

# Safe-NET Network Transformer

## Safely and reliably supply power to secondary grid systems

Utilities provide safe and reliable electrical service to their end customers. In large metropolitan areas with densely populated cities, utilities provide this service over secondary network distribution systems. These network systems are largely underground, therefore the network transformers that support these systems are a vital and critical part of the electrical infrastructure.

GE's Safe-NET network transformers are the safest transformers available in the industry for secondary network applications. Safe-NET network transformers are designed to supply power to the network bus and are capable of handling significant short-term overload conditions in this application. GE's exclusive transformer tank design features patented tank technology that minimizes the danger from a transformer rupture event, mitigating its impact to adjacent assets and public safety.

### Key Benefits

- **Increased Public Safety**  
Patented tank design significantly reduces risk to the public and property that may be in close proximity to the transformer location when a high-energy event occurs
- **Increased Operational Safety and Performance**  
Tank design is capable of withstanding in excess of 11 mega joules of energy, exceeding the pressure requirements laid out in the IEEE C57.12.40 standard
- **Validated Risk Mitigation and Peace of Mind**  
Independent, 3rd party validation by KEMA of tank design and response to high energy events
- **Exceptional Product Durability and Reliability**  
The zinc epoxy primer and black epoxy top-coat paint utilized is superior to any other paint solution used today, passing 10,000-hour salt-spray certification tests
- **Eco-friendly with Low Carbon Footprint**  
Available high flash point vegetable-based insulating oil reduces environmental impact

### Applications

GE's Safe-NET Network Transformers are used in applications where safety, reliability, service continuity and minimum maintenance are the key objectives, including:

- Underground metropolitan vault applications
- Office towers, skyscrapers
- Government, commercial, institutional and industrial facilities
- Vault applications with occasional/continuous submersion

GE's Network Transformers can also be applied to non-network applications where superior sealing and corrosion protection are of primary importance. These non-network applications also include intertie (step) transformers for interconnecting two different voltage systems.



## Exclusive Tank Design

- Patented tank technology provides a safe and controlled failure-mode during high energy events
- Exclusive transformer tank design and patented tank technology minimizes the danger from an "end-of-life" event resulting from a high-energy fault
- Best in class corrosion resistant paint minimizes maintenance over long haul and increases life cycle of transformer

## Exceeds Industry Standards

- The Safe-NET tank design exceeds the tank pressure requirements laid out in the ANSI/IEEE® C57.12.40 standard
- Patented tank design can contain most high energy events
- Best in class product lifecycle including an installed base with 85+ years of service

## 3rd Party Validated

- GE's units are capable of withstanding in excess of 11MJ of energy, confirmed by KEMA® testing
- Tested and certified to the highest North American standard for ground-level seismic levels, CBC-2013 section 1705A.12 and IBC 2012 section 1705.12, tested to (an acceleration value of) SDS = 2.5
- Superior zinc epoxy primer and black epoxy top coat paint with 10,000 hour salt-spray certification





