



Medium Voltage Transformers

Selection Guide

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PRODUCT SCOPE



PAD MOUNTED
Class 7230

PAD MOUNTED transformers are best suited for commercial applications in public access areas and where underground service is required. Predominately designed as liquid-filled, but may be available as dry type depending on voltage ratings. ANSI Standards require each pad mounted transformer to be tamperproof. High and low voltage terminations are housed in two side-by-side cabinets.

Design Life

- 20 years*—compact, low-profile design and rectangular construction provide years of service.

Environmental Information

- Insulating fluid available from Square D in mineral oil, R-Temp® fluid, or silicone
- Sealed tank construction on fluid-filled units
- Special waste disposal considerations for fluid-filled units

Ratings and Configurations

- 75–5,000 kVA
- 2.5 to 34 kV primary
- 55°C, 55/65°C or 65°C Insulation Class
- Live or dead front
- Loop or radial-feed system

Cost of Ownership

- Low initial costs
- Cost associated with maintenance to ensure proper fluid levels on liquid-filled units
- Costs associated with fluid containment may be required, depending on rating
- Substantial decommissioning costs

For more information about pad mounted transformers, see Square D bulletins 43500-054-03, 0150SC9402, and MO2-R2.



SUBSTATION
Class 7240

SUBSTATION liquid-filled transformers are ideal for use in light-to-medium industrial applications. Station-type transformers can be applied as a stand-alone application, but are usually part of a substation lineup where transformers can be used between the high voltage and low voltage equipment.

Design Life

- 20 years*—standard rectangular construction optimizes the dielectric value of the insulating fluid.

Environmental Information

- Insulating fluid available from Square D in mineral oil, R-Temp® fluid, or silicone
- Sealed tank construction
- Suitable for some harsh environments
- Special waste disposal considerations for fluid-filled units

Ratings and Configurations

- 225–10,000 kVA
- 2.5 to 46 kV primary
- 55°C, 55/65°C or 65°C Insulation Class
- Live front, radial-feed system
- Cover or sidewall-mounted bushings

Cost of Ownership

- Low initial costs
- Cost associated with maintenance to ensure proper fluid levels
- Special protection usually required for installations that are indoor, on rooftops, or in close proximity to buildings
- Substantial decommissioning costs

For more information about substation transformers, see Square D bulletin 43500-054-04.



NETWORK
Class 7270

NETWORK transformers are designed specifically for use in network configurations that supply critical power to utility grid systems.

Design Life

- 20 years*—electrically and mechanically designed to meet the special demands of a network grid. Considered to be the most reliable distribution system available.
- Designed according to ANSI standards

Environmental Information

- Insulating fluid available from Square D in mineral oil or silicone.
- Sealed tank construction
- Special waste disposal considerations for fluid-filled units

Ratings

- 300–2,500 kVA
- 2.5 to 15 kV primary

Cost of Ownership

- Significant installation costs
- Generally the most costly to install and maintain
- Cost associated with maintenance to ensure proper fluid levels on liquid-filled units
- Substantial decommissioning costs

For more information about network transformers, see Square D bulletin 43500-054-07.

* Design life is a function of operating conditions and maintenance. This does not constitute any expressed or implied warranty.



POWER-DRY™
Class 7420



UNI-CAST™
Class 7320



POWER-CAST®
Class 7310

POWER-DRY dry type transformers meet requirements for commercial applications such as light industrial, multiple-floor buildings and rooftop installations. The coils of POWER-DRY transformers are impregnated using a vacuum pressure impregnation process (VPI). POWER-DRY transformers can be found in stand-alone applications, but more commonly are part of a substation lineup between the high voltage and low voltage equipment.

Design Life

- 20 years*—compact, barrel-wound rectangular winding construction for long service life. Circular windings for higher basic impulse level (BIL) ratings.

Environmental Information

- Intended for relatively clean environments
- No fluids translates to low fire risks
- No special waste disposal considerations
- Excellent replacement for PCB-filled and gas-filled transformers
- Most of the transformer can be recycled

Ratings

- 75–1333 kVA single-phase
- 225–5,000 kVA three-phase
- 2.5 to 25 kV primary
- 220°C insulation temperature limit
- Fan cooling for short-term overloads

Cost of Ownership

- Low initial costs
- Limited maintenance

For more information about POWER-DRY dry type transformers, see Square D Bulletins 7420BR9301, 1050SC9402, 7300PD9203, 43006-851-01, and D1-N.

