International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 4 Issue 9, September-2015

# Using the Mobile Substations in 132Kv Network and Studying their Effects on the Losses of Network

Hassan Dehghan[1], Mohamadreza Hashemi[2],
Hamidreza Mahdian[3], Hamed Esmaeili[4]

[1]Research & Development Unit (R&D) Sane Shargh Company, Mashhad, Iran
[2,3]Khorasan Regional Electricity Company Mashhad, Iran
[4]Khorasan gas power station management

**ABSTRACT**

**In most cases, distribution companies have to construct 20 Kv long lines for feeding far loads, while most of the time, the high voltage lines are passing by these loads. In this paper, the possibility of using the mobile substations connected to aforementioned high voltage lines for feeding this kind of loads and also the effect of using these substations on the network losses is studied. An economic analysis is done about the time needed for regaining investments of buying mobile substation by the help of decreasing the network losses. The suggested models are tested by the help of a simulation on DIGSILENT software and a simple distribution network.**

**Keywords: mobile substations, losses, distribution networks, load distribution**

## 1. INTRODUCTION

Reaching to a safe network with minimum outage and developing the equipments of transmission network and distribution network are two important purposes of power industry. Power system has a variety of substations. In a classification, substations can be organized functionally into four categories: step up substations, distribution substations, switching substations and hybrid substations. Also they can be organized into four groups from the layout point of view: standard layout, compact layout, mobile substations layout and modular substations layout. In this paper we discuss about effects of using mobile substations on the losses of distribution network, in order to feed a special region. In this paper, the purpose of exerting the mobile substations is increasing the transmission voltage.

## II. MOBILE SUBSTATIONS

Mobile substations are substations which their control room, high voltage equipments and medium voltage equipments are installed on a trailer chassis, so they are transportable. When it's needed to energize a place quickly, these kinds of substations are exerted. Concerning the transferability of these substations, they can be transferred or even sold after solving the problem. Concerning dimensions of the trailer chassis, mobile substations can be constructed up to 132 Kv in both kinds of air isolation (AIS) and gas isolation (GIS) and about 230 Kv voltage level, it can be just in type of gas isolation. Notice that the layout of the mobile substations is single-transformer and they have less expandability. Some of the most popular uses of mobile substations are:

1. Emergency conditions: like outage of main substation, because of equipment fault or control system fault.
2. At the time of repairing or maintaining the existence substations, mobile substations can be used for feeding the network.
3. When constructing the usual substation is difficult or impossible, then these types of substations can be used permanently.

4. At the time of adjusting the load of existence substations or increasing the capacity of a substation temporarily.
5. When constructing a usual substation is difficult or is not available.

Some of the advantages and disadvantages of these types of substations are mentioned below

### A. Advantages

- **Easy to transfer:** Because of locating all the equipments on a trailer, transferring is so easy.
- **Fast and easy to install and run and operating the substation:** These substations are easy to establish, because they are needless to have any foundation and any construction. Also they can be operated quickly, because all their connections have tested already by the manufacturer factory.
- **Reusability:** These substations can be transferred or even sold easily, Because of the transportability of these substations.


**Figure 1: sample of a mobile substation constructed by Fanavaran-e Sane Shargh Company**

### B. Disadvantages

- **Necessity to observe the admissible distances among the equipments, with considering the dimensions of the chassis.**
- **Less reliability in comparison to usual substations.** They have less reliability in comparison to usual H layout substations due to there is generally only one transformer in mobile substations, but usual H layout substations have two transformers.
- **Impressibility of environmental contaminations**: Environmental contaminations affect these substations, because these types of substations are uncovered.

## III. STRUCTURE OF THE PROBLEM

One of the uses of mobile substations is when a load is located between two existence substations, for example in figure 2, assume that substation A feeds the load of region A (left side) and substation B feeds the load of region B (right side). The two aforementioned substations are connected through a 132 Kv transmission line. Now assume that there are some customers between these two substations who should be fed.

