PAD-MOUNTED CAPACITOR BANKS
15kV •25 kV

Figure 1. *Exterior view of Federal Pacific Pad-Mounted Capacitor Bank. Pad-Mounted capacitor banks bring aesthetic view to field installations, eliminating clutter on overhead poles, while also making certain that components are not exposed to the environment.*

Pad-mounted capacitor banks with dead-front bushing wells for connection of entrance cables are available in ratings of 15kV and 25kV. Federal Pacific has the capability to build capacitor banks in a variety of configurations, but has developed the pad-mounted configuration for electric utility accounts. These pad-mounted capacitor banks have broad applicability throughout the industry, including non-utility facilities.

The capacitors are installed to boost the voltage back within the operating tolerance of the system and, thereby, provide voltage stability. Without capacitors, load circuits will operate at reduced voltage ... motors will run slower and overheat, lights will not burn as bright, relays in process industries will drop out, etc., creating end-user system disturbances.

Capacitors extend the range of substations by allowing feeder circuits to have longer runs of cable. Extending the range of substations also means that capacitors serve to increase network capacity. For individual customer facilities, it may be necessary or desirable to provide improved voltage regulation at the installation. For this purpose, on-site pad-mounted capacitor banks near customer loads provide power factor correction.

Figure 2. *Dead-front compartment with bushing wells to accommodate inserts and elbow connectors (not furnished) for cable entry. Units are furnished with clear polycarbonate barrier in dead-front compartment to permit viewing vacuum interrupter targets.*

Figure 3. *Live-front compartment of pad-mounted capacitor bank. Unit is shown with front barrier over fused voltage transformer and compartment front barriers removed. Red GPO-3 fiberglass barriers are standard. Optional clear polycarbonate barrier in live-front compartment, which provides enhanced visibility over standard red fiberglass barrier, are available.*

Federal Pacific pad-mounted capacitor banks have three (3) major advantages: voltage stability, increased network capacity, and power factor correction. These all combine to provide cost savings through lower system losses.

For application in the electric industry, individual capacitor units are rated in kvars (kilovars-amperes reactance) and are applied in banks called shunt- capacitor banks. For underground distribution systems, capacitor banks are installed in pad-mounted enclosures as small, distributed installations that are connected to main-primer feeder circuits at a considerable distance from the substation. These distributed banks can be fixed on the circuit or switched on and off as dictated for system stability.

A three-phase capacitor bank is arranged with one or more capacitors in each phase (called a leg) of the bank. Typical sizes for individual capacitors are 100 kvars, 200 kvars, and 300 kvars, up to 600 kvars. Units of less than 100 kvars are also available. If there is more than one capacitor in each leg, the capacitors are connected in parallel. For capacitors in parallel, the kvars add so that a bank with two (2) 200-kvar capacitors per phase would be a 1200 kvar bank.

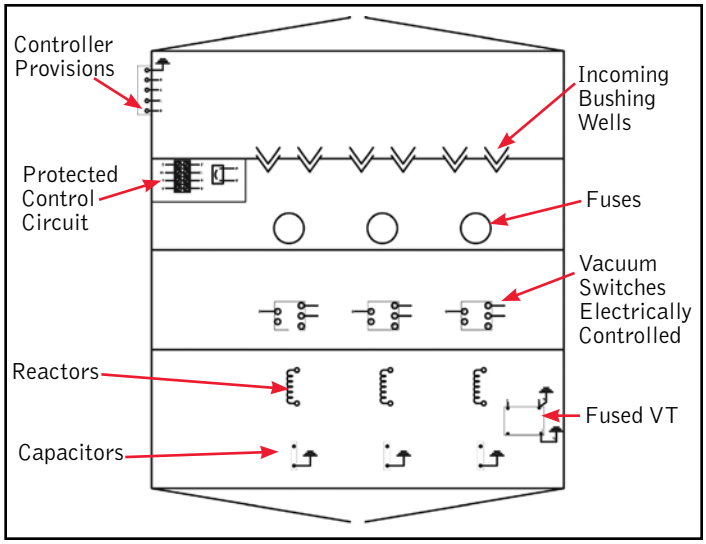

Figure 4. *Typical Physical Orientation Of Components Within The Pad-Mounted Capacitor Bank Is Illustrated In The Above Diagram. Other Configurations Are Available.*

Components & Application Data

Bushings and Bushing Wells: Federal Pacific provides cycloaliphatic epoxy bushings (600 amperes) or bushing wells (200 amperes) to all capacitor banks in order to supply input connections from the main-primary feeder to the pad-mounted capacitor bank. These connections can either be radial through a single three-phase set of connectors or looped through two (2) three-phase sets of connectors. Federal Pacific bushings and bushing wells are designed to ANSI 386 requirements and, therefore, accommodate all similarly designed load-break and non-loadbreak elbow connectors, components, and accessories. Load break elbows are not to be used for switching the capacitors.