UNI-CAST transformers are best suited for light-to-medium industries such as food and beverage, high-technology, pharmaceuticals, and pulp and paper. UNI-CAST transformers combine the best of cast coil construction with POWER-DRY engineering. The primary coil is manufactured with the same casting technique as the POWER-CAST transformer. The sheet-wound secondary coil is encapsulated and impregnated using the VPI technology of the POWER-DRY transformer. An epoxy compound encapsulates the coil end of the UNI-CAST transformer.

Design Life

- 30 years*—cast coil primary winding construction provides long-lasting durability. Circular windings infused with epoxy improve short circuit strength.

Environmental Information

- Intended for relatively clean environments, but can be used in some harsher environments
- No fluids translates to low fire risks
- No special waste disposal considerations
- Excellent replacement for PCB-filled transformers
- No special decommissioning costs

Ratings

- 500–3,750 kVA (fan cooling allows higher kVA ratings)
- 2.5 to 35 kV primary
- 185°C insulation temperature limit
- Fan cooling for short-term overloads

Cost of Ownership

- Moderate cost when long life expectancy is considered
- Virtually maintenance free

For more information about UNI-CAST transformers, see Square D bulletins 7320BR9301, 1050SC9402, 7300PD9203, and 43006-054-09.

POWER-CAST transformers provide the rugged durability needed for harsh environments where chemical fumes, dust, or vibration may be present in industries such as automotive, chemical, and rapid transit. The windings of POWER-CAST transformers are completely impregnated and cast in individual molds using unfilled epoxy resin. The unfilled resin, combined with fiberglass mat, forms the solid dielectric.

Design Life

- 40 years*—cast coil construction coupled with standard copper windings provides long-lasting durability. Cast primary and secondary windings are designed with superior mechanical reinforcement throughout the full length of the coils.

Environmental Information

- Intended for the harshest environments where long-term dependability is a must
- No fluids translates to low fire risks
- No special waste disposal considerations
- Excellent replacement for PCB-filled transformers
- No special decommissioning costs

Ratings

- 500–10,000 kVA
- 2.5 to 46 kV primary
- 185°C insulation temperature limit
- 50% overload available with most ratings on transformers

Cost of Ownership

- Investment in reliability lowers the overall cost over its long life span
- Virtually maintenance free

For more information about POWER-CAST transformers, see Square D bulletins 7310BR9301, 1050SC9402, 7300PD9203, 43006-054-01.

* Design life is a function of operating conditions and maintenance. This does not constitute any expressed or implied warranty.

TOPICS TO CONSIDER WHEN SELECTING A TRANSFORMER

In the early 1900s, liquid-filled transformers were the industry standard. Despite the variety of applications, they were the only transformer type available. Today, manufacturers offer alternatives, designing liquid-filled or dry type transformers to serve *specific* applications. Although virtually any transformer can be used in any application, some transformers are simply better because they are designed specifically for the application.

The transformer's application, how and where the transformer will be used, significantly influences the selection. Local codes also impact the selection. Yet, even when the application is known, there is no easy selection formula. Selection becomes a matter of making the best choice from many options. Knowing all of the selection criteria can lead to the optimum transformer for the job.

SELECTION CRITERIA

Selection criteria can be broken down into four main parts.

- **Installation Site** is the first consideration when selecting a transformer. Determining where the transformer will be used is the first step that leads to narrowing the selection.
- **Transformer Use** covers how the transformer will be applied. Making application decisions can better define the type of transformer needed.
- **Transformer Capabilities** includes transformer ratings and electrical and mechanical capabilities that will be necessary for a particular transformer to handle the load.
- **Costs** provides information about hidden cost that can influence the section and purchasing decision.

When all of this information is factored together, it may help define which transformer is more appropriate for an application. Not all selection criteria apply to every application, but these sections provide a comprehensive list of topics that may influence selection of one transformer over another.

The topics and transformer types are represented in Table 1, on page 5. The transformer type is compared according to how well the transformer rates in regard to the topic. Each topic in this table is discussed in more detail in the sections that follow. If more information is required, contact the Square D Medium Voltage Transformer Product Management Group, Monroe, NC.