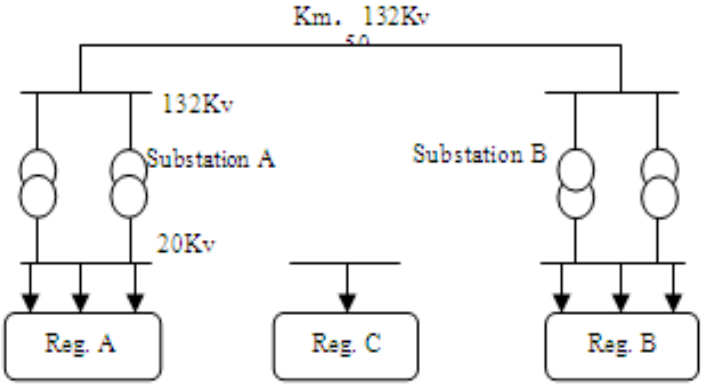


**Figure 2: schematic of system which is studying**

In simulations done by DIGSILENT software, region A and region B are assumed to be two similar distribution networks with 12.5 MW loads. The length of the 132 Kv line is assumed to be 50 KM. Region C is between the two substations located in 25 KM of each substations. Notice that the nominal power of the transformers of substation A and substation B is 30 MVA. The nominal power of mobile substation is assumed to be 15 MVA. The effects of using simple mobile substations on the network losses for different positions of region C are considered in the following:

**C.** Centralized load distribution of region C:

As the simplest condition, the load of region C is assumed to be 5 MW and concentrated.
There are two methods for feeding the region C:

**First condition:** Feeding by the help of substation A or substation B. In this condition, one 20 Kv long line will be constructed form the output of one of these 20 Kv substations (Transmission voltage is 20 Kv).

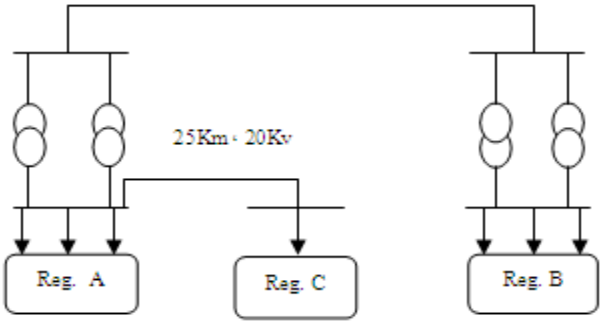


**Figure 3: Using 20 Kv line for feeding the load of region C**

**Second condition:** Using a mobile substation that is fed directly by a 132 Kv line located between two substations and its output feeds the region C (Transmission voltage is 132 Kv).

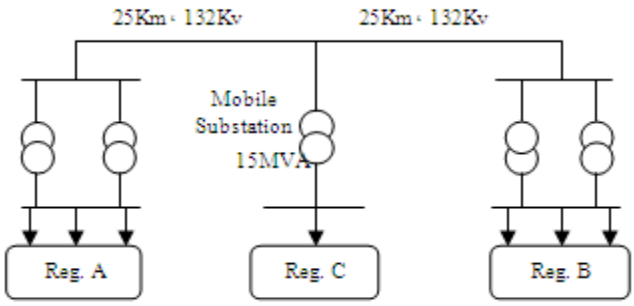


**Figure 4: using Mobile Substation for feeding region C**

Table 1 shows the results of simulation. In this condition, economic calculations show that if we assume each kilo watt hour energy is 750 rials, we can have 2496.6 million rials saved annually, because of decreasing the network losses. If we assume that for buying each mobile substation, 8 milliard rials should be spent by masters, then, it will take about 3 years to return investments, due to decrease the network losses. After this time, it will provide benefits.

**TABLE 1: Results of simulation for the load of region C (5 MW) (The Load of Network is 30 MW)**

| First Condition | | | Second Condition | |
|---|---|---|---|---|
| Losses of network (MW) | Percent of losses | Losses of 20 Kv feeder | Losses of network (MW) | Percent of Losses |
| 1.63 | 5.15% | 19.63% | 1.25 | 4% |

For studying the effects of changing the load of region C, this time its load is changed to 7.5 MW. The results are shown in table 2.

