

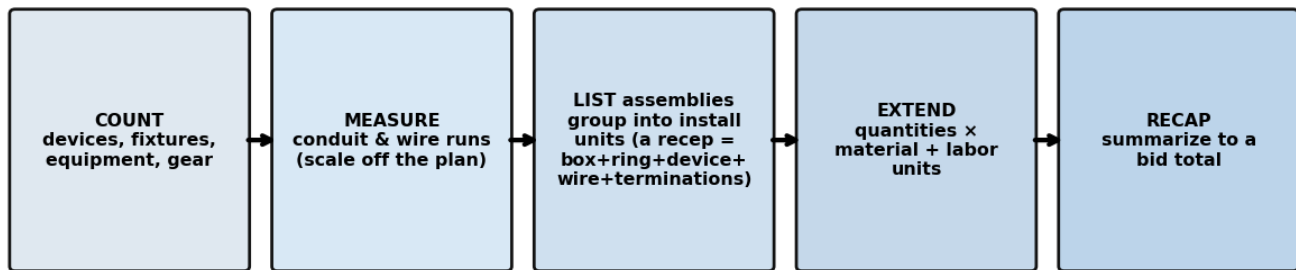
Module 3.1 — The Takeoff Process

Phase 3 begins. Open the bid package, count and measure the whole job with published rules, recap and build assemblies, then close out with the scope letter, RFIs, and a bid-day checklist.

Welcome to Phase 3 — Estimating & Bidding. You can install and repair the work now; this phase teaches how the work is priced and won. It starts with the **takeoff**: counting and measuring every piece of the job off the drawings and specifications. A complete takeoff turns pricing into arithmetic. A missed feeder or a forgotten system costs money on every job no matter how well it is installed. This module walks through opening the bid package, counting and measuring with published rules and numbers, recapping the worksheets, building assemblies, catching missed scope, and the scope letter, RFIs, and bid-day checks that finish the job.

Part A — The Takeoff Workflow

THE QUANTITY TAKEOFF — count it before you can price it



Count → measure → group into assemblies → extend by material and labor units → recap to a bid total.

The figure shows the core loop. Published estimating sequences (Jaffarian; Kiper in EC&M) put plan review, spec reading, and a scope sheet before the first count:

1. Review the architectural, mechanical, and electrical drawings. Electrical work often shows up on non-E sheets.
2. Read the General Conditions and Division 26: bid form, alternates, tax, allowances, retainage, temporary power, bonds, liquidated damages, and owner-furnished equipment.
3. Fill out a **Scope of Work sheet**. Mark each item FBE, IBE, FBO, or IBO (furnished by electrical, installed by electrical, furnished by others, installed by others). Record device grade, wire type, raceway type by location, minimum conduit size, and fitting type.
4. Count the vendor-quoted packages first: luminaires, gear, fire alarm, security, data, sound. Suppliers need time to price them.
5. Take off one system completely before starting the next.

6. Measure feeders, then branch circuits, then special-system raceways.
7. Recap the worksheets, derive the secondary materials ("quantities from quantities"), then price and extend (Module 3.2).
8. Check the estimate, confirm every addendum, send the scope letter, and review with the chief estimator.

Order inside the count (Jaffarian): fixtures, switches, receptacles and floor boxes and phone outlets, special systems, disconnects and one-off items, panels and gear, feeders, branch circuits, special-system raceway. While counting fixtures, "balloon panel locations with a highlighter" (Kiper) so you can find them again for the branch-circuit work.