- **Installation Flexibility.** The installation site is always one of the first

Table 1: Topics to Consider for Medium and Small Power Transformers

Application Consideration	Liquid-Filled			Dry Type		
	Oil	R-Temp	Silicone	VPI	UNI-CAST®	POWER-CAST®
INSTALLATION SITE						
Installation flexibility	1	2	2	3	4	BEST
Ambient conditions	4	4	4	3	4	BEST
Environmental safety	1	1	1	BEST	4	4
Flammability	1	3	3	4	4	BEST
Public access restrictions	4	4	4	3	3	3
Low liability insurance	1	2	2	3	4	BEST
TRANSFORMER CAPABILITIES						
Electrical Capability						
Short-term thermal overload	3	3	3	4	4	BEST
Short-circuit strength	2	2	2	4	4	BEST
Partial discharge	N/A	N/A	N/A	3	BEST	BEST
Mechanical Capability						
Immediate start up	3	3	3	3	4	BEST
Impact loading	2	2	2	2	4	BEST
Impulse strength	2	2	2	3	4	BEST
Transient voltage strength	3	3	3	4	4	BEST
Size (weight & dimensions) ^①	BEST	4	4	3	3	3
COSTS						
Low initial purchase cost	BEST	3	3	BEST	2	1
Hidden cost	1	1	1	4	BEST	BEST
Low site preparation costs	1	1	1	4	BEST	BEST
Low maintenance costs	1	1	1	4	BEST	BEST
Clean up	2	1	1	BEST	BEST	BEST
Design life	2	2	2	3	4	BEST
High efficiency	4	4	4	3	4	BEST
High reliability	2	2	2	3	4	BEST
Decommission costs	1	1	1	4	4	BEST

Legend 1 ➡ 2 ➡ 3 ➡ 4 ➡ BEST

BEST transformer choice for this subject.

1 indicates the least beneficial transformer selection for this subject.

① Smaller is best.

INSTALLATION SITE

The location and environment where the transformer will be installed is a major concern and may limit the type of the transformer that can be used. Table 2 shows which transformers are better suited for a particular location. Following Table 2 is a list of considerations that apply to where the transformer will be located.

Table 2: Preferred Transformer Selection by Installation Site

Site Location	Transformer Product Scope						
	Liquid-Filled			Dry Type		Cast Coil	
	Pad Mounted	Substation Type	Network	Pad Mounted	POWER-DRY Substation Type	UNI-CAST	POWER-CAST
Indoor (secured)	X	●	●	○	●	●	●
Outdoor							
Secured	○	●	X	○	●	●	●
Unsecured (tamperproof)	●	X	X	●	○	X	X
Rooftop	●	●	X	○	○	○	●
Industrial							
Utility drop (substations)	X	●	X	○	○	○	○
Distribution	X	●	X	X	○	●	●
Residential neighborhood	●	X	X	X	X	X	X
Commercial building							
Apartment complex	●	X	X	○	○	X	X
Shopping centers	●	X	X	●	●	○	○
Institutional buildings (hospitals, schools, restaurant)	●	X	X	○	○	○	●
Government	●	●	●	○	○	○	●

Legend ● Preferred for this application ○ Optional for this application X Not likely for this application

considerations. Square D dry type and cast coil transformers are the most versatile of any transformer available on the market today. Square D dry type transformers have the potential to be installed in virtually any application or environment. Because dry types do not contain fluid, they eliminate the concern for spilling or leaking fluid and reduce other risks associated with liquid-filled transformers. When compared to dry type electrical equipment, liquid-filled transformers may also be subject to more regulations or local codes. Using liquid-filled transformers to meet these regulations or codes could add to the overall cost of the project. Those costs might be avoided if dry type or cast coil transformers are selected.

- **Ambient Conditions.** The atmospheric conditions in which a transformer will operate may influence transformer selection. Whether it will be located indoors, outdoors, or exposed to air-borne contaminants, are a few examples that may help to determine which transformer is better suited for the application. An outdoor installation in a substation lineup may be best filled by a liquid-filled transformer, while a POWER-DRY dry type transformer may be a better solution in clean, indoor, secure environments. A cast coil transformer may be the best choice in a harsh environment. The smooth surfaces of the cast coil have less crevices and ledges where dust, dirt, or other contaminants can collect. The windings are protected from the negative affects of moisture and other air-borne contaminants.
- **Environmental Safety.** As environmental concerns increase, environmental

safety regulations become part of the transformer selection process. Wherever a potential for contaminating the environment exists, the best choice is a dry type transformer. Because they contain no fluids, dry type transformers can be placed near lakes or rivers, near sensitive nature areas, or within or in close proximity to occupied buildings. To avoid the liability of a potentially hazardous fluid spill or expensive cleanup, select dry type transformers.