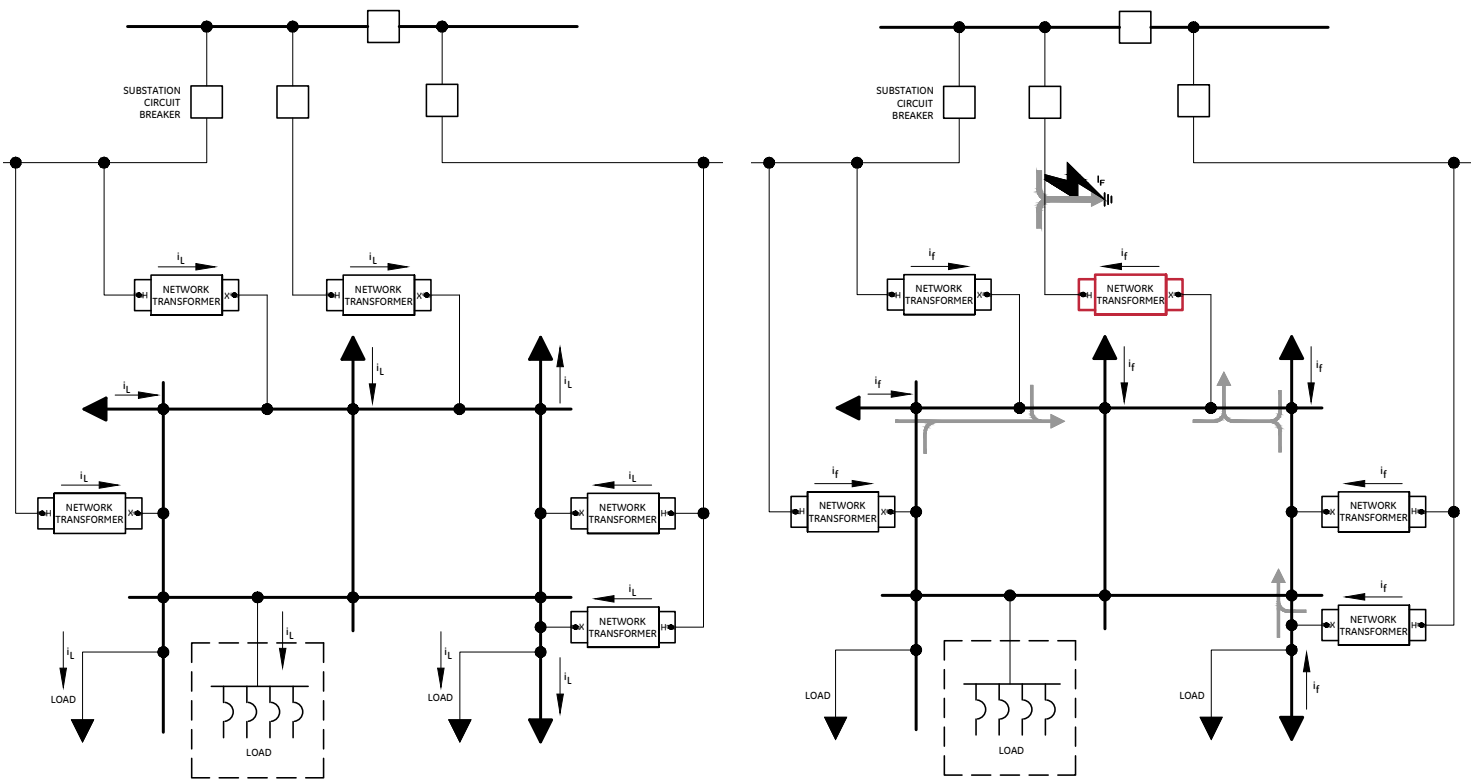
## Low Voltage Secondary Network Overview

Since the 1920's, the low voltage secondary network has been an effective method of serving dense loads like office buildings and downtown areas. The basic design of the network system ensures high reliability and dependable power quality. The network system's reliability comes from having multiple sources. The grid network in the diagram below shows that the network system is fed by multiple transformers with multiple sources back at the substation. This means that the loss of any single transformer or line will not have an effect on the load served by the network.

However, the very same strengths of the low voltage secondary network lead directly to its challenges. The multiple sources of load current can potentially become multiple sources of fault current during a fault. Because of these multiple sources, the fault current and total energy available for a fault become significant.

Since the networks are uniquely effective for serving dense loads, this puts them in populated areas. For this reason, steps must be taken to eliminate any threat to the surrounding populace in the rare case of a system failure.

### Single Line Diagrams for Secondary Network System



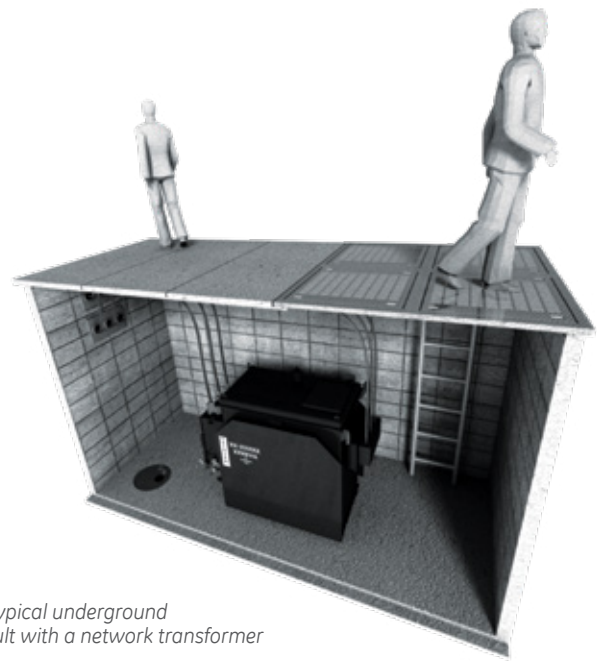
*Normal Load Conditions: Load is shared among all the transformers. The system includes connections to other parts of the grid that may act as a load or a source.*