**TABLE 2: Results of simulation for the load of region C (7.5 MW) (The load of network is 32.5 MW)**

| First Condition | | | Second Condition | |
|---|---|---|---|---|
| Losses of network (MW) | Percent of losses | Losses of 20 Kv line | Losses of network (MW) | Percent of Losses |
| 2.4 | 7.38% | 35% | 1.61 | 5% |

As you can see in table 2, by increasing the load of region C, the losses of 20 Kv line will increase in comparison to total losses of network. So if region C is removed, then the losses of network will decrease considerably. (2.38% decrease). By doing similar economic calculations, it's indicated that in this condition, it will take 1.5 years to return the investments, due to decrease the losses of network. By doing these simulations for various amounts of load of region C and different amounts for length of 20 Kv line, it's indicated that: The more load of region C and length of 20 Kv line increase, the more losses of network and time needed to return investments decrease.

### D. Decentralized load distribution through 20 KV line

In last section, load distribution was assumed to be centralized in region C, while in most cases it's decentralized in 20 Kv line.

**First condition:** in this condition, it's assumed that load is decentralized in 20 Kv line. The effect of exerting mobile substation and loading 20 Kv line on the losses of network is studied. Figure 5 shows that how load distributes over the 20 Kv line.

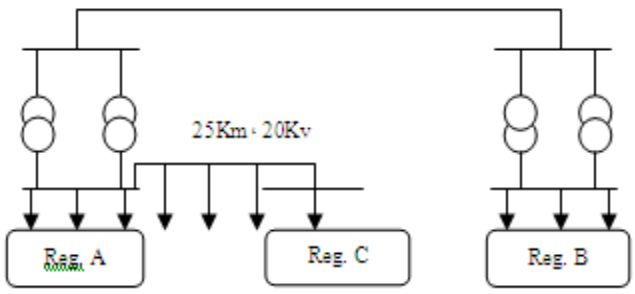


**Figure 5: Decentralized load distribution over the 20 Kv Line**

The consumed active power of each load is assumed to be 2 MW, so the total loads of network are 33 MW in this condition.

**Second condition:** in this condition, it's assumed that for feeding the loads shown in figure 5, a mobile substation is exerted (figure 6).

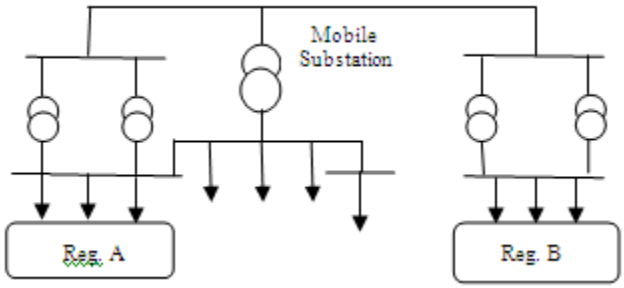


**Figure 6: Using mobile substation for feeding the loads with decentralized load distribution**

**TABLE 3: Result of simulation for decentralized load distribution**

| First Condition | | | Second Condition | | |
|---|---|---|---|---|---|
| Losses (MW) | Percent of Losses | Loading at the first of 20 Kv Line | Losses (MW) | Percent of Losses | Loading at the first of 20 Kv Line |
| 1.52 | 4.4% | 85.47% | 1.29 | 3.75% | 25.5% |

The results showed that in this condition, using the mobile substation caused 0.65 MW decrease in losses and 60% decrease in load of 20KV line. In this condition it will take about 5 years to regain investments. They also showed that by increasing the length of 132 Kv line to 100 KM, network losses will decrease again and it will take 3.5 years to regain the investments. In this condition, the most important advantage of mobile substation is to decrease loading the 20 Kv line.

### C. FIRST CONDITION

In this condition we assume that 20 Kv lines which are coming from substation A and substation B are connected together and the load distribution is decentralized. (Figure 7) In this condition, the total loads of network are assumed to be 40 MW.

