MOBILE TRANSFORMERS AND MOBILE SUBSTATIONS FOR RAPIDLY RESTORING ELECTRICAL SERVICE

[1]Mr. Lalit singh bisen, [2]Dr. Dharmendra kumar singh
[1] B.E. Scholar, [2]Associate professor
[1,2]Dr. C. V. Raman Institute Of Science And Technology

Abstract-This paper will define the parameters utilities contemplating shared mobile use need to consider when specifying mobile substations, discuss limitations due to utility system differences and road regulations, offer suggestions to erase transportation difficulties, and give actual examples of shared utility use for the reader to consider.

INTRODUCTION

The definition of mobile substation (or portable substation) may vary from utility to utility, from manufacturer, and even from one part of the world to another.

Our definition of a mobile substation is a completely self-contained trailer mounted unit comprised of transformer, cooling equipment, high voltage and low voltage disconnects and power circuit protection (fuses or breakers/switchers), metering, relaying (communication optional), AC and DC auxiliary power, surge protection, with optional cable reeling equipment[1].

The mobile substation should be fully assembled with minimum temporary bracing, and should be shipped from the factory with the transformer filled with insulating oil. Field processing of transformer oil should not be required. The maximum height of the unit should be 13 feet 6 inches or less, and the maximum width should be 8 feet 6 inches or less. State and Federal road regulations should be met. These will define the other physical parameters of the substation, including but not limited to trailer length, total weight, required tractor configuration, axle and kingpin permissible loading, and axle spacing [1].

Set-up time under emergency conditions, as a guideline, should be a maximum of 4 hours or less. Today even very small utilities are considering use of mobile substations. In addition, the MVA size and circuit breaker interrupting ratings of mobile substations are also increasing as power systems grow.

DESCRIPTION OF MOBILE TRANSFORMERS AND SUBSTATIONS

In the usual stationary or fixed applications, the transformers, switchgear, protective systems, and station back-up power can be spread over a large area for insulating, safety, and maintenance purposes. In contrast, the mobile system is generally self-contained and mounted on a large trailer. Figures 6 and 7 show a typical mobile substation with some of the ancillary equipment. The units are generally mounted on mobile trailers (or possibly, in some special cases, on flatbed Railcars).

In most cases, special permits are still required to move the units because of the large weight. Differing state transportation load limits on non-Federal local roads further complicate the issue [5].

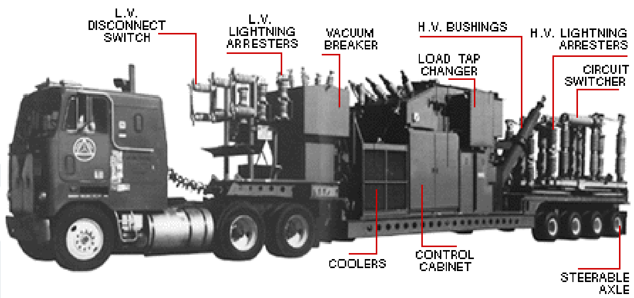

Fig. - Component of mobile transformer

Mobile transformers are used by utilities to temporarily replace transformers that are out of Service either for maintenance or because of forced outage. Mobile transformers are most widely available in the medium-power range (10 to 100 MVA) with HV ratings to 245 kV. Large power Transformers or higher-voltage transformers are too large to be mobile either because of physical Dimensions or weight.

In the image which is used to characterize the pattern. We use a syntactic approach for the description of objects. The knowledge vector obtained here gives information about the direction and the length of lines in the contour of objects which can then be given as input to a classifier module. The normalization of this vector plays an important role in the

COMPARISON OF MOBILE AND FIXED TRANSFORMERS

	Mobile	Fixed
Insulation	Nomex®/Oil	Paper/Oil-Nomex®
Trise (ºC)	Up to 115	65
Flux Density	1.78	1.5–1.75
Current Density	4 kA/cm2	0.25–0.5 kA/cm2
Loss Evaluation	No	Yes
Full Load Losses	1.5%	<0.5%
%Z	12–15%	<10%
Breakers	Yes	
Substation		
Switches	Yes	Substation
Auxiliary Power	Yes	Substation

MOBILE TRANSFORMER CHARACTERISTICS

	Low	Nominal	High
MVA Rating	5	25	100
HV (kV)	35	115	245
LV (kV)	5	15	115
Total Weight (1000#)	50	95	150

MOBILE SUBSTATION APPLICATIONS

Single point contact for project management, plug and play installation, on-board fluid containment, and resolved voltage regulation with an aesthetically pleasing design.

Many of the critical infrastructures in this country rely heavily on electric power for their continued operation. Certain infrastructures, including the communications industry, public health, and government services such as first responders in emergencies, have a crucial role to play in a rapid response to outages. However, the critical infrastructure that would deal most directly with MTS systems is the electric power industry, which owns and operates the substations in which MTS systems would be used to replace lost equipment.

