

Battery Calculations — Step-by-Step Guide (Fire Alarm Systems)

Compliant with NFPA 72-2019 and NEC 2020 — verify adopted editions and AHJ amendments

Scope & Use

This guide shows how to size secondary (standby) batteries for protected premises fire alarm systems. It covers both non-audio (horn/strobe) systems and speaker/voice (EVACS/MNS) systems. Confirm your municipality's adopted editions; many jurisdictions using the 2021 I-Codes reference NFPA 72-2019 and NEC 2020.

Code Requirements — Duty Cycle & Method

- Baseline duty cycle (most systems): operate 24 h in standby (quiescent) + 5 min in alarm at maximum connected load. [NFPA 72-2019 §10.6.7.2.1]
- Voice/EVACS & in-building MNS: operate 24 h in standby + 15 min in alarm at maximum connected load. [§10.6.7.2.1.2, §10.6.7.2.1.7]
- Include only loads that are NOT automatically disconnected when on secondary power. [§10.6.7.2.2]
- Apply a safety margin of at least 20% to the calculated amp-hours. [§10.6.7.2.1.1]
- Chargers must restore batteries to full charge within 48 h after the required duty cycle discharge. [§10.6.10.3.2]
- Document battery capacity and de-rating in the submittals. [NFPA 72-2019 Chapter 7]

Step 1 — Gather Nameplate Data

- Control units and modules: FACU mainboard, SLC/NAC cards, network cards, annunciators, boosters (standby and alarm currents).
- Initiating devices that draw standby current: duct/beam detectors, relay bases, addressable modules, etc.
- Notification appliances (horns, horn/strobes, strobes): alarm current at selected candela.
- Audio equipment (for voice): amplifier standby current and alarm/input current at your speaker load; list speaker taps (W).
- Identify any outputs that drop on battery (e.g., door holders). These are excluded from secondary load.

Step 2 — Tally Standby and Alarm Currents

Define the currents for each power supply (FACU, NAC extender, audio PSU) separately:

- I_{sb} = total standby current (A) — everything energized during standby on batteries.
- I_{al} = total alarm current (A) — the load present during the alarm period (5 or 15 minutes).

Notes:

- Non-audio systems: NACs are ≈ 0 A in standby; in alarm add the sum of device currents on all active NACs at selected candela.
- Voice systems: Sum speaker tap watts by channel to determine delivered audio watts. Use manufacturer data for amplifier input alarm current. If not available, estimate $I_{amp,alarm} \approx W_{out} / (V_{bat} \times \eta)$, where $V_{bat} \approx 24$ Vdc and $\eta \approx 0.8-0.9$ for Class-D. Add strobes on NACs separately.

Step 3 — Compute Required Amp-Hours

Use the duty cycle hours:

- $t_{sb} = 24$ h (baseline)
- $t_{al} = 0.083$ h (5 min) for non-audio, or 0.25 h (15 min) for voice/EVACS

Formulas:

$$C_{base} = I_{sb} \times t_{sb} + I_{al} \times t_{al}$$

$$C_{req} = 1.2 \times C_{base} \quad (\text{apply } \geq 20\% \text{ code margin})$$

- Select the next standard battery size $\geq C_{req}$ (per supply).
- Verify the charger supports the chosen capacity and can recharge within 48 h (manufacturer limits may cap usable Ah).
- Consider temperature effects and aging; cold environments may require additional margin per manufacturer curves.

Step 4 — Worked Examples

1. Example A — Non-audio horn/strobe (single 24 V supply):

Standby: FACU 0.15 A + 50 SLC devices $\times 0.0003$ A = 0.015 A + LCD annunciator 0.04 A $\rightarrow I_{sb} = 0.205$ A.

Alarm: NAC strobes 12×0.085 A = 1.02 A; panel extra 0.25 A $\rightarrow I_{al} = 1.27$ A.

$C_{base} = 0.205 \times 24 + 1.27 \times 0.083 = 4.92 + 0.105 \approx 5.03$ Ah; $C_{req} = 1.2 \times 5.03 \approx 6.04$ Ah \rightarrow select 7 Ah.

2. Example B — Voice with strobes (separate NAC + 100 W audio amp):

Standby: FACU 0.15 A + SLC 0.015 A + amp standby 0.20 A $\rightarrow I_{sb} = 0.365$ A.

Alarm: Strobes (NAC) 0.90 A + panel 0.25 A + amp (100 W, $\eta \approx 0.85$) $\approx 100 / (24 \times 0.85) \approx 4.9$ A $\rightarrow I_{al} \approx 6.05$ A.

$C_{base} = 0.365 \times 24 + 6.05 \times 0.25 = 8.76 + 1.51 = 10.27$ Ah; $C_{req} = 1.2 \times 10.27 \approx 12.32$ Ah \rightarrow select 18 Ah (check charger limits).

Step 5 — Worksheets (Fill-In)

A) Battery Load Worksheet (per power supply):

Load Item	Qty	Standby (A)	Alarm (A)	Dropped on Battery?	Notes
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B) Speaker Tap Summary (per audio channel):

Channel/Zone	Speaker Qty	Tap (W)	Subtotal (W)	Notes
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Step 6 — Documentation & Acceptance

- Include calculations in submittals (NFPA 72 Chapter 7): list loads, duty cycle, totals (I_{sb} , I_{al}), C_{base} , margin, and selected battery size/model.
- Provide separate calculations for each FACU, NAC extender, and amplifier power supply.
- During acceptance (NFPA 72 Chapter 14), verify battery performance and charger restore time; record results.

Code Pointers (NFPA 72-2019 unless noted)

- §10.6.7.2.1 — 24 h + 5 min baseline duty cycle
- §10.6.7.2.1.1 — $\geq 20\%$ capacity margin
- §10.6.7.2.1.2 — EVACS 24 h + 15 min
- §10.6.7.2.1.7 — In-building MNS 24 h + 15 min
- §10.6.7.2.2 — Include only loads not dropped on transfer to secondary power
- §10.6.10.3.2 — 48 h recharge requirement
- Chapter 7 — Documentation content (include battery calcs)
- NEC 2020 Article 760 — Wiring methods; confirm charger and wiring ratings