- **Flammability.** Catastrophic failure can be a concern with liquid-filled transformers. Most often, transformers are applied outdoors away from buildings, but if located within buildings or on rooftops, they usually need special drainage or dikes for containing potential leaks. Some fluids have high flashpoints. Square D is the only company that offers three fluid types: oil, R-Temp[®] and silicone. For indoor installations, any of the Square D dry type transformers may be better suited, because dry type transformers may not require special fireproof vaults, sprinkler systems, or other expensive fire protection systems. If the cast coils are subjected to an electric arc or ignited with an external direct flame, the coils will self-extinguish once the ignition source is removed.
- **Public Access Restrictions.** If the transformer is to be installed in a public area, industry standards define the type of security for a particular transformer. If liquid-filled pad mounted transformers are used, ANSI C57.12.28 states that the transformers must be tamperproof. If any other transformers are applied, they are not required to be tamperproof, but must be in a secured location that is isolated from the public. Local standards or codes may also set limits on public protection. Reviewing and complying with all applicable standards is necessary.
- **Insurance/Liability.** Most insurance companies recognize that dry type transformers have lower liability because they contain no fluids. The advantage of the Square D dry type or cast coil transformer is that the transformer or substation can easily be placed within the facility, closer to the load. Locating it closer to the load reduces energy losses. The location of a transformer is usually regulated by local standards and codes for electrical, safety, or fire prevention and protection. For example, the codes may dictate the proximity of the transformer to a building or state the location and provisions required for indoor installations. If a liquid-filled transformer is to be located in or near a building, a fluid with low flammability may be required. However, if a project uses *only* dry type transformers, insurance costs may be reduced, giving added incentive to specify dry type transformers.

TRANSFORMER USE

See *Medium Voltage Transformers Specification Guide No. 0150SC9402* for detailed specifications.

See *Liquid-Filled Pad Mounted Transformers No. MOD-7* for details on loop and radial systems

To specify the correct transformer, analyze how the transformer will be used. Answers to the following questions can help in selecting the most practical transformer for the application.

1. Is the transformer single-phase or 3-phase?

Most transformers are classified as single-phase or 3-phase (one- or 3-wire). Square D has a broad scope of 3-phase transformers, but has a limited offering for single-phase. In single-phase substations and station type transformers, Square D offers ranges of 75–3,500 kVA.

2. How will the transformer be connected?

- Underground power lines to the transformer require a cabinet, compartment, or air terminal chamber to protect individuals from accidental contact with energized parts or components. In most cases, pad mounted transformers are used for this application. By definition, only the pad mounted transformer includes a tamperproof compartment, which restricts unauthorized contact or tampering with connections. Substations can also be applied where the incoming service is underground. Adding air terminal chambers to the transformer provides a barrier against accidental contact. The chambers are not tamperproof and require additional security.
- Overhead, incoming lines to the transformer are relatively easy to connect, but usually require cover mounted bushings. When a substation transformer is part of a substation lineup, the transformer usually has sidewall mounted bushings that are connected on each side to the coordinated high voltage and low voltage gear.
- Combination underground and overhead power on any type of transformer is possible, but additional coordination between the equipment is necessary.
- Dead-front or live-front. Most often, pad mounted transformers are specified as dead-front transformers, which have no exposed, live parts in the primary compartment. Live-front transformers have exposed, live parts.

3. What is the configuration of the system?

Transformer selection also depends on the system configuration. The system can be designed in three ways:

- Loop systems. Only liquid-filled or dry type pad mounted transformers, can be connected in a loop-feed configuration. A transformer designed for a loop-feed application has six high voltage bushings. Two bushings for each phase (H1A, H2A, H3A, and H1B, H2B, H3B). This enables all transformers on a circuit to be connected in a loop configuration. On wye and grounded-wye connected transformers, an H0 or H0X0 bushing is normally used.
- Radial systems. Any transformer can be applied in a radial system including pad mounted, station type, substation, liquid filled or dry type. Radial-feed transformers have three high-voltage bushings (H1, H2, H3). Each phase has one bushing for each of the incoming high voltage cables.
- Network systems. Only network transformers are designed for use in network systems. Network configurations are usually installed in larger cities or in government projects where the load is extremely critical. To maintain constant service, multiple network transformers are interconnected into a parallel network system that forms a grid pattern. Each network transformer has a primary grounding switch. This grounds the primary winding when the transformer is disconnected from the circuit. If a fault occurs in any circuit, the secondary network protector isolates the offending circuit from the other circuits in the network. The network grid system is widely believed to be the most reliable, but is also the most expensive.