Fuses: Federal Pacific provides fuses to pad-mounted capacitor banks in order to protect the circuit in the event of a fault in the bank. In the smaller pad-mounted capacitor banks, each leg is fused and the bank taken off-line when one capacitor fails because the over-voltage is too great on the remaining capacitors. Current-limiting fuses help to prevent capacitor case rupture.

Switches: Federal Pacific provides switches in each leg to take the bank on- or off-line. Capacitor switching is an extremely tough duty and switching can be frequent. The duty is severe because the rate of rise of recovery voltage during a switching operation is very steep, which can cause a re-strike if the dielectric is not adequate. Air is not typically used as the insulating medium for capacitor switches because the length of the air gap and the size of the switch has to be large to avoid a restrike.

The frequent switching requirement is best handled by a vacuum switch, which has very little wear on its contacts during switching. Insulating medium available for the vacuum interrupter includes oil, SF6 gas, and solid dielectric. Federal Pacific allows the customer to choose the brand of capacitor switch they prefer.

Inductive Reactors: Federal Pacific provides inductive reactors in capacitor banks in order to tame the capacitor switching duty by reducing switching in-rush surges and limiting the fault current. The reactors used in Federal Pacific's Pad-Mounted Capacitor Bank are made by the Federal Pacific Transformer Division, which has made inductive reactors for capacitor-bank applications for many years.

Control Components: Federal Pacific provides control components in order to supply control power, sensing, and the switching capability necessary to switch on-and off-line. A fused voltage transformer (1500va) is tapped to the high-voltage circuit and supplies control power for the pad-mounted capacitor bank. The secondary of the voltage transformer includes a low-voltage circuit breaker for switching and protecting the secondary circuit. Optionally, the transformer can be used to provide sensing voltage input proportional to the line voltage to a controller. The optional control (or controller socket) uses the input voltage as a measure of line voltage, which establishes whether the capacitor bank is to be switched on-or off-line. Such switching can be performed manually by locally using the handle on the capacitor switch, which is hookstick operable.

Switching can alternately be performed with the capacitor switch relayed for automatic switching, which will include a capacitor-trip device, and remotely when the customer provides appropriate communication components. All of these components can be arranged within a compact enclosure. The circuit diagrams for a few different pad-mounted capacitor banks are illustrated in Figure 5.

Pad-mounted capacitor banks have valued advantages for the underground distribution system:

1. They extend the ability of the power supply system to support longer lines to the load.
2. Growing systems into newer developments are more typically served underground and pad-mounted capacitor banks fit this growth segment.
3. The enclosed components offer a more aesthetic appearance than exposed overhead components, making them well suited for utility, industrial, commercial, and institutional installations.
4. The enclosure affords considerable protection from the environmental flora and fauna.
5. Access to components is easier to achieve at ground level than on a pole.
6. Component integration can be arranged in a fairly low-profile enclosure.
7. Underground circuits are less prone to storm damage.