*Primary Fault Condition: Now all the transformers provide fault current as do the other parts of the grid. The current adds up and flows through the single transformer. The highlighted transformer is at risk if the fault is not cleared fast enough.*

## Network Transformer Application Overview

The transformers that are used in these low voltage secondary networks are referred to as network transformers. Space limitations in urban environments result in the network transformers being installed in various applications such as indoor and outdoor vaults as well as inside buildings. All of these applications will typically have these network transformers in close proximity to pedestrian and other traffic. The image to the right represents a typical application for a network transformer, where it is placed in an underground vault under a sidewalk, with an open, ventilated grate. Additionally, it's not uncommon for these underground vaults to be either partially or fully submerged in combinations of fresh water or salt water run-off, subjecting them to accelerated corrosion.

Because of this placement, safety is the highest priority for the underground network and specifically the network transformer. When high energy transformer events occur, this can lead to uncontained ruptures and collateral damage. The network transformer needs to be able to safely handle and dissipate that energy within the vault and away from pedestrians.



*A typical underground vault with a network transformer*

## Network Transformer Overview

GE's Network Transformers offer utilities a solution that can help them provide safe, reliable and dependable electrical service to their end customers. GE's Network Transformer installed base includes units with 85+ years of service, giving utilities peace of mind and operational assurance for their networks.

### Network Transformer Portfolio

- 300 – 2500 KVA, 3 Phase
- Suitable for secondary networks and spot networks

### Patented Tank Technology

- Rupture resistant tank design allows for a safe and controlled sequence of events during high energy event
- Exceeds the tank pressure requirements laid out in ANSI/IEEE C57.12.40 standard

### Long Operational Life

- Safe-NET design evolved from products with 85+ years of service
- Tested and certified to the maximum (ground level) seismic levels in North America
- Corrosion resistant exterior

### Superior Coil Design

- High short circuit strength
- Insulation system designed for increased loading capacity

### Mechanical Strength

- Rugged clamping
- Safe lifting provisions

### Industry Leader in Quality

- GE's Six-Sigma quality initiative ensures superiority in design and manufacturing



# GE's Network Transformers High Fault Energy Tank Design

## Challenge

Arcing, corrosion and overloading are the three key drivers for end-of-life tank events in network transformers. Given the network transformers placement in underground vaults, which very often are below sidewalks, service events in the field pose a risk of injury to individuals in close proximity as well as additional asset damage and power outages. Traditional network transformers do not have the same capacity to contain high energy events which can often cause undesired collateral damage resulting from an uncontrolled tank rupture.

## Solution

GE addresses the challenge of high-fault energy driven tank events, and the limitations with traditional network transformer designs, with its Safe-NET Transformer which:

- Has a patented tank design that improves the tank's ability to contain high-fault energy events by 3X, and mitigates the risk associated with tank rupture and evacuation of fluid.
- Provides a safe and controlled response during high energy events and ruptures. The energy and fluid are directed downward and away from the vault opening, limiting external damage and minimizing the public safety risk.
- Uses the best in class corrosion resistant paint, zinc epoxy primer and black epoxy top coat paint, which has passed the 10,000 hour salt spray certification. This minimizes maintenance, prevents corrosion over long haul and increases life cycle of transformer.

## Validation

GE's Network Transformers have been validated by independent third party test agencies.

### Tested & Validated by KEMA

GE's Network Transformers are capable of withstanding in excess of 11MJ of energy, with KEMA testing confirming that all scenarios yield controlled energy evacuation downward and through the tank radiators.

### Seismic Certification

Tested and certified to the highest North American standard for ground-level seismic levels, validating that the transformers are expected to withstand the mechanical vibrations of an earthquake.