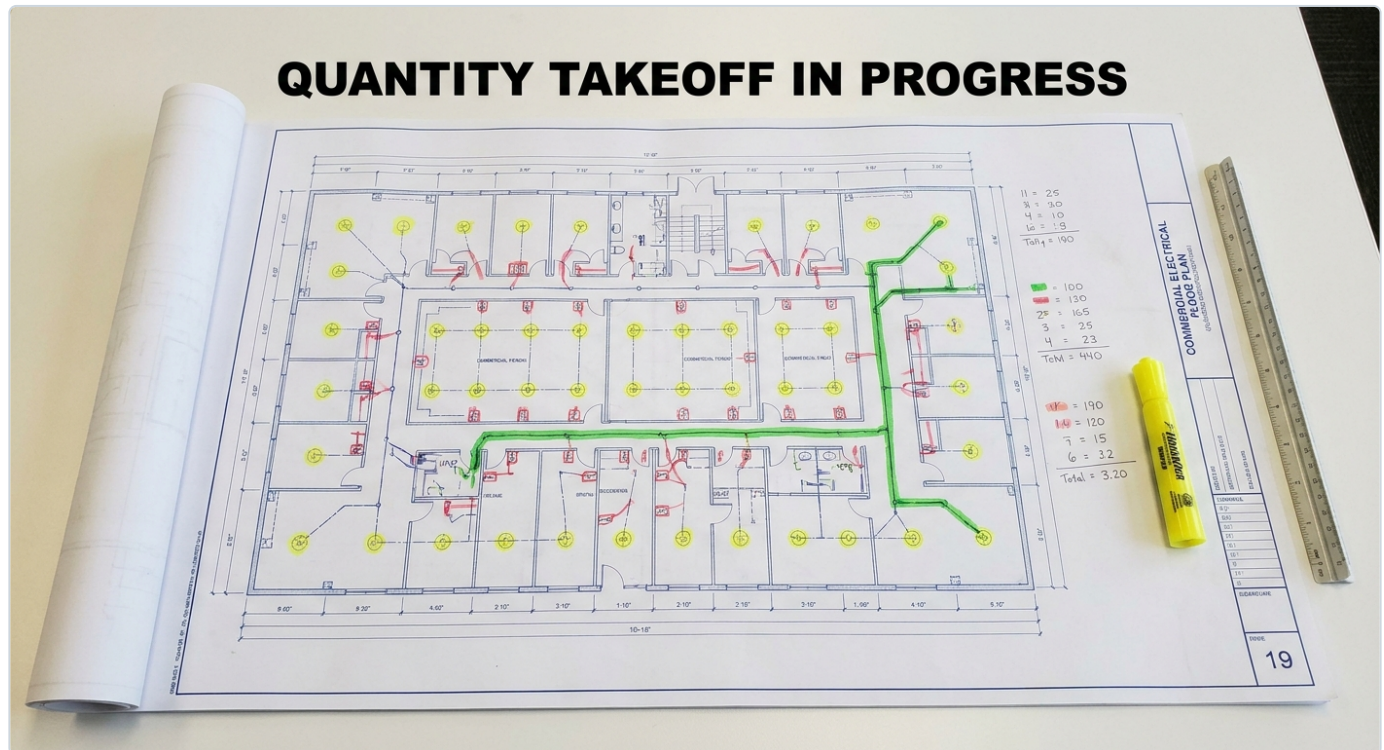
A1. STEP-BY-STEP: open the bid package

Document	What you pull from it
Invitation / Instructions to Bidders	Bid date and time, where bids go, the bid form, bond requirement, withdrawal rules, the RFI contact and cutoff
Drawing index	Every sheet and its revision date. Confirm each listed E-sheet is actually in the set
E-sheets	A common order is legend, site, lighting, power, systems, one-line and risers, schedules, details. Numbering varies by design firm
Division 26 specifications	26 05 00 Common Work Results; 26 05 19 low-voltage conductors and cables; 26 05 26 grounding and bonding; 26 05 29 hangers and supports; 26 05 33 raceway and boxes; 26 05 53 identification; 26 24 13 switchboards; 26 24 16 panelboards; 26 27 26 wiring devices; 26 51 00 interior lighting; 26 56 00 exterior lighting
Divisions 27 and 28	Communications, fire alarm, and security. These may or may not be in the electrical contract
Section 01 51 00 Temporary Utilities	Temporary power scope and who pays for the power used
Addenda	Changes to sheets, specs, schedule, phasing, allowances, and working hours

1. Log the bid date, time, and delivery address from the Instructions to Bidders.
2. Check the drawing index against the sheets you have. Write down every sheet number, date, and revision you are bidding from.
3. Read each Division 26 section. Every spec section has three parts: **Part 1 General**, **Part 2 Products** (acceptable manufacturers), and **Part 3 Execution** (installation method). Part 3 is where raceway rules hide. The EC&M estimating e-book's example: PVC "may not be permitted to be installed in the slab or underground" on one job even though it was allowed on the last one.
4. Read 01 51 00 and list the temporary power items: temporary service, power consumption, lights and receptacles per area, trailer hookups, perimeter security lighting, fence grounding, welder connections, temporary generation.
5. Fill out the Scope of Work sheet (FBE/IBE/FBO/IBO) before you count anything.