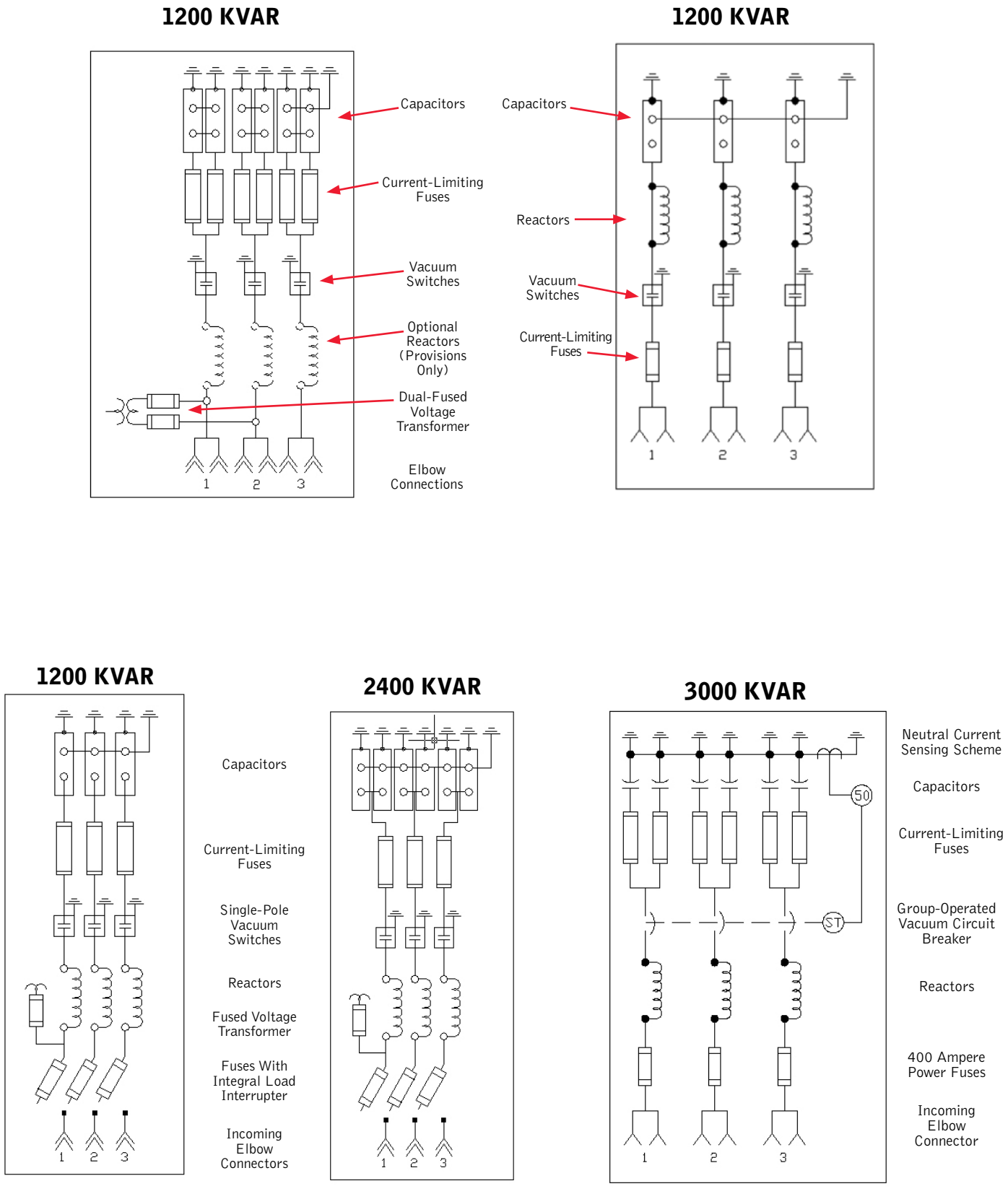

Figure 5. *The circuit diagrams for a few different pad-mounted capacitor banks are illustrated above. These illustrations show all the major components. Consult the factory for alternate designs.*