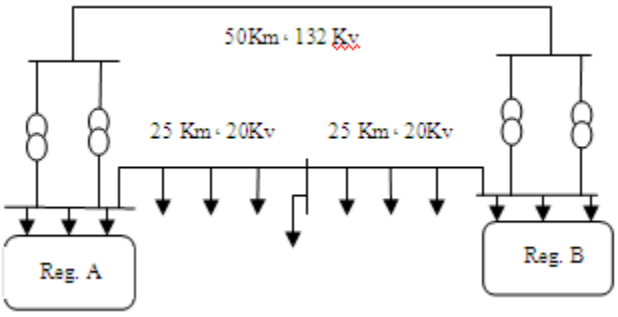


**Figure7: Connecting the 20 Kv lines of substation A and substation B**

### D. Second Condition

assume that a mobile substation is added to the network, in a way that the three middle loads are fed by mobile substation and the remained loads are fed by the two other substations

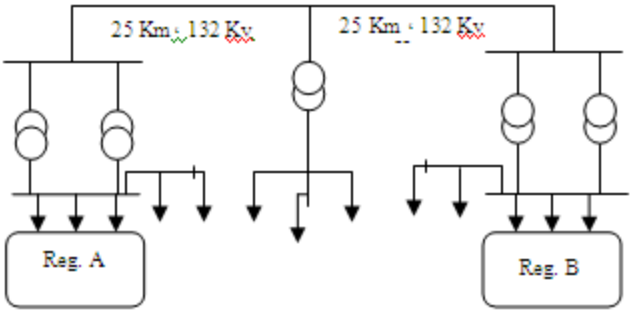


**Figure 8: Using mobile substation for feeding the middle loads**

The results of this simulation are shown in table 4.

**TABLE 4: Results of Simulation**

| First Condition | | | Second Condition | | |
|---|---|---|---|---|---|
| Losses (MW) | Loading the 20 Kv line of substation A | Loading the 20 Kv line of substation B | Losses (MW) | Loading the 20 KV line of substation A | Loading the 20 Kv line of substation B |
| 1.82 | 84.21% | **77.44 %** | 1.41 | 46.6% | 39.95% |

As results show, in this condition, exerting the mobile substation caused to decrease the losses to 0.41 MW and the load of 20 Kv lines will be half. Under these circumstances, it will take 3 years to regain investments. The results show the more load of network and length of 132 Kv increase, the more network losses and time needed for regaining the investments decrease. In this paper, the system which was studied is a simple one, because the main purpose of this paper is studying the effects of exerting mobile substation on the losses of distribution network. In next step, studying the real networks like Mashhad distribution network and Khorasan distribution network are on program.

## CONCLUSION

In this paper, we have discussed about some cases of exerting mobile substations in distribution network. We can use mobile substations instead of constructing 20 Kv long lines for feeding loads with special geographic position and this will increase transmission voltage. The results of simulations and economic calculations showed that exerting mobile substations will decrease losses of network highly and the investments spent on buying mobile substations will return in a few years due to decrease the losses. After that it will provide benefits for operating companies.

## REFERENCES

[1] R.Kumar," Use of Mobile Unit Substation (MUS) at Ontario Hydro",985-C-SUB-1,0-7803-4883-4/98,1998 IEEE

[2] G.Hamoud," Cost/Benefit Analysis for Use of Mobile Unit Substation In Customer Delivery System "Paper Presented at the 2004 International PMAPS Conference ,Ame, Iowa ,USA,September,12-16,2004.

[3] IEEE Guide for the Safe Installation of Mobile Substation Equipments,IEEE Std. 12-68- 2005.

[4] J J.Lopez- Roldan, J.Alfasten, J.Decleroq, R.Gijs, P.Mossoux, and M.Van Dyck, " Technical Consideration regarding the Design and installation of Mobile Substation," CIGRE Session 2004,Rep.B3-210

[5] IEEE Recommended Practice for Seismic Design of Substation.,IEEE Std.693-1997