifications.
      1) 24" diameter
      2) 12" above grade. All poles in a given area or within a single project shall be the same finished height. Base height above grade may need to be adjusted if area contains sidewalk and grass installations.
      3) Refer to Drawing E1 – *Non-Vehicular Area Lightpole Base Detail*, at the end of this section, for additional installation requirements on the IUPUI campus.

7. Roadway Lighting
   a. The University typically does not supply roadway lighting. Roadway lighting is provided by the City of Indianapolis thru the local utility.
   b. Roadway lighting shall be aluminum 30’ poles with base suitable to withstand regional wind loading.
   c. Power source is preferred from the local utility (including pole).
   d. Poles may have single or double arm “cobra head” fixtures or floods suitable for the application. Contact CFS Utilities for approval.
   e. Lamps shall be LED standard. For other lamps types, e.g. metal halide, HPS, etc., contact CFS Utilities.

8. Portal and Informational Signs
   a. Unlit signs are preferred. If sign is to be lighted, exterior, in-ground reflective lighting is preferred. If interior lighted, preferred sign light source is LED.
   b. Exterior lighted signs shall be powered from Campus buildings where possible. Voltage shall be 120V. Control shall be by photocell with override switch. OCP shall be provided by an exterior accessible molded case circuit breaker.
   c. For other power sources, contact IUPUI CFS Utilities.

9. Parking Lot Lighting
   a. Power source for parking lots may be from the local utility provider or from Campus buildings. If from Campus buildings, circuits shall not be combined with any other exterior lighting and must be separately metered. Contact IUPUI CFS Utilities for metering requirements.
   b. Fixtures shall be International Dark Sky Association approved dark sky friendly. Lamps shall be LED or as approved.
   c. Parking lot pole bases shall be concrete at least 24” diameter incorporating depth and rebar for suitable regional wind withstand resistance. Poles may incorporatea light pole base protector.
10. Traffic Lights – By City of Indianapolis, Coordinate with City thru Engineering Services or CFS.

D. IUS (New Albany) Specific Exterior Lighting Requirements

1. Exterior light levels are to be 1 foot-candle minimum, maintained.

2. Voltage Source: All power sources shall originate in Campus buildings.

3. Controls: Sensus wireless control module.

4. Walkway light fixture
   a. Solitaire style
      1) Fixture shall be Kim “Solitaire” SRSP2 style. Die-cast aluminum housing elements with clear Lexan lens. Fixture shall be fully gasketed and shall use stainless steel hardware. Fixture shall attach directly to pole; use type “FM” (flush mount) mounting feature. Light source shall be LED with 4000°K color temperature, 6000 minimum lumen output, and 0-10V full range dimming capabilities. Provide with appropriate NEMA distribution pattern(s), as determined by calculations, to provide proper walkway illumination.

2) Pole shall be Kim Type PRA, 4” round, non-tapered, seamless 6063-T6 alloy extruded aluminum shaft welded to a 356 alloy cast aluminum base. Pole shall be 12’ tall. Provide complete with hand-hole and base cover.
3) Finish of fixture shall be Dark Bronze Gloss Smooth polyester powder coatpaint. Finish of pole shall be factory applied Dark Bronze anodized finish to match fixture.
4) Provide each fixture complete with a 7-pin receptacle mounted on top of fixture. The receptacle shall be compatible with a Sensus wireless control module. Each fixture shall be furnished with a shorting cap for the receptacle. Sensus control modules will be furnished and installed by IU Utilities. Cost associated with furnishing and installation on the Sensus control modules must be included in the IU cost model as a “below the line” item.