TRANSFORMER
CAPABILITIES

The capabilities of a transformer include ratings, electrical, and mechanical.

Ratings

Voltage ratings available for the Square D transformer product scope are shown in Table 3 below. Square D offers a broad range of liquid-filled and dry type transformers; however, some ratings and voltages may not be available for some transformer types.

Table 3: Voltage Ratings for Transformer Product Scope

Transformer Type		Primary Voltage — Basic Impulse Levels (BIL)				
		5 kV 60 kV BIL	15 kV 95 kV BIL	25 kV 125 kV BIL	34 kV 150 or 200 kV BIL	46 kV 250 kV BIL
		kVA Rating				
Liquid-Filled ^①	Pad Mounted	75–5,000	75–5,000	75–5,000	225–5,000	750–5,000
	Substation ^②	225–10,000	225–10,000	225–10,000	225–10,000	750–10,000
	Network	300–2,500	300–2,500			
VPI Dry Type	Pad Mounted	Winding Temp. Rise				
		80°C	75–750	75–750		
		115°C	75–750	75–750		
	Substation ^② POWER-DRY	80°C	75–5,000	75–3,000	1,000–3,000	
		115°C	75–5,000	75–3,750	1,000–3,000	
		150°C	75–5,000	75–5,000	100–3,000	
Cast Coil	UNI-CAST	80°C	500–3,000	500–3,750		
		100°C	500–3,000	500–3,750		
	POWER-CAST	80°C	500–10,000	500–10,000	500–10,000	500–10,000

① Liquid-filled available with mineral oil, silicone, or R-Temp fluid.

② Substation includes primary and secondary unit substations and stand-alone station-type, small power transformers.

Electrical Capability

In many applications, transformers may be subjected to potentially catastrophic conditions. When selecting a transformer, consider whether the transformer will be able to operate under “worst-case” conditions. Most industrial and many commercial and institutional applications need the transformer to operate in adverse electrical conditions. Although the transformer industry has common standards, such as NEMA and ANSI, the electrical capability of a transformer is the result of the individual design practices of the manufacturer. The following list outlines many of the electrical conditions common in commercial and industrial applications.

- **Short-Term Thermal Overload.** Short-term and sudden thermal overloads can occur in almost every installation, but may occur most often in industrial applications. All Square D transformers are designed and built to meet or exceed industry standards for short-term thermal overload. However, if frequent short-term overload is a concern, the POWER-CAST transformer exceeds the overload capability of liquid-filled units and may be the better choice for this situation. The POWER-CAST transformer operates at low current densities. Its long time-constant provides greater capability to withstand sudden, momentary high overloads.

Electrical Capability (cont)

- **Short-Circuit Strength.** The transformer's ability to withstand short-circuit forces is critical to the life of the transformer. These forces can be found in any application and, in some cases, can be a chronic occurrence. To obtain outstanding mechanical and dielectric strength, only the epoxy impregnated, fiberglass construction found in the Square D cast coil design can produce a solid dielectric system. A unique feature of the POWER-CAST transformer is that both the primary and secondary coils are wound using the same conductor materials and coil-winding specifications. *Both* coils are vacuum cast in separate molds in pure, unfilled epoxy. The epoxy penetrates through the Nomex and fiberglass, completely encasing the copper wire. This design ensures that the coils cannot be distorted during power surges or secondary line faults.
- **Partial Discharge.** Partial discharge is gas ionization that occurs in the insulating material of dry type transformers. The partial discharge test measures the transfer of energy in picocoulombs from one potential to the other, which in the case of cast coils would be turn-to-turn or layer-to-layer. If partial discharge is detected, it indicates a void in the insulation. Voids can eventually deteriorate the dielectric system, contributing to early transformer malfunction. The Square D cast coil design and construction process provides protection against partial discharge. During the casting process, while under vacuum, pure unfilled epoxy is introduced into the windings. The layers of absorbent fiberglass cloth are fully impregnated with epoxy resin to ensure a winding that is free from partial discharge. At the Square D Monroe facility, Square D performs the partial discharge tests and guarantees every high voltage coil to be free of partial discharge at 120 percent of rated voltage.