Dead-Front Compartment for Cable Entrance

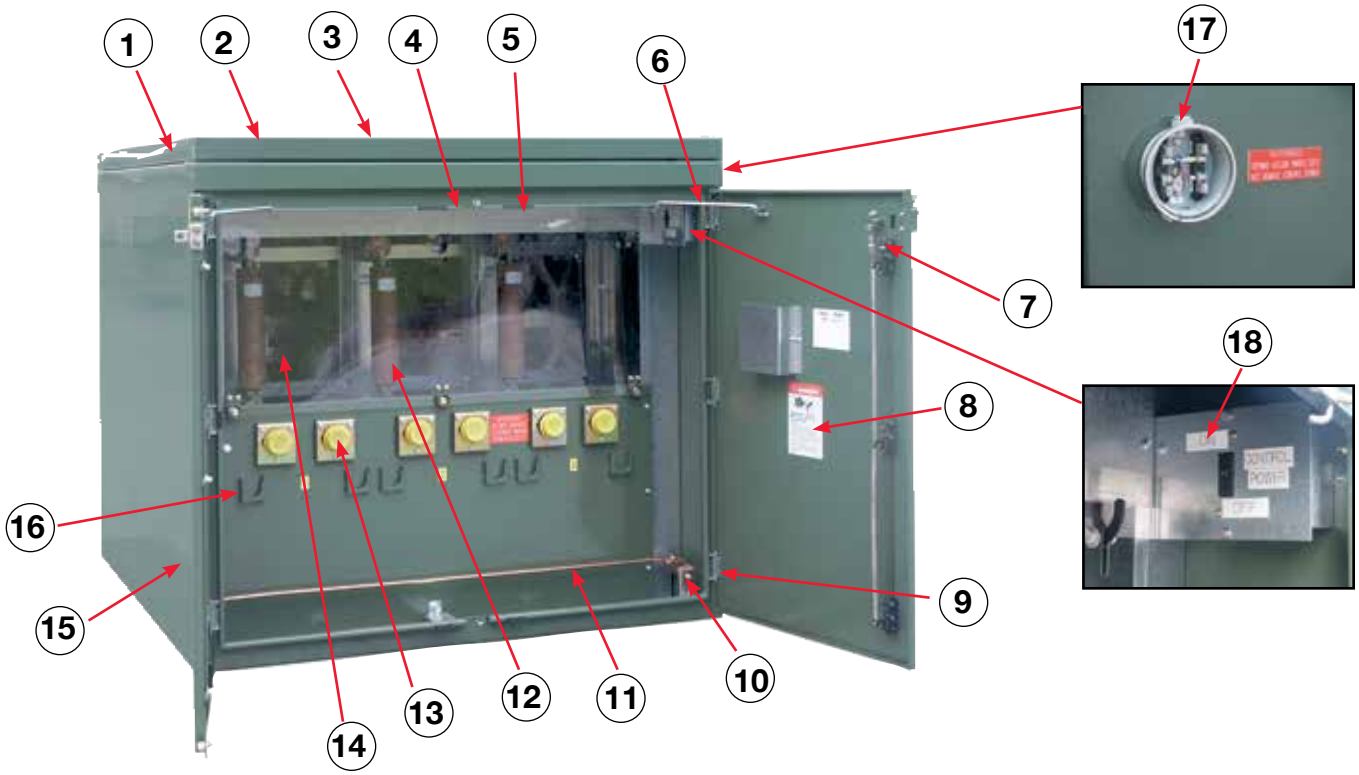

Figure 6. *Pad-Mounted Capacitor Bank — Features of the dead-front compartment.*

1. **Ventilated at Roof** — Interior ventilation maze helps keep interior dry.
2. **"No-Drip" Compound** – Coating insulates underside of roof to control moisture condensation.
3. **Cross Break on Roof** – Provides slope to roof to keep moisture from collecting on top.
4. **Ventilated at Doors** – Deep overlapping of doors with enclosure door-opening flanges develops a ventilation maze to increase air movement inside while restricting penetration.
5. **Gasket Bumpers** – Around door opening on flanges protect finish from metal-to-metal contact.
6. **Stainless-Steel Windbrace** – Secures doors open from wind-blown closure.
7. **Automatic Door Latches** – Self-latching, self-resetting three-point arrangement has no fast moving parts to snag personnel; automotive-type door latches pass severe test requirements. Moving parts, springs and bushings are stainless steel.
8. **Hazard Alerting Signs** – Necessary warnings are provided on long-life labels
9. **Stainless-Steel Hinges and Pins** – Ensure proper door operation without sticking.
10. **Enclosure Ground Pad** – In termination compartment, allows connection of concentric neutrals and enclosure ground rod.
11. **Ground Bus** – Round edge copper bus across full width of compartment allows connection of grounds.
12. **Current-Limiting Fuses** – Provide protection for capacitor bank.
13. **200-Ampere Bushing Wells** – Federal Pacific cycloaliphatic bushing wells meet ANSI 386 requirements; accommodates all brands of inserts and elbows – not to be operated when capacitor switch is closed.
14. **Removable Clear Polycarbonate Barrier** – Secured to enclosure with penta-head bolts; lifts off to provide access to fuses. Red GPO-3 insulating fiberglass barriers are standard.
15. **11-Gauge Steel Enclosure, Roof and Doors** — Provides exceptionally tough, electrically bonded, durable enclosure protecting components from vandals.
16. **Parking Stands** — Allow installation of standoff bushings to accommodate elbows removed from energized connector interface and are of stainless steel.
17. **Provisions for Controller** – Options available to provide mounting ring and controller (on side on enclosure) or housed within a low-voltage compartment.
18. **Control-Power Switch** – Option allows on/off control of power to mounting ring & controller.