6. Start a running question list for RFIs (Part G).

Part B — STEP-BY-STEP: Doing the Takeoff



A real takeoff: one highlighter color per system, counts tallied in the margin, lengths scaled off the plan.

B1. Set up and check the scale

1. **Confirm the scale on every sheet.** One sheet can carry two scales. The Navy's estimating handbook (NAVFAC P-405) lists the common errors: "using the wrong scale; reading the wrong side of a scale," and missing a detail drawn at a different scale. A sheet marked NTS (not to scale) has to be measured from dimensions or other sheets.
2. **Calibrate PDFs to a known dimension.** Scanned or mis-printed sets break the printed scale. Use a dimension of 20 ft or more and check both directions (PlanSwift). In Bluebeam: Measurements panel → Calibrate → click the ends of a known length → enter the real length → apply to the pages.
3. **One color per system**, the same across the whole set. Jaffarian's colors: yellow fixtures, green switches and receptacles, red fire alarm, purple other systems, blue disconnects, motors, and miscellaneous, light green panels on the riser, orange feeders.
4. **Read the symbol legend** and the general notes before the first count.

B2. STEP-BY-STEP: counting (Jaffarian method)

1. List the fixture types with lamps and mounting code (R recessed, S surface, W wall, P pendant, ST stem, RF), one column per drawing.

2. Zero the hand counter and count one type per pass. Color each symbol completely: "Do not check it off or half color it."
3. Add a missed symbol the moment you find it. Put a dash where a type does not appear on a sheet, so a blank cell always means "not counted yet."
4. **Switches:** single-poles go on the counter. Record 3-ways, 4-ways, and multi-gang groups as hash marks in the sheet's lower-right corner. A 2-gang pair of single-poles counts as 2 switches plus one hash for the 2-gang ring and plate.
5. **Receptacles:** same method. A switch and receptacle under one plate gets one receptacle click, one switch hash, and one combination-plate hash.
6. **Special systems:** put the most common device (smoke detectors, for example) on the counter and hash-mark the rest. Compare the plan count to the riser diagram. "If there is a discrepancy, use the higher count."
7. **Disconnects and motor connections:** write amps and poles, NEMA enclosure type, voltage, wire count and size, and flex size. Mark FBO where someone else furnishes it.
8. **One-of-a-kind items** go on a miscellaneous worksheet: pull boxes, meter can, plywood backboards, pads, pole bases, trenching, time clocks, photocells, ground rods.
9. **Gear:** color each panel on the riser and the heading of its panel schedule. Every uncolored panel is a miss.

B3. STEP-BY-STEP: measuring conduit and wire

1. Measure feeders first, panel to panel, with the scale or the digital length tool. Add vertical rises from the riser diagram.
2. Measure branch circuits sheet by sheet, outlet to outlet along the likely route, then the homerun to the panel.
3. **Ceiling drops** (switch legs and homeruns dropping down a wall): click each drop and multiply by the drop length, then add that to the wheel footage. Get the drop length from the ceiling height minus the device height. Never over-run the measuring wheel to cover drops.
4. **Slab turn-ups** to receptacles at 18 in. above floor: one click = **3 ft** (18 in. down plus 18 in. up) for each run between outlets.
5. **Homerun out of the slab** to the panel: two clicks = **6 ft**.
6. **Flex whips:** 3 ft of flex, 1 straight and 1 90° connector per motor or equipment connection; 5 ft per transformer; 6 ft and 2 straight connectors per recessed fixture.
7. Record each run by conduit size, type, and fill (for example 3#12 in 1/2 in. EMT). Each measured run gets "two clicks" for its two connectors.
8. Do not add waste to conduit footage at the counter. Wire make-up and waste are added once, at the recap (Part C).

Jaffarian notes that branch circuits and feeders can be "as much as 70 percent" of the total labor on a job. Careless measuring costs more than a missed fixture.