The electrical grid is a tightly integrated network that requires precise operation of all components to safely and efficiently provide power to end users. While the vast majority of outages are due to power line failures, the grid is also highly vulnerable to disruption at substations, where multiple lines intersect. Because substations are nodal points, a single failure can impact a large number of end users. There are thousands of substations across the country, and in any year, transformers at some of these will fail or be pulled from service. Unexpected failures can seriously disrupt the grid in the surrounding territory. As indicated earlier, there is usually sufficient redundancy in the system to withstand most single-transformer failures;

However, substations serving low-load-density areas may not have sufficient contingency to overcome the loss.

MTS systems are used for a variety of reasons within a utility. However, the losses and costs associated with these systems are generally too high for them to be used as long-term replacements. In addition, MTS systems have lower impedance, which results in higher fault currents, leading to greater stress on grid components such as breakers. Rather, utilities utilize MTS systems for their main advantage—their rapid deployment capability (roughly 12 to 24 hours). Their flexibility allows them to be switched from one task to another relatively easily and is in fact a main rationale for a utility to own and operate MTS.

<u>The potential purposes of an MTS include the following:-</u>

Planned maintenance

Temporary substation capacity increases

Forced outage repairs

Weather and other natural outages

Sabotage and attacks

PLANNED MAINTENANCE

MTS systems are used on a day-to-day basis within the utility to provide alternate capacity during planned maintenance of substations. Because it is desirable to have MTS systems available for emergency duty during peak loading or extreme weather conditions, utilities schedule their planned maintenance around the time when MTS systems are less likely to be needed for emergency use. Since the utility will have only a limited number of MTS systems, substation repairs must then be staggered or delayed due to unplanned substation transformer outages.

Mobile unit is designed to be a multi-purpose package delivering maximum kVA for allowable weight. Performance and design criteria vary considerably from those of a conventional transformer. The margin between the operating voltage level of the insulation structure (BIL) and the operating voltage is generally smaller, the average winding temperature rise over ambient is generally higher, the overload capability is less (If only oil/paper is used. It should be noted that for modern Nomex® or hybrid systems, this is not true.), and losses and impedance tend to be higher. The circuitry of the mobile unit is generally more complicated, in order to meet a variety of operating situations in a particular utility system.

Typical mobile transformer characteristics are shown in Tables 2 and 3. High-side voltages range from 35 to 245 kV with sizes ranging from 5 MVA to 100 MVA. Estimates by transformer manufacturers indicate that there are roughly 500 to 600 mobile transformers in service (slightly greater than 1% of the medium-power transformer inventory). Some of these transformers are quite old but are still serviceable because the number of hours that the mobile transformers are used is much lower than that of fixed installations. Because the mobile units operate at a higher power density than stationary units, losses are higher and, consequently, utilities use them only until a suitable stationary unit is obtained. According to manufacturers of mobile substations, the cost is about three times the cost of the fixed transformer alone. However, this includes the trailer, switchgear, breakers, emergency or station power supply, a compact high-power-density transformer, and enhanced cooling capability.

TEMPORARY SUBSTATION CAPACITY INCREASES

MTS systems may be called upon when an area may be faced with a temporary load increase that is not expected to last more than several months or perhaps a couple of years. Examples are construction projects or major plant modifications that require high electrical loads that will drop following completion. Special events can boost the capacity needs for a short time period. An MTS can be used to avoid the cost of a permanent upgrade that would rarely be used. Another example is to rapidly provide increased substation capacity during peak load conditions prior to substation upgrades, in the case where equipment deliveries were delayed or other problems arose that slowed the capacity expansion.

FORCED OUTAGE REPAIRS

One of the main areas in utility systems where MTS systems could reduce vulnerabilities is in medium-voltage rural areas without redundancy. Often the grid in these areas is topologically in a radial arrangement that does not allow for the redundancy of parallel circuits. Loss of a substation or even a key transformer within the substation can cause significant supply problems downstream. The Dyersburg example described in Sect. 2.2.3 shows the social and economic impact of the loss of a substation in regions that do not have multiple feeds.

Unplanned repairs can be called for due to existing equipment failure, weather phenomenon, or intentional disruptions. Equipment failure is the most common rationale for deployment. Lightning can cause a delayed failure or accelerate the aging of critical elements of the transformer. As transformers age, an increasing percentage of them can face sudden failure. Utilities attempt to monitor transformer conditions such as oil chemistry or load profiles to predict impending failure, but for many reasons, unexpected failures can still occur. Subsequent to forced outages there are startup issues that should be addressed.

The IEEE Recommended Practices for Emergency and Standby Power Systems for Industrial and Commercial Applications (IEEE, 1987) contain words of caution in the section on startup power. Paragraph 3.3.6 applies to all mobile equipment of all types in emergency situations:-

"Mobile equipment may suffice if it can be reasonably assumed to be available when needed. (Who has the highest priority when all have the need?)" Section 4.5.6 of the same standard suggests rental equipment as a viable alternative if mobile power is found to be too expensive (IEEE, 1987).