Live-Front Compartment for Access to Components

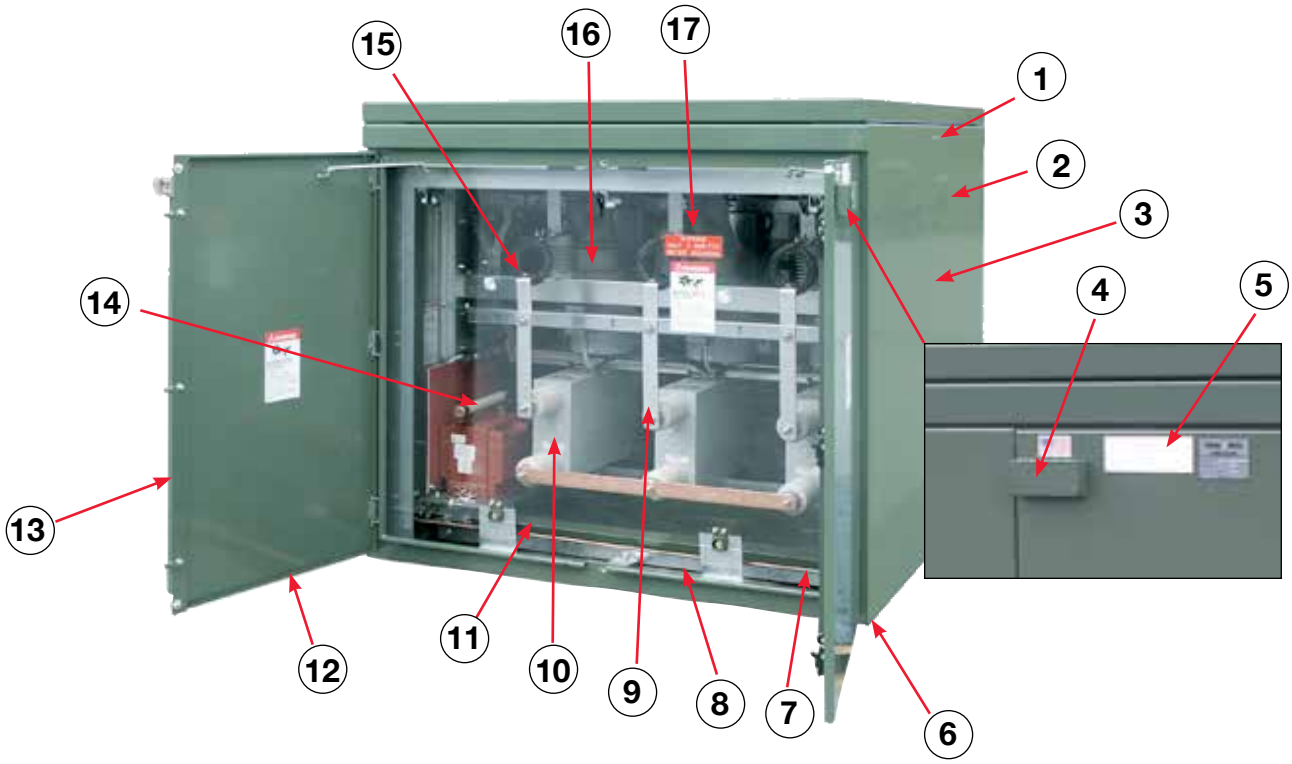

***Figure 7**. Pad-Mounted Capacitor Bank — Features of the live-front compartment.*

1. **Blind-Tapped Holes** – Provide secure location for lifting angles, which are backed with protective non-hygroscopic material to keep angles from scratching enclosure during handling and installation.
2. **Louvers** – Provide additional ventilation for enclosures in areas requiring increased air circulation.
3. **Enclosure & Finish** – Exceed security requirements in ANSI C57.12.28.
4. **Stainless-Steel Door Handle** – Hinged cover blocks access to penta-head bolt until padlock is removed.
5. **Nameplate & Signs** – Provide pertinent unit information and optional signs for customer designations.
6. **Gasketing on Flange** –At bottom of enclosure provides protection during installation; seals enclosure bottom to pad.
7. **Ground Bus** – Flat round-edge copper bus for enclosure ground full width of door opening.
8. **Galvanized Floor Plate** – Below essential areas provide further isolation from environment, but leaves openings at grounding areas.
9. **Aluminum Bus** – Provided as standard for interconnecting components; copper bus is optional.
10. **Capacitors** – Sized to meet bank requirements with copper bus interconnecting ground bushings.
11. **Containment Reservoir** – Collection pan for any liquid leaking from damaged capacitors.
12. **Passive Door** – Secured closed with penta-head bolts and is overlapped by active door.
13. **Finish** – Standard Color is Munsell No.7GY3.29/1.5 Dark Green (optional colors available).
14. **Fused Voltage Transformer** – Provides control power for switched-bank controllers and operation of capacitor switches.
15. **Reactors** – One per phase to limit in-rush currents and fault current.
16. **Capacitor Switch** – Single-pole manual switching or switched bank with controller for capacitor circuits.
17. **Removable Clear Polycarbonate Barrier (optional)** – Secured to enclosure with penta-head bolts; lifts off to provide access to capacitors and VT fuses. Red GPO-3 insulating fiberglass barriers are standard.