B4. Digital takeoff tools

Tool	Count	Length	Notes
Bluebeam Revu	Tools > Measure > Count (Shift+Alt+C). Visual Search finds a symbol, then "Apply Count Measurement to Checked"	Tools > Measure > Length (Shift+Alt+L)	Give each count a unique Subject so the Markups List totals across pages. Audit Visual Search results
STACK	Count (Alt+C), Autocount	Linear (Alt+L); "Linear with Drop" (Alt+D) adds a drop at each point	Multiplier for repeated floors. Prompts you to set scale before linear work
PlanSwift	Count item, Auto Count	Linear and Segment items	Scale from a known dimension of 20 ft or more in both directions, then verify with the Dimension tool

Audit every auto-count. In a VDCI demonstration, Bluebeam's auto-count missed fixtures drawn with a different line style. Spot-check each auto-count by hand on at least one sheet.

Part C — The Worksheet

SAMPLE TAKEOFF WORKSHEET

ITEM	COUNT	MATERIAL ea	LABOR-HRS ea
Duplex receptacle (20A, commercial)	42	\$3.10	0.35
277V 2x4 LED troffer	60	\$78	0.55
Single-pole switch	18	\$2.40	0.30
20A 1-pole breaker	30	\$9	0.25
1/2" EMT (per 100 ft)	24	\$38	2.5
#12 THHN (per 1000 ft)	9	\$95	—
4" sq box + mud ring	60	\$3.80	0.25

Labor-hour values come from a labor-unit table (e.g. the National Electrical Estimator / NECA MLU). Count × unit = total hours; total hours × your loaded labor rate = labor cost. Add material, then overhead & profit (Module 3.2).

Each line: item, count, material each, labor-hours each. Count × labor unit = total hours → labor cost (Module 3.2).

C1. Worksheet columns (Jaffarian)

Worksheet	Columns
Fixtures	Type, lamps, mounting, total, then one column per sheet (E-1, E-2, E-3 ...)
Feeder schedule	From, to, raceway size, number of raceways, length, footage, type, 90s, terminations, straps, trench; wire number, size, length, footage
Branch circuits (one per drawing)	Wire size, wire total, conduit footage by fill (3#12, 4#12, 5#12), connectors (EMT) or bushings (rigid) for each conduit size and type, and a column for wire pulled through continuous fixture rows

The Navy's material takeoff sheet (P-405) adds two useful columns: unit of issue and waste factor. Keep the worksheet for the field foreman; it becomes the material list.

C2. Worked example 1: one feeder line

From the main distribution panel (MDP) to lighting panel LP: two parallel 3 in. rigid conduits on a 60 ft run.

Item	Math	Quantity
Conduit	2 raceways $\times$ 60 ft	120 ft of 3 in. GRC
90° elbows	2 per raceway	4
Terminations	2 per raceway	4
Trench	From the plan	55 ft
Conductors	4 per raceway $\times$ 2	8 $\times$ 350 kcmil
Wire footage	8 $\times$ 75 ft (60 ft run plus 15 ft make-up in Jaffarian's example)	600 ft

The 15 ft of feeder make-up is the example's number, not a published rule. Take make-up from the actual gear layout.

C3. Worked example 2: branch-circuit recap with waste

Fill	Conduit ft	Wire ft
3#12 in 1/2 in. EMT	820	$820 \times 3 = 2,460$
4#12 in 1/2 in. EMT	410	$410 \times 4 = 1,640$
5#12 in 1/2 in. EMT	160	$160 \times 5 = 800$
3#12 in 1/2 in. GRC (slab)	340	$340 \times 3 = 1,020$
#12 through fixture rows	—	330
Subtotal		6,250
$\times$ 1.15 make-up and waste, rounded up to the next 10		7,190

Jaffarian says "most estimators" add **15 percent** to wire for make-up and waste. NEC 2026 300.16(A) (300.14 in 2023) requires "at least 150 mm (6 in.) of free conductor" at each outlet, junction, and switch point. That 6 in. is the code minimum, not a waste allowance; the 15 percent covers it.

