	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 24 04 Panelboards
		Date: 9/01/24
		Author: Office of Facilities
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Change History


Date	Description of Change	Pages / Sections Modified	Change Approver Initials
9/01/24	Updated section on System Design and Performance Requirements, Product Standards, Manufacturers, Equipment, Installation Guidelines and Quality Control.	Complete Revision	BSS
9/26/17	Updated section on System Design and Performance Requirements <i>and</i> Manufacturers	2 – B. 6 (paragraph added); 2>3 – D.	SO
8/01/17	Updated section on Panelboard Designation Format <i>and</i> Identification requirements.	4 – 1. c. 4.; e. Remove f. 2. a	SO
6/15/16	Updated division section from 16422 to 26 24.04, removed references to other section numbers	-	mgl44
11/21/14	Add paragraph #2 to clarify power separation, sequence subparagraph numbering. Add text to paragraph #9 to clarify minimum rating.	15 – 16442 B. #2. (Panelboards; System Design and Performance Requirements)	SO
10/17/14	Add paragraphs #9. & #10. for clarification.	15 - 16442, B. #9 & #10., (Panelboards; System Design and Performance Requirements)	SO
10/17/14	Add text to subparagraph 2. a. for clarification.	18 – 16442. F. #2. a. Panelboards; Installation Guidelines; Identification	SO

A. Summary


This section contains design criteria for panelboards, including distribution panels and branch circuit panels.

B. System Design and Performance Requirements

- Where possible, provide separate panelboards to serve each of the following load classifications:
 - Lighting
 - Motors and general-use receptacles
 - Equipment requiring clean power
- Panelboard(s) should have a dedicated feeder from upstream distribution panel, panelboard, transformer or switchgear. Feeder taps, use of sub-feed or feed-through lugs as a means to serve panelboards is not a preferred method & will only be considered for special circumstances that are identified early in the design.


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3. Laboratory panelboards serving blocks of labs and distribution panelboards, sized 400A and larger, shall be equipped with a redundant main circuit breaker to be used temporarily to re-feed panelboard from another source with the intent to minimize power outages where shutdowns are needed for upstream electrical distribution equipment. Arrangements should be considered on a case-by-case basis with Yale Engineering and Operations as key stakeholders.
4. The design of panelboards fed from the secondary of a transformer shall consider incident energy as a factor to improve safety, where possible. As an example, it may be the case where the incident energy at the secondary of a 500kVA transformer could be significantly higher than the equivalent use of (4) 112.5kVA or (2) 225kVA transformers and associated panelboards. In this example, the preference is to keep incident energy at or below 8.0cal/cm² at electrical equipment and thereby, the use of multiple transformers may be justified. Other secondary factors that may justify segmentation of distribution system could include improved flexibility for maintenance and decreased downtime for planned shutdowns that would affect building occupants and critical building loads. Placement of a panelboard and the first main overcurrent protective device downstream of the secondary of a transformer should be evaluated with respect to incident energy at the equipment's location. It may be likely that a more robust safety benefit can be achieved when an enclosed circuit breaker is installed immediately downstream of a transformer secondary with the intent to limit incident energy at the panelboard located away from the enclosed circuit breaker.
5. Panelboards must be surface mounted in electrical closets, where electrical closets are available. Where electrical closets are not available, locate panelboards in mechanical rooms or other similar unfinished utility spaces where surface mounting is permissible. Do not install surface-mounted panelboards within janitorial closets or similar type spaces where the storage of material may impede access to electrical equipment. Installation of panelboards within IT spaces is generally not allowed; where unavoidable, installation shall be vetted with Yale IT department as a key stakeholder.
6. Selective coordination for panelboards shall abide by NEMA ABP1-2016, manufacturer's tables and 2023 NEC requirements. Fusible panelboards are generally not allowed in favor of panelboards equipped with molded case circuit breakers. Should fusible panelboards be found to be the only option to achieve selective coordination, the deviation should be identified to Yale Engineering

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early in the design phase. Panelboards that serve laboratory loads, other selected critical loads and/or industrial type processes at Power/Thermal/Chiller plants shall be selectively coordinated.

7. Feeders terminating to panelboard breaker frames rated 600A or higher shall be lashed with ½” sisal rope to improve integrity during short circuit conditions.
8. Panelboard main circuit breakers and other integral instrumentation located behind accessible compartment doors shall be equipped with finger safe features.
9. Door hinges must be piano type, double hinged, with a lockable latch.
10. Where electrical closets, mechanical rooms, or similar unfinished areas are not available and panelboards must be located in finished areas, flush-mount the panels in walls with all branch circuit conduits concealed within the walls. Provide spare two-inch conduit to a spare 12-inch by 12-inch junction box with hinged cover mounted in an accessible, concealed location.
11. The nameplate ampacity of panelboards must be a minimum of 125 percent of the connected load at nominal system voltage.
12. For coordination reasons, all main circuit breakers over 200 amps shall be equipped with electronic, adjustable long time, short time settings with time delays as well as instantaneous settings. Electronic trip units that rely on a minimum amount of current by way of integral current transformers shall not be used where metering is an added feature used by Yale Facilities; in these cases, the electronic trip units shall be provided with a built-in power supply to maintain signal integrity.
13. Panelboards rated at 100 amperes must contain minimum space for 30, single-pole circuits. Panelboards rated at 225 amperes must contain minimum space for 42, single-pole circuits. At a minimum, panelboards must contain available spare space that is equal to or greater than 25% of the actively used poles. Use of panelboards with space greater than 42 poles is generally prohibited.
14. Include in each panelboard a minimum of one spare, 20-ampere, 1-pole circuit breaker for every 750 square feet of floor area served by such panelboard. Certain occupancies, such as laboratories, must be provided with more spares as directed by the Yale University Project Manager.
15. Ensure that panelboard schedules shown on construction design documents include panelboard identification, location, breaker sizes, breaker special features

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(such as ground fault, SWD, HACR, LSIG, GFEP), load in volt-amperes for both new and existing circuits, NEMA rating, AIC rating, imbalance calculations in % from phase to phase, connected load, demand load and load descriptions. Design shall strive to limit imbalance between phases to 10% or below. Methodology for determining load calculation may be requested from time to time, depending on project scope and application.