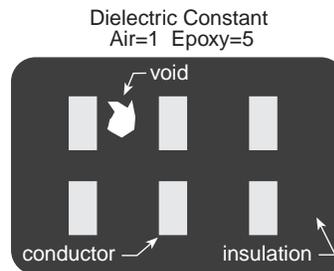


Figure 1: Void in dielectric system

Mechanical Capability

- **Immediate Start Up.** The ability to energize without incident at full rated load from a cold start is always a concern. Before any liquid-filled transformer can be put into service, a dielectric fluid test should be performed to verify the integrity of the insulation system. Before any conventional dry type transformer can be energized, it may require predrying or a slow staggered application of power. These additional procedures, add extra costs to the transformer and project. Only POWER-CAST transformers can be installed at an ambient temperature as low as -50°C and be powered up immediately. No extra time is need for drying, which eliminates nonproductive time waiting for a transformer to dry. Also, moisture absorption is a concern if the transformer has been out of service for any length of time. POWER-CAST transformers require no predrying because the insulating materials are non-hygroscopic. The transformer can be immediately switched on, avoiding the expense of equipment for drying and the supporting labor.

- **Impact Loading.** Unusually-high impact loads are rare, but they do occur in applications such as mass transit or pulp and paper mill power systems. To ensure that a transformer can handle the extreme forces of high-impact loading, only POWER-CAST transformers should be specified. The cast coil transformer windings are fully braced and imbedded in rock-solid cast epoxy resin that diffuses the load and evenly distributes it over the whole coil.
- **Impulse and Transient Voltage Strength.** Evidence has shown that switching surges, lightning, or other voltage transients conditions cause most coil failures in transformers. Under these conditions, cast coil windings handle voltage distribution better than any other design. Figure 2 shows how the typical Square D cast coil design distributes voltages surges uniformly between all turns of the high voltage winding, allowing the transformer to more reliably withstand these transients.
- **Size (weights and dimensions).** Size and weight restrictions influence the design of any transformer and may limit the type of transformer that can be applied. Square D can design transformers to fit within most limitations. Dry type transformer are especially versatile. In fact, most Square D dry type transformers can be designed with special enclosures with high voltage and low voltage terminations on the front and rear. This allows the transformer to be rotated 90° so that it can replace a liquid-filled transformers or be placed in areas with severely limited space.

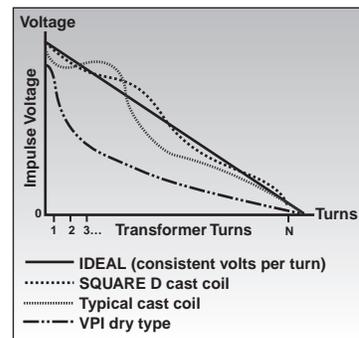


Figure 2: Comparison of voltage distribution

COSTS

Every customer and manufacturer recognizes that cost is one of the predominant issues. If cost is the *only* issue, oil-filled transformers are the most logical selection because they have the lowest initial cost. When the price of a transformer overrides all other factors, Square D offers more low-cost liquid-filled transformer options than any other transformer manufacturer. Only Square D directly manufactures pad mounted, substation, and network type transformers that can be filled with mineral oil, silicone, or R-Temp fluid.

However, other issues affecting cost during the transformer lifetime should not be overlooked. Site preparation, maintenance, clean up, design life, efficiency, reliability, and decommissioning are among the issues that can add to installation and overall cost. When the total cost of oil-filled and dry type transformers are compared, dry type transformers have proven to be more versatile and less costly to install, operate, maintain, and dispose of. These factors often outweigh any initial cost premiums of dry type transformers.

Initial Costs

Before considering long-term costs that are sometimes hidden, examine the initial costs that appear up front. When the only factor for selecting a transformer is low initial cost, then the best choice is limited to an oil-filled pad mounted or substation transformer. Figure 3 shows the initial cost differences among transformers. However, choosing a transformer using only this narrow criteria may not buy savings in the long term. Looming in the future are possible government or industry standards that may require additional safety precautions. Although these transformers are non-hazardous today, tightening of environmental requirements is always a possibility.

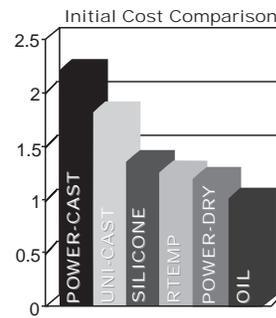


Figure 3: Comparison of initial purchase price of a transformer

Hidden Costs

Hidden expenses, which may influence transformer selection, add to the total cost of a transformer. For example, oil-filled transformers may need special site preparation for public safety or eye appeal. Provisions to contain fluid, such as curbing or catch pits, are usually required by local codes or federal standards. These costs increase the planning and expense of an entire project. Some of the less obvious considerations are discussed in detail below. Before making a selection based on the price alone, compare the total cost of installation and ownership of liquid and dry type transformers.