C4. STEP-BY-STEP: recap

1. Total each column on every sheet's worksheet. Check that each sheet column has a number or a dash, never a blank.
2. Carry the sheet totals to one recap sheet per system.
3. Apply the 15 percent wire factor once, at the recap.
4. Derive the secondary materials (Part D): boxes, rings, plates, couplings, straps, wirenuts, markers.
5. Run the code checks (fill, 125 percent, EGC) in the checkpoint box.
6. Hand the recap to pricing (Module 3.2).

Part D — Think in Assemblies

Estimators do not price loose parts. They price **assemblies**: one counted task, such as "install a commercial-grade duplex receptacle," that carries all its parts and its labor. McCormick Systems' training manual uses assemblies such as "DUPLEX STD" and "3 #12 ½" EMT S/S STRAP." One count then pulls in every part and every labor hour at once.

D1. A 20 A duplex receptacle assembly (built from Jaffarian's derivation rules)

Component	Quantity	Rule
4 in. square box	1	One box per 1-gang ring, 2-gang ring, or blank cover
1-gang mud ring	1 (fewer where devices share multi-gang rings)	Gang deduction, worked example 3
20 A spec-grade duplex	1	Grade and color from the Scope of Work sheet
Plate	1	Plates for receptacles, special outlets, phone outlets
Wirenuts	3 per box	Jaffarian allowance
EMT connectors	2 per measured run	"Two clicks" per run
EMT couplings	1 per 10 ft plus 1 per elbow	Jaffarian allowance
Straps	Within 3 ft of each box and every 10 ft	NEC 2026 358.30(A)
Labor hours	From a labor-unit manual	Module 3.2

The NECA Manual of Labor Units gives three labor units for each item, including Normal and Difficult columns. Its units include material handling, drawing study, layout, installation, and normal non-productive time. The values are sold by NECA and are not printed here.

D2. Derivation rules: quantities from quantities

- **Couplings:** 1 per 10 ft of EMT plus 1 per elbow. Worked: 820 ft of 1/2 in. EMT $\rightarrow 820 \div 10 = 82$ couplings, plus one for each elbow counted.
- **Straps** (358.30(A)): EMT fastened "at intervals not to exceed 3 m (10 ft)" and "within 900 mm (3 ft) of each outlet box."
- **Wirenuts:** 3 per box.
- **Wire markers:** 30 per panelboard, switchboard, or MCC, plus 1 per special-system termination.
- **Flex whips:** 3 ft per motor or equipment connection, 5 ft per transformer, 6 ft per recessed fixture (B3).
- **Equipment connections** are priced by size band: #14-#6, #4-#1, 1/0-4/0, 250-500 kcmil.

Worked example 3: rings, boxes, and plates (Jaffarian).

Step	Math	Result
Devices under multi-gang rings	$24 \text{ two-gang} \times 2 + 6 \text{ three-gang} \times 3 + 2 \text{ four-gang} \times 4 = 48 + 18 + 8$	74 devices
1-gang rings	$238 \text{ total devices} - 74$	164
4 in. square boxes	$67 \text{ blank covers} + 164 \text{ one-gang rings} + 24 \text{ two-gang rings}$	255
Single-gang switch plates	$98 \text{ switches} - (24 \times 2 + 6 \times 3 + 2 \times 4)$	24

Part E — Don't Miss Scope

The money is lost in what you forget to count. Sweep the whole set: **gear and feeders** (the one-line), **fire alarm and low-voltage**, **site/underground and excavation**, **temporary power**, **permits and inspections**, and **general conditions** (lifts, hoisting, as-builts). A missed feeder or forgotten fire-alarm scope can erase the whole job's profit.