16. Panelboards shall be fully rated for the short circuit current available at the main terminals. Minimum rating shall be 22 KAIC including all branch and/or feeder breakers. Available short circuit current at selected points shall be shown on One-Line Diagram(s) as part of design documents to demonstrate equipment is properly rated. Initial design can be based on transformer impedance and cable impedances immediately upstream; however, as design progresses available short circuit from either Yale's medium voltage system or the local utility's point of common coupling shall be used for construction document calculations.
17. All panelboards associated with emergency / alternate electrical systems shall be separated by a wall with a minimum of a 2 hour fire rating. All emergency / alternate panelboards, transformers, etc. shall be in a separate room from the normal power system.

C. Product Standards

Ensure that all products conform to the latest version of the following standards:

- NEMA PB1, Panelboards
- UL 50, Enclosures for Electrical Equipment
- UL 67, Standard for Panelboards
- NFPA 70, National Electrical Code
- ANSI/NETA ATS

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D. Manufacturers

Subject to compliance with the design requirements, provide products by one of the following manufacturers:

- ABB
- Eaton
- Square D

E. Equipment


1. Panelboards must include the following features:
 - a. A copper bus with a full-capacity neutral.
 - b. A copper ground bar. Panels on clean power systems shall include additional insulated/isolated ground bar.
 - c. A hinged cover with externally-accessible screws.
 - d. Bolt-on circuit breakers. Plugged-in type circuit breakers are not acceptable.
2. Load centers are not acceptable.
3. Panelboards must be fully bussed with mounting brackets for all positions, including spares.
4. Panelboards serving non-linear loads that comprise 40% or greater of the panelboard's total load shall be equipped with 200% rated neutral bus.
5. Panelboards shall be equipped with lockout hardware for all 3 phase loads, including main circuit breaker.
6. Distribution panelboards serving laboratory blocks shall be equipped with a power quality meter (Sq D type 5560) capable of capturing voltage sags and swells, as well as monitoring of harmonics.

F. Installation Guidelines

Where panelboards are flush-mounted in fire-rated walls, include installation details to maintain the fire resistance rating of the wall assembly.

1. Panelboard Designation Format

Panelboard designations must adhere to the following format, which provides identifiers for system type and panel location, separated by a slash (for example, HPP/3M1, ELP/B2, CP/1).

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- a. The first component of the system identifier must indicate the type of distribution system.
 - (1) For normal systems: no letter.
 - (2) For emergency/alternate systems, use the letter E.
- b. The second component of the system identifier must indicate the system voltage level.
 - (1) For systems of 120/208 and 240 volts and below: no letter.
 - (2) For systems of 480 volts, use the letter H.
- c. The third component of the system identifier must indicate the classification of loads served.
 - (1) For lighting, use the letters LP.
 - (2) For ordinary power, use the letters PP.
 - (3) For clean power, use the letters CP.
 - (4) For distribution power downstream from the main, use the letters DP.
- d. The first component of the location identifier must indicate the floor on which the panel is located.
 - (1) For sub-basements: use the letters SB.
 - (2) For basements: use the letter B.
 - (3) For numbered floors: use the floor number (for example, 1).
 - (4) For mezzanines: use the number of the floor number from which access is gained followed by the letter M (for example, 2M).
 - (5) For attics: use the letter A.
 - (6) For penthouses: use the letter P.
- e. The second component of the location identifier will indicate the next count of same panel type on that floor.


For sections of multiple panels on same floor. Examples:

480/277 Lighting Panels: HLP1-1, HLP1-2

120/208 Lighting Panels: LP1-1, LP1-2

480/277 Power Panels: HPP1-1, HPP1-2

120/208 Power Panels: PP1-1, PP1-2

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- f. The third component of the location identifier must indicate supplementary information, when applicable (for example, sections of multiple panels or the sequence of sub-panels).

For sections of multiple panels at the same location. Examples:

120/208 Lighting Panels: LP1-1A, LP1-1B, LP1-1C

- g. The Identifier of MDP shall be used for the main incoming panel only.

For the main panel in a building, the identifier is HMDP for normal service at 480 volts and EHMDP for alternate service at 480 volts. (maximum of one per building for each service)

2. Identification Requirements

- a. For the panel front, provide an engraved, phenolic nameplate indicating the panel designation. Nameplate shall be black background with white letters and attached to the panel with stainless steel screws, no adhesive.
- b. The directory must be typewritten and indicate circuit designations assigned in the panel schedule.
- c. Number all circuit wiring with preprinted, adhesive identification labels.

G. Quality Control

With all connected loads energized, measure the current in each phase and neutral of the panel feeder over the course of 24 hours sampled every 30 cycles, and submit the results to Yale University. Should imbalance be found to exceed 10% between phases, rearrangement of circuits will be required at no expense to the OWNER and repeat measurement of currents for one day to demonstrate reworked circuitry does not exceed 10% imbalance.

END OF SECTION