- Site Preparation Cost.** Transformer installations may be subject to state, local, and industry regulations or guidelines that cover fire protection, public access, or public safety. In addition, special construction precautions may be required for liquid-filled transformers. For example, cement block rooms, special curbing, catch pits and special pumps may be required to handle the possibility of spilled or burning fluid. Because dry type transformers contain no fluid, the costs to prepare a site may be substantially lower when compared to liquid-filled units.
- Maintenance Costs.** Liquid-filled transformers need regular liquid level gauge checks, dielectric tests, or other tests to confirm the integrity of the fluid. Dry type transformers, on the other hand, do not have added maintenance cost. They are easily maintained in clean environments with no fluid or gauges to continually monitor. When maintenance is required, door handles and removable panels on Square D transformers allow quick access into the enclosure. Less maintenance, may reduce the number of maintenance engineers necessary, which saves time and money and limits downtime. Although all Square D dry type transformers are easier to maintain than liquid-filled transformers, POWER-CAST transformers have the most maintenance advantages. POWER-CAST transformers do not require special tools, equipment, or additional precautions normally needed for liquid-filled transformers. Any off-line maintenance can be performed in open air. Both the high and low voltage coils of the POWER-CAST transformer are cast in epoxy and are 100 percent non-hygroscopic. If the coils need cleaning, many customers

de-energized the transformer and simply wash the coils with water, because water does not penetrate the coils. More traditional cleaning methods can also be used such as vacuuming or blowing with compressed air.

- **Clean Up.** A leak or spill from a liquid-filled transformer before, during, or after initial installation, can be expensive and time consuming. This is true even though the Environmental Protection Agency (EPA) considers the fluids to be nonhazardous. The Oil Pollution Act of 1990, more specifically, regulation 40 CFR 110, deals with discharge of oil. Square D and most transformer manufacturers use mineral oil, Silicone 561[®] and R-Temp fluids. Square D dry type transformers do not contain fluid. The absence of fluid eliminates any chance for added expense and time delays that might be caused by government-witnessed oil spill cleanup.
- **Design Life.** Expected design life can influence initial cost if one transformer is designed to last longer than another. The design life for a POWER-CAST transformer is longer than the design life of a liquid-filled transformer.^① In addition to the possibility of delaying capital expense for a replacement transformer, a POWER-CAST transformer with a longer design life may also reduce facility down time, which is required for change out and retrofit of the transformer.
- **Efficiency.** The cost of transformer operation, such as no load and load energy losses, may influence the type of transformer specified. The price of electricity and the load demand profile can also affect overall costs. Currently, users are driving a move toward more energy-efficient transformers. Pending federal guidelines that will regulate energy efficiency may soon be law. Identifying this as a requirement now might eliminate the need to replace or upgrade a transformer in the near future. Copper-wound transformers with an 80°C temperature rise tend to have lower losses and higher operating efficiency than transformers with aluminum windings. Because copper-wound transformers are more efficient, their operating costs are generally lower.
- **Reliability.** Reliability relates to a number of concerns. Lost production time, damage to the product being manufactured, damage to the electrical equipment or system, or worse yet, no power in critical situations are concerns that mean money. Also, consider repairs and the frequency of transformer replacement when calculating costs. The reliability of the Square D dry type transformer is attributed to a combination of quality materials and intelligent design. Square D medium voltage transformers are manufactured in a facility that is Quality Systems Registered by Underwriters Laboratories to ISO 9001. POWER-CAST transformers are constructed with a solid dielectric system. After being cast and tested, this inherently stable system is less subject to thermal and age deterioration than those constructed with thin sheets of paper or liquid insulation. The windings of a POWER-CAST transformer contain high tensile strength glass fiber. Each turn of the winding is completely embedded in a matrix of glass, Nomex, and epoxy to provide unsurpassed short circuit and mechanical strength. This ensures unequalled reliability of POWER-CAST transformers.
- **Decommission Costs.** Disposing of a liquid-filled transformer can be expensive and may involve complicated regulations for removal and disposal. This may add significant costs in the future, which are increasing everyday. These costs should not be overlooked when first specifying the type of transformer. Square D dry type transformers do not contain fluid. Therefore, they are less complicated to discard. If a Square D dry type transformer must be decommissioned, it contains metals such as copper, aluminum, and steel that can be easily recycled or disposed of in accordance with federal, state, and local regulations.