Mistake	How to catch it
Missing an addendum	Confirm every addendum is received. Addendum narratives can leave out changes, so compare the current sheets against the ones they replace
Missing keyed or sheet notes	A takeoff is not complete until "all sheet notes are fully understood and accounted for" (Electrical Contractor magazine)
Wrong conduit type above ceilings or in slab	Read Part 3 of 26 05 33. Record raceway type by location (underground, slab, surface, partitions, ceilings) on the Scope of Work sheet
Bidding an old sheet revision	Record the drawing versions used and list sheet dates and revisions in the proposal
Fire alarm or low-voltage assumed by the other side	Fire alarm, low-voltage, EV charging, and temporary power are the categories most often disputed after award. Include each one or exclude it by name
Gear missed off the one-line	Color each panel on the riser and on its schedule; any uncolored panel is a miss
Ignoring the site plan	Light pole bases, transformer pads, trench width and depth, asphalt repair, concrete encasement
Special-system plan count lower than the riser	Use the higher count
Owner-furnished fixtures of unknown weight	Mike Holt's case: 3 owner fixtures estimated at 3 hours each weighed over 500 lb each and took 3 workers 3 days. Ask for weights

Settle who pays for these in the spec or the scope letter (Jaffarian's list): excavation and backfill, pole bases, pads, safety switches, motor starters, fixture support, temperature-control wiring, interlock wiring, primary raceway and cable, the primary transformer, painting, pitch pockets, cutting and patching.

Part F — The Scope Letter, Clarifications, and Exclusions

The scope letter (or proposal) states exactly what the price includes. Kiper's list of contents:

1. Base bid.
2. Alternates, each as an add or a deduct.
3. Drawing list with dates and revisions.
4. Specification sections covered.
5. Addenda received.
6. How long the price is valid.
7. Change-order, back-charge, and delay terms, and payment terms.
8. Exclusions, such as overtime, hazardous materials, utility company charges, demolition, taxes and bond, temporary power, trash, rock excavation, and roof penetrations.

Electrical Contractor magazine suggests opening with the basis of the price, for example "This proposal is based on the following documents: E100, specification 16000 and addendum 1," then listing exclusions, then stating that only work "clearly shown and described" is included. The same article says to exclude language that makes the electrical contractor responsible for studying every trade's documents for electrical work. Send the scope letter 1 to 2 days before the bid (Electrical Estimating 101). On public contracts bid directly to the owner, exclusions are usually not allowed. Keep a master exclusions template and edit it for each job (Kiper).

Part G — The RFI Process

A request for information (RFI) asks the designer to settle a conflict or gap before bid day. Steps from Electrical Contractor magazine's "Estimating Blind":

1. List what you know and what you don't while reading the documents.
2. Set a submit-by date that leaves time for an answer. The cutoff comes from the project's Instructions to Bidders.
3. Remove questions the documents already answer.
4. Write specific questions with sheet and section references. For example, when a fixture symbol on a plan sheet is missing from the fixture schedule, name the sheet, the room, and the schedule, and ask which type to price.
5. Send to the contact named in the Instructions to Bidders.
6. Carry the answers into the estimate and the scope letter. Answers usually come back as addenda.

Part H — Bid-Day Checklist

1. Quantities finished at least 24 hours before the bid (Kiper).
2. Every addendum logged and acknowledged on the bid form.
3. Supplier quotes checked for quantity, spares, exclusions, and lead time.
4. Phone quotes written on a form: supplier, contact, price, freight, exclusions.
5. Bid bond and other forms prepared days ahead (EC&M e-book).
6. Hours-per-device sanity check: total system hours ÷ device count, compared with past jobs.
7. Copper priced at the current market when wire is a large share of the material.
8. Scope letter sent with the drawing list, addenda, and exclusions.
9. Bid form signed and delivered to the address and by the time in the invitation (McCormick Systems checklist).

Estimating Checkpoints: NEC 2026 sections a takeoff depends on (2023 number in parentheses where it moved)