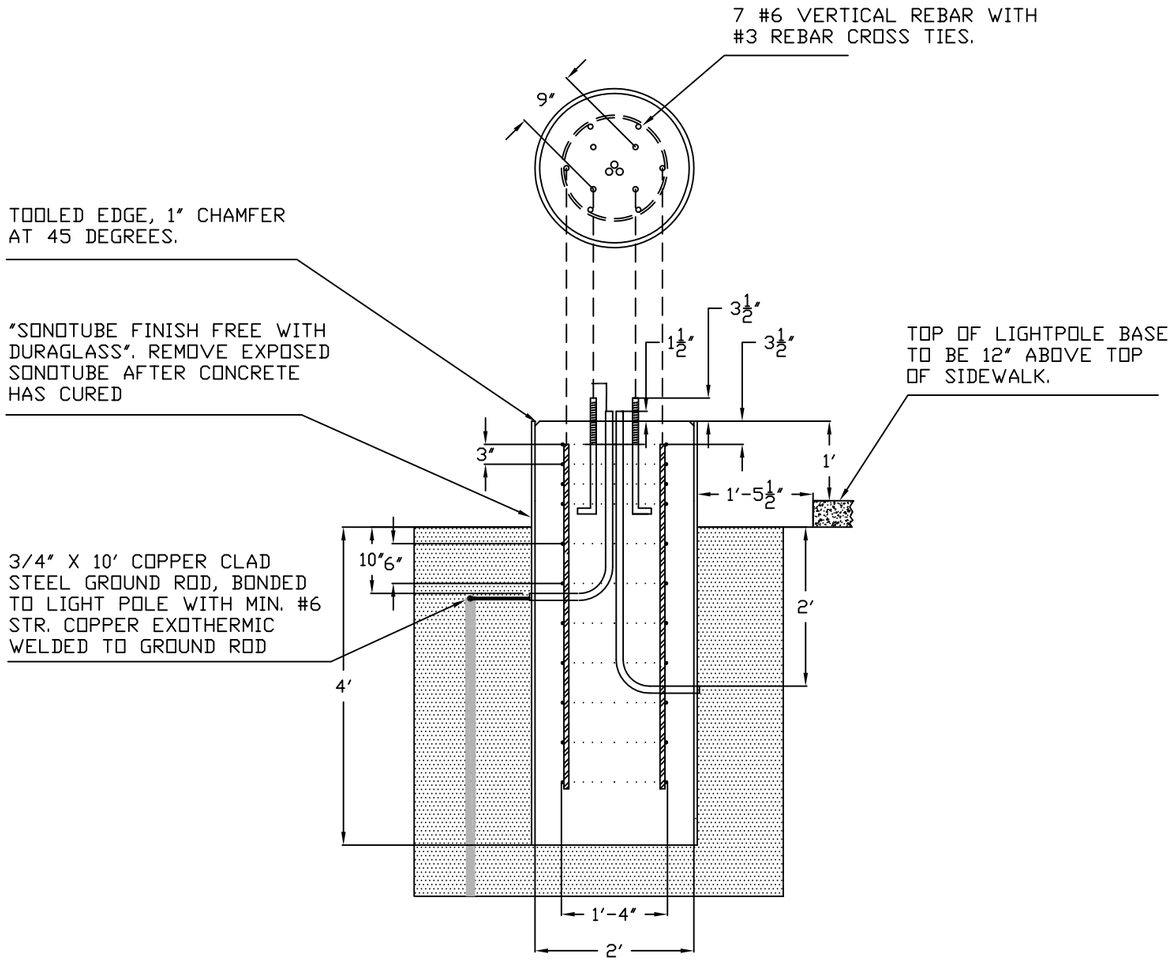
5. Roadway / parking lot light fixture
   a. Archetype style
      1) Fixture shall be Kim “Archetype”, Model AR. One-piece cast aluminum housing and lens frame, completely gasketed with 3/16” thick clear tempered glass lens. Support arm shall be one piece extruded aluminum with internal bolt guides. All hardware shall be stainless steel. Lamp shall be 250 or 400 Watt HPS or LED equivalent. Provide with appropriate NEMA distribution pattern(s), as determined by calculations, to provide proper illumination for area being lit.
      2) Pole shall be Kim Type PRA, 6” round, non-tapered, seamless 6063-T6 alloy extruded aluminum shaft welded to a 356 alloy cast aluminum base. Pole shall be 25’ or 30’ tall, as required by project. Provide complete with hand-hole and base cover. Poles shall have a factory installed pendulum vibration dampener. Vibration dampener shall be internally mounted with stainless steel hardware, finished to match pole.
      3) Finish of fixture shall be Dark Bronze polyester powder coat paint. Finish of pole shall be factory applied Dark Bronze anodized finish to match fixture.
      4) Provide each fixture complete with a 7-pin receptacle mounted on top of pole. The receptacle shall be compatible with a Sensus wireless control module. Each fixture shall be furnished with a shorting cap for the receptacle. Sensus control modules will be furnished and installed by IU Utilities. Cost associated with furnishing and installation on the Sensus control modules must be included in the IU cost model as a “below the line” item.

E. IUNW (Gary) Specific Exterior Lighting Requirements – Future

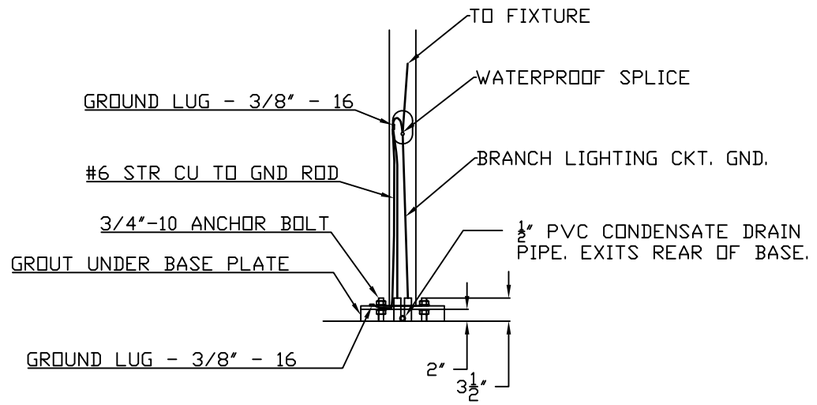
F. IUSB (South Bend) Specific Exterior Lighting Requirements – Future

G. IUK (Kokomo) Specific Exterior Lighting Requirements – Future

H. IUE (Richmond) Specific Exterior Lighting Requirements - Future



NOTE: CONCRETE COMPRESSIVE STRENGTH 4,000 PSI MINIMUM



NON-VEHICULAR AREA LIGHTPOLE BASE DETAIL

NO SCALE

INDIANA UNIVERSITY
PURDUE UNIVERSITY
INDIANAPOLIS

IUPUI

CAMPUS FACILITIES
SERVICES
ENGINEERING

PHYSICAL PLANT
1220 WISHARD BLVD
INDIANAPOLIS, IN 46202

PROJECT TITLE:

IUPUI SITE LIGHTING

ORIGINAL DRAWING SIZE:

11" X 17"

SHEET TITLE:

NON-VEHICULAR AREA LIGHTPOLE BASE DETAIL

REVISIONS:

DRAWN BY:	
CHECKED BY:	
DATE:	JANUARY 2014
WORK REQ. #:	
MMS PROJ. #:	
CAD FILE NAME:	
BLDG. #:	
CAMPUS:	IN
SHEET:	E1
OF 1 SHEETS	