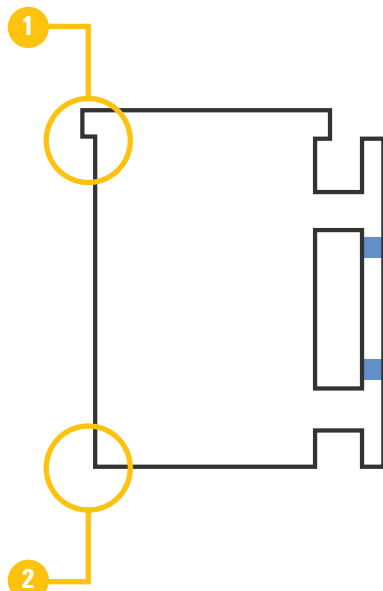
### Exceeds ANSI/IEEE Standards

The tank design far exceeds the tank pressure requirements laid out in ANSI/IEEE C57.12.40 standard.

## Controlled High Energy Tank Design Sequence

### Initial State

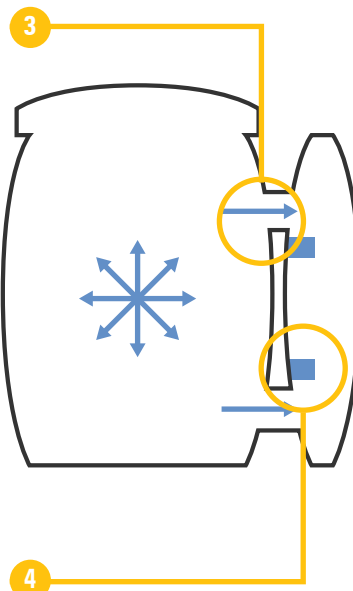
Increase tank rupture pressure by cover improvement



Increase bottom rupture capability

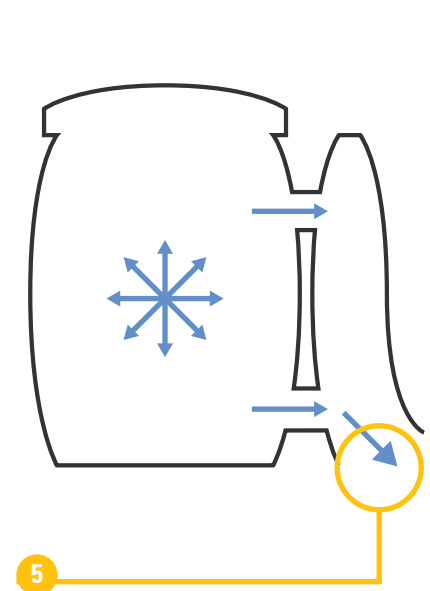
### Up to 11 MJ of Pressure Relief

Pressure relief through header pipe into radiator



Radiator Spacer Failure allows "pillowing", creating large expansion volume

### Over 11MJ of Pressure Relief

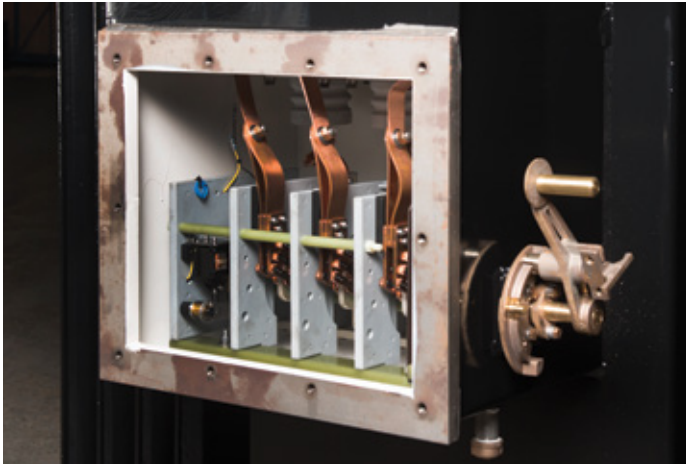


Radiator designed to fail at bottom or side serving as a directional blowout port



# Network Transformer Features

Switch-box with cover removed (primary switch is exposed)