- **Article 100 Continuous Load:** "A load where the maximum current is expected to continue for 3 hours or more." **210.19(A)(1)** branch conductors and **210.20(A)** branch OCPD: at least the noncontinuous load plus 125 percent of the continuous load. Example: 16 A of continuous lighting $\times 1.25 = 20$ A minimum breaker.
- **215.4(A)(1)** (215.2(A)(1)) feeder conductors and **215.5** (215.3) feeder OCPD: same 125 percent rule.
- **300.19(A)** (300.17): fill "shall not exceed the allowable percentage fill specified in Chapter 9 Table 1" (40 percent for over 2 wires). Fill check with Chapter 9 Tables 4 and 5: 1/2 in. EMT $0.304 \text{ in}^2 \times 0.40 = 0.1216 \text{ in}^2 \div 0.0133 \text{ in}^2$ (#12 THHN) = 9.1, so 9 conductors, matching Annex C Table C.1; a 5#12 legend line is legal. 3/4 in. EMT $0.533 \times 0.40 = 0.2132 \div 0.0211$ (#10 THHN) = 10.1, so 10 conductors.
- **Table 310.15(C)(1)** adjustment: 4–6 current-carrying conductors 80 percent, 7–9 70 percent, 10–20 50 percent. Combining homeruns can force #10 wire.
- **Table 250.122** EGC: 15 A $\rightarrow$ 14 Cu, 20 A $\rightarrow$ 12 Cu, 60 A $\rightarrow$ 10 Cu, 100 A $\rightarrow$ 8 Cu. **250.122(D)** (250.122(B)): if ungrounded conductors are increased in size for any reason other than 310.15(B) or (C), wire-type EGCs "shall be increased in size proportionately." A feeder upsized for voltage drop needs an upsized EGC on the feeder schedule.
- **300.16(A)** (300.14): 6 in. of free conductor at each box • **314.16** box fill sets the box size in each assembly • **358.30(A)** EMT straps every 10 ft and within 3 ft of each box.
- Confirm the **scale** before measuring (Module 1.1), read the **specifications** as well as the drawings, and track **addenda** and **RFIs**.

Hands-On Field Exercise

- Before counting, make a sheet/revision/date list from the drawing index and fill out an FBE/IBE/FBO/IBO Scope of Work sheet.
- Take a small commercial plan and **count** every fixture, receptacle, and switch by symbol, color-coding as you go. Use counter clicks for single-poles and hash marks for 3-ways and multi-gang groups.
- Count the same sheet again in Bluebeam or STACK and compare the two counts. Explain every difference.
- **Measure** the feeder and two homeruns, adding the 3 ft slab turn-ups and the 6 ft homerun out of the slab.
- Recap one branch worksheet with the 15 percent wire factor and check one legend fill against Table C.1.
- Derive rings, boxes, and plates for your count using the worked example 3 method.
- Walk the full set, list every non-power scope item, and write a one-page scope letter with exclusions.
- Write two RFIs with sheet and section references.

Sources used in this module (public documents)

- Richard Jaffarian, Electrical Estimating Techniques, Electrical Resources, Inc.: electricalresources.com
- Don Kiper, "The Estimating Sequence," Parts 2 and 3 (2018), and "The Estimating Department Checkup," Part 3 (2019), EC&M: ecmweb.com
- Mike Holt, "Preparation: the key to a solid estimate," EC&M: ecmweb.com. Mike Holt, Understanding Electrical Estimating: mikeholt.com
- EC&M Estimating Tips e-book (December 2023): ecmweb.com
- Electrical Contractor magazine: "Know These Legal Obligations," "Estimating Blind," "How Long Should It Take?": ecmag.com
- Electrical Estimating 101, "The Scope Letter": electrical estimating101.com
- McCormick Systems, "Am I Missing Anything? An Estimating Checklist" (2026), and training manual assemblies: mccormicksys.com
- NECA Manual of Labor Units product page: necanet.org
- Red Rhino, Electrical Takeoff Software Workflow: hardhatis.com. "Scope Creep in Electrical Bids": thunderonthegulf.com
- NAVFAC P-405, Seabee Planner's and Estimator's Handbook, Chapter 2.
- Bluebeam support: Count tool, Visual Search, page scale, takeoffs and measurements: support.bluebeam.com. VDCI auto-count article: vdc.edu
- STACK support: Create Takeoffs, Takeoff Measurement Types: support.stackct.com
- PlanSwift (ConstructConnect) help: Count tool; setting and verifying page scale: help.constructconnect.com
- CSI MasterFormat Division 26 listings: arcat.com, sweets.construction.com; Western Michigan University Division 26 design guidelines: wmich.edu
- NFPA 70, National Electrical Code 2026 (free read-only access at nfpa.org): Article 100, 210.19, 210.20, 215.4, 215.5, 250.122, 300.16, 300.19, 310.15, 314.16, 358.30, Chapter 9, Annex C.

Next: Module 3.2 — Labor Units, Pricing & Bid Assembly.