Optional Features

When ordering, specify optional features desired by adding individual suffix letter designations following the last digit of the catalog number of the unit specified developed using the chart of Catalog Number Designations in the "HOW TO ORDER" section on the next page.

For example, a 15kV 1200 kvar capacitor bank with 200-ampere bushing well for loop-through application using a solid-dielectric switch and NX current-limiting fuses, GE capacitors, a mounting ring for a controller and a copper bus instead of aluminum will have the designation: CB42 – 26U – NGYY2-C.

Barriers

B6 Clear polycarbonate barriers instead of red GPO-3 fiberglass.
B7 Hinged barriers instead of lift-off barriers on dead-front side.
B8 Hinged barriers instead of lift-off barriers on live-front side.

UNIT DIMENSIONS

kv Voltage	KVAR	Height	Width	Depth
15	150-1800	60"	64"	68"
	2400 and up	CONSULT FACTORY		
25	CONSULT FACTORY			

Special Finish Color & Materials

C All Copper Bus
F2 ANSI 61 Light Gray
F3 ANSI 70 Sky Gray
F5 Coal Tar coating on lower three inches of cabinet
F6 Type 304 Stainless-steel external surfaces (door, roof, and enclosure)
F7 Stainless-steel or non-ferrous hardware, including internal mounting angles, brackets, etc. and with three-point roller latch on door replacing automatic door-latch system.
F8 All stainless steel – Combines F6 and F7

Figure 8. *In this dead-front capacitor bank, the current-limiting fuses are visible through the optional clear polycarbonate barrier (suffix-B6).*

HOW TO ORDER:

Federal Pacific will develop 15kV and 25kV pad-mounted capacitor banks sized to 3600 kvars. The customer is to select (1) the desired components, choosing capacitors, bushings, bushing wells, current-limiting fuses, capacitor switch, reactor, choosing from the brands listed for each component, (2) the desired optional features from those listed and, (3) whether the bank is to be manual, switched or automatic. Consult factory for alternate designs and optional features.

Pad-Mounted Capacitor Bank Catalog Number Designations:

CB _ _ - _ _ _ - _ _ _ _ ←

Controller Required
Y1 - Yes, FP to provide Controller and Mounting Ring (Specify Controller Brand and Part Number in RFQ and Purchase Order)

Y2 - Yes, FP to provide Controller Mounting Ring Only (Specify Controller Mounting Ring Brand and Part Number in RFQ and Purchase Order) Controller by Others

0 - No controller required

Reactor Required
Y - Yes (Specify Reactor Size in Henrys in RFQ and Purchase Order)
N - No

Capacitor Brand (Specify Individual Capacitor Unit KVAR rating and Voltage in RFQ and Purchase Order)
A - ABB
C - Cooper
G - General Electric

Fuse Type
L - Cooper X-Limiter Current-Limiting Fuse (Specify Ampere Rating and Part Number in RFQ and Purchase Order)
N - Cooper NX Current-Limiting Fuse (Specify Ampere Rating and Part Number in RFQ and Purchase Order)
X - Other (Specify Brand, Rating and Part Number in RFQ and Purchase Order)

Switch Type
T - Oil Switch — Maysteel Trinetics
U - Solid-Dielectric Switch — Maysteel Ultra Vac
X - Other (Specify Brand, Rating and Part Number in RFQ and Purchase Order)

Quantity of Bushings or Bushing Wells
3 - Bushings or Bushing Wells for Radial-Tap Application
6 - Bushings or Bushing Wells for Loop-Through Application

Bushing or Bushing Well Ratings
2 - 200-Ampere Bushing Wells
6 - 600-Ampere Bushings

Total Bank KVAR
1 — 150
3 — 300
6 — 600
9 — 900
2 — 1200
5 — 1500
8 — 1800
4 — 2400
7 — 3600
8 — Other (Specify Actual KVAR rating as a dash number immediately following last number in catalog number — for example CB48-6DS-2110-450 for a 450 kvar capacitor bank)

4 — 15kV Class
5 — 25kV Class

CB - Capacitor Bank

Notes