Primary switch contacts and rotor



Switch-box liquid-level gauge and filling provision



Transformer lifting lug



Main tank thermometer



Main tank liquid level gauge

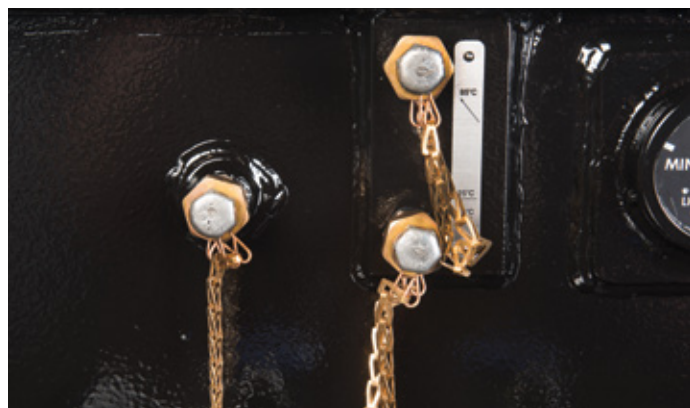


# Network Transformer Technical Specification

	STANDARD OFFERING	OPTIONAL OFFERING
<b>Power Ratings</b>	300kVA through 2500kVA (three-phase only)	<ul style="list-style-type: none"> <li>Up to 3000kVA for step-down/intertie designs</li> <li>Special kVA ratings to maximize kVA/in<sup>3</sup> in the vault</li> </ul>
<b>Voltage Ratings</b>	<ul style="list-style-type: none"> <li>Primary Voltages from 2.4kV through 34.5kV</li> <li>Primary taps per C57.12.40</li> <li>Secondary Voltages from 208GrdY/120 to 480GrdY/277</li> </ul>	<ul style="list-style-type: none"> <li>Dual Voltage (series multiple) primary</li> <li>Special Primary taps</li> <li>Secondary Voltages up to 4.33kV (60kV BIL rating)</li> </ul>
<b>BIL Ratings</b>	<ul style="list-style-type: none"> <li>Primary BIL ratings 60kV to 200kV BIL</li> <li>Secondary BIL rating of 30kV BIL</li> </ul>	Non-standard BIL ratings
<b>Thermal Ratings</b>	Thermal rating of 55°C/65°C rise	Thermal rating of 65°C rise
<b>Impedance</b>	Impedances per C57.12.40	Special Impedances
<b>Efficiency</b>	Meets or exceeds required DOE efficiency levels	Small vault and high-efficiency designs
<b>Frequency</b>	<ul style="list-style-type: none"> <li>50 Hz frequency</li> <li>60 Hz frequency</li> </ul>	
<b>Ratings</b>	IEEE C57.12.40 and IEC 60076-1	<ul style="list-style-type: none"> <li>K-Factor ratings for non-sinusoidal load currents</li> <li>Designs for elevations higher than 3300 feet</li> </ul>
<b>Insulating Fluid</b>	Mineral Oil or FR3	
<b>Tank &amp; Features</b>	<ul style="list-style-type: none"> <li>Safe-NET High-Fault Energy Tank Design rated for 11 MJ of fault energy</li> <li>Steel thicknesses per C57.12.40</li> <li>4" tall I-beam sub-base</li> <li>Welded Hand-holes(s)</li> <li>Secondary Throat dimensions per C57.12.40</li> <li>Welded Secondary bushings with flex connectors</li> <li>Robust lifting provisions</li> <li>Exceptional paint system: zinc-rich epoxy primer &amp; black epoxy top coat, 6.0 mils dry film thickness</li> <li>Laser-etched Stainless Steel nameplate, 1/16" thick</li> </ul>	<ul style="list-style-type: none"> <li>Stainless steel tank or radiators</li> <li>1.5" tall bar sub-base or up to 8" tall I-beam sub-base (also in stainless steel)</li> <li>Bolted Hand-hole(s)</li> <li>Special primary or secondary bushing locations</li> <li>Bolted bushings</li> <li>Insulated Neutral bushing(s)</li> </ul>
<b>Primary Switch</b>	<ul style="list-style-type: none"> <li>GE designed Primary Grounding &amp; Disconnect Switch which meets C57.12.40-2011 short-circuit requirements</li> <li>Single-compartment switch-box</li> <li>Bushings or Bushing-wells welded on top of box</li> <li>Drain on the bottom of the switch box</li> <li>Deadbreak interlock</li> </ul>	<ul style="list-style-type: none"> <li>Switch capable of interrupting magnetizing current (Mag-I interlock)</li> <li>Sequential Grounding Switch, additional interlocks &amp; other special switches</li> <li>Phase Sequence Identification (Phasing tubes)</li> <li>Switch-box viewing window</li> <li>Two-compartment box with wipe-sleeves</li> <li>Other special HV entrances</li> </ul>
<b>Gauges &amp; Valves</b>	<ul style="list-style-type: none"> <li>Mechanical gauges on tank (without alarm contacts)</li> <li>Welded dial-type magnetic liquid level gauge, on tank and switch-box</li> <li>Dial-type thermometer</li> </ul>	<ul style="list-style-type: none"> <li>Special temperature, liquid-level, and pressure sensors with alarm contacts or analog output</li> <li>DGA sensors and other special Monitoring &amp; Diagnostics devices</li> <li>Special drain valves and oil sampling valves</li> </ul>