SQUARE D COMPANY
REGISTERED TO ISO 9001
CERTIFICATE NO. A2225

Square D medium voltage transformers are manufactured in a facility that is Quality Systems Registered by Underwriters Laboratories to ISO 9001

^① Design life is a function of operating conditions and maintenance. This does not constitute any expressed or implied warranty.

RECOGNIZING KEY STATEMENTS IN SPECIFICATIONS

Often, a specification does not directly identify a specific transformer, but will contain key statements. These statements can indicate that one transformer may be better for an application than another. The specification may also identify the expected performance of the transformer. Below is a list of commonly used terms in specifications that point to selection of a particular transformer. Although more than one type of transformer may be applicable, understanding the key terms may help in recognizing that one transformer may be better suited than another for a specific application.

LIQUID-FILLED TRANSFORMERS

Specifications containing the following statements can indicate a **liquid-filled** transformer:

- self cooled, natural convection (outside) air (OA)
- sealed tank, welded cover, or other parts of the tank, such as radiators or cooling panels
- accessories using words such as oil temperature, liquid level, pressure relief, drain valve with sampling device, drain plug
- ANSI and/or IEEE specifications C57.12.00, C57.12.10, C57.12.22, C57.12.26, C57.12.28, C57.12.40, C57-12.50, C57.12.51, C57.12.90
- average temperature rise to be 55°, 65° or 55°/65°C
- fluid is oil, R-Temp, or silicone
- compartments are side by side, covered, or have sidewall-mounted bushings



DRY TYPE TRANSFORMERS

POWER-DRY™ Transformers

Specifications containing the following statements can indicate **POWER-DRY** dry type transformers:

- vacuum pressure impregnated, vacuum pressure encapsulated, windings are dipped
- ventilated compartment
- maximum temperature rise of 150°, 115°, or 80°C
- basic impulse levels (BIL) lower than standard liquid filled ratings, for example, 60 kV BIL on 15 kV transformer)
- temperature device described as monitor, single-phase, or 3-phase coil monitoring
- ANSI and/or IEEE specifications C57.12.01, C57.12.50, C57.12.51, C57.12.55, C57.12.56, C57.12.58, C57.12.59, C57.12.70, C57.12.80, C57.12.91, C57.94, C57.94, C57.96
- insulation system manufactured for 220°C and UL (Underwriters Laboratories) approved
- forced-air overloads
- NOMEX insulation
- self cooled, air-to-air cooling, or “AA”



UNI-CAST™ Transformers

Specifications containing the following statements may require dry type transformers, **UNI-CAST** cast primary and vacuum pressure impregnated (VPI) secondary:

- ventilated compartment
- average temperature rise 100°C
- partial cast, soft cast, combination cast
- temperature device described as “monitor”
- partial discharge testing on high voltage winding
- solid dielectric, high voltage windings
- end cavities of winding sealed with air dry epoxy
- air-to-air and forced-air (AA/FA) overload rated kVA by 33-1/3%
- sheet wound LV
- encapsulated LV



POWER-CAST® Transformers

Specifications containing the following statements may require **POWER-CAST** cast primary and secondary, dry type transformers:

- ventilated compartment
- average temperature rise 80°C
- coils must be red (or other color)
- temperature device described as “monitor”
- vacuum cast coil, completely impregnated
- fiberglass cloth and tape
- solid dielectric high voltage and low voltage windings
- filled epoxy (competitor’s casting method)
- AA/FA overload rated by 50% on 1,000–5,000 kVA
- copper windings on high and low voltage
- impulse of the windings at least equal to the BIL specified by ANSI 57.12.90 for oil-filled transformers



SUMMARY

Although initial cost is a big factor in selecting a transformer, where and how the transformer will be applied affects which transformer is the best solution to obtain the *most value* for the investment. All the topics described in this document must be considered and should be factored into the *total* cost of the transformer. When the cumulative costs are compared against initial cost outlay, dry type transformers, POWER-DRY, UNI-CAST, or POWER-CAST, can offer *long-term* value.

After a transformer selection has been identified, Square D has developed two ways that can assist in preparing a detailed specification. Ask for the *Medium Voltage Transformers Specification Guide* no. 0150SC9402, or *SpecRight® WINDOWS®*-based software.

Each transformer application usually has a unique set of requirements. The combined team of Square D field sales representatives, product designers and engineers, manufacturing staff, and customer service is experienced in designing and delivering transformers that fit the requirements of each unique installation.

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Square D Company
1809 Airport Road
Monroe, NC 28111 USA

Order No. 0150PD9602 3M FP 3/97



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Printed in USA