WEATHER AND OTHER NATURAL OUTAGES

Weather and natural disasters are the main cause of electrical outages, although most often these have a larger impact on the power lines leading to and from the substations than on the substations and transformers themselves. Some natural disasters can harm substation operations and create a need for MTS systems. The most likely are intense thunderstorms and tornados. Tornados are powerful enough that if they strike a substation, the equipment will generally be destroyed and require replacement. Floods also can cause massive damage either from the force of the water or shorting out and thus damaging equipment. It is generally flooding or flying debris that causes damage during hurricanes since substations can be designed to withstand hurricane-level winds.

SABOTAGE AND ATTACKS

Intentional disruptions such as sabotage could severely harm our Nation's electrical grid, and most substations are very vulnerable to attack. Substations are usually unmanned, remote, exposed, and have few physical barriers. Utilities rely more on redundancy of the grid for mitigation rather than on hardening of individual sites. The larger sites frequently have personnel and improved protections, but the consequences of loss of these large sites are comparatively.

Greater as well. There are few options available for the replacement of a destroyed high-power transformer. While MTS systems as large as 100 MVA exist, MTS systems are typically below 50 MVA in size, with high-side voltages not exceeding 230 kV. High-power transformers, as described above, are greater than 100 MVA and can have high-side voltages of 345 kV or higher and at present cannot be backed up by MTS.

MTS systems can play a crucial role in several scenarios involving deliberate attacks. The ultimate target may be a critical infrastructure with limited access to electric power through just one or two medium-power substations. If the facility is vital to area health or other social needs and its substation links are destroyed, MTS systems may be useful in returning the facility to normal operations more quickly. This may be especially true if the attack strikes several substations, perhaps in order to bring down portions of a large urban area. The choice the utility

Must make is generally between mobile substations and either fixed or mobile emergency generation. Even with the use of emergency generation, small mobile transformers may be called upon to adjust voltages in the area, or to mitigate prolonged disruption.

CONCLUSION

A mobile substation, or MTS, is designed to bring electricity temporarily to areas that have lost it.They are used during war, natural catastrophe or an equipment breakdown. An MTS has the following features: Trailer for unit, emergency electrical supply, transformer, switchgear and breakers. This mobile power station can be on location within 24 hours and provide temporary electrical power to the downed area. The units are designed for outside elements, some having an outside coating that will last for more than twenty years. When put into service, an MTS is expensive. Its expense precludes long term use, but it is perfect for temporary needs. Their greatest advantage is in the ability to move it from one location to another quickly. Besides mobility, the MTS offers service providers time to make repairs and get service back on. The mobile substation is also useful when maintenance work is needed on substations. This keeps consumer's power from being shut off during repairs. Their compact size also makes the units easier to use in small areas.

REFERENCES

[1] ABB Power Products Division and ABB Power Systems, ABB Products, systems, services in Power: an overview, ABB library and database located at:http://www.abb.com/global/veabb/veabb051.nsf/0/d78692ef1282021ec1257164006f0dd9/$file/presentationpt.pdf

[2] Bartley, William H. and Rowland I. James, "Transformer Asset Management," 2003 Second Annual Technical Conference on New Diagnostic Concepts for Better Asset Management November 10-12, 2003 Radisson Deauville Resort, Miami Beach, FL (Bartley 2003a).

[3] Bartley, William H., "Investigating Transformer Failures," 2003 Third Annual Technical Conference on New Diagnostic Concepts for Better Asset Management November 8-10, 2004Holiday Inn Capitol Plaza, Sacramento, CA (Bartley 2003b).

[4] Allgemeine Zeitung, April 21, 2006. Article at the ABB library archives:http://www.abb.com/global/abbzh/abbzh251.nsf!OpenDatabase&db=/global/seitp/seitp321.nsf&v=9AAC750000&e=us&m=9F2&c=4AA7ACF50738D3B3C1256EE600420386.

[5] Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks: Report and Recommendations to the Federal Communications Commission, June 12, 2006

[6] Morales, D.K. 1992, Defense Energy Program Policy Memorandum (DEPPM) 92-1, Office of the Assistant Secretary of Defense, January 14.Nashville Electric Systems Press Release (http://www.nespower.com/press_releases/p040306a.aspx.

[7] NERC (2005), Electricity Supply and Demand Database, North American Electric Reliability Council, September. http://www.nerc.com/~esd/Patterson TVA (Communication with Oak Ridge National Laboratory, use approved by TVA) Smith-King, Tonya "Recovery on as scarred locals look to skies in dread," Jackson Sun April 7, 2006 (See also http://www.jacksonsun.com/apps/pbcs.dll/frontpage) Stiegemeir, Craig L. and Ramsis Giris, Rapidly Deployable Recovery Transformers, IEEE.