HV entrance/Switch-Box



Oil sampling valves

## Typical Ratings

The range of ratings below are representative of ratings which GE can provide, but are not the limit of our capabilities.

POWER [kVA]	PRIMARY VOLTAGE [V]	SECONDARY VOLTAGE [V]
300	2400-34500	208Y/120-4330Y/2500
500	4160Y/2400-34500Y/19920	
600*		
750		
1000	4160-34500	480Y/277-4330Y/2500
1500	4160Y/2400-34500Y/19920	
2000	12000-34500	
2500	12470Y/7200-34500Y/19920	

\* GE can custom design kVA ratings to maximize the kVA/in<sup>3</sup> in your vault, such as 600kVA.



Final assembly and inspection

## Network Transformer Product Testing

100% of our units are tested per the Routine Tests defined in IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers (C57.12.00) and tested per IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers (C57.12.90).

GE can perform design and other tests as defined by IEEE and IEC standards on-site at our manufacturing facility and with 3rd party test labs. The table below summarizes all the special testing we conduct.

TESTING TYPE	ON-SITE	3RD PARTY
Temperature Rise (Heat Run)	•	
Dissolved Gas Analysis (sample taken on-site)		•
Audible Sound Level	•	
Short-Circuit Capability		•
RIV (µV)	•	
Partial Discharge (pC)	•	
Winding Insulation Resistance (Meggar)	•	
Insulation Power Factor	•	
Capacitance	•	
ANSI Impulse	•	
Front-of-wave Impulse	•	
Seismic Testing		•
Pressure Testing	•	



Electrical test



## Manufacturing Facility

GE designs, manufactures and tests to the highest standards in the industry at its state-of-the-art manufacturing facilities. GE has an excellent track record in safety and is dedicated to the research, application and development of an extensive range of technology solutions for customers in the utility and energy industries.

## Exceptional Quality and Reliability

- ISO® 9001 certified processes
- ANSI compliant products available
- 3rd party product certifications, including KEMA and other internationally recognized testing facilities
- Multiple checkpoints in the production, assembly and inspection process yield high quality products
- Rigorous electrical, oil quality, and leak testing
- Special testing such as heat run and sound tests with reporting capability available
- On-site GE quality engineers and technicians

## Advanced Technology and Manufacturing

State-of-the-art 600,000 square-foot manufacturing facility comprised of operations such metal fabrication, welding, core assembly, and coatings. The manufacturing site is ISO 9001 certified and conducts quality inspections for purchased and outsourced materials. The manufacturing facility is located in Shreveport, LA and serves customers around the world.



*Assembly of Interior cabling and barwork*

GE Power  
Grid Solutions

+1 877-605-6777 (toll free in North America)  
+1 678-844-6777 (direct number)

[GEGridSolutions.com](http://GEGridSolutions.com)

ANSI is a registered trademark of American National Standards Institute, Incorporated.

IEEE is a registered trademark of the Institute of Electrical Electronics Engineers, Inc.  
KEMA is a registered trademark of DNV.

ISO is a registered trademark of the International Organization for Standardization.

GE, the GE monogram and Safe-NET are trademarks of the General Electric Company.

GE reserves the right to make changes to specifications of products described at any time without notice and without obligation to notify any person of such changes.

Copyright 2019, General Electric Company.



imagination at work