VOLTAGE REDUCTION SCHEMES

I. INTRODUCTION

In the early 1970's, U.S. electric utilities began practicing automated voltage reduction of the distribution system voltage via their System Energy Control Center computers such as SCADA. The purpose at first was to control the system MW Demand during periods of emergency power supply conditions. This included such things as fuel shortages caused by strikes at coal mines. It also was used because of delays in construction of large base load plants due to environmental and regulatory (NRC) procedures which caused supply side shortages. It also was used when short term high peak loads occurred due to unusual weather related conditions that sent the system peak demand beyond the generating capacity to meet that demand.

Later on, the Oil Embargo of 1973-74 caused regulatory bodies to impose Energy Conservation rules on the U.S. utilities. Here again the use of revised voltage schedules for Distribution Systems was used to reduce energy usage by holding lower system voltages constant. This was implemented with much fanfare in California with a lack of consensus on the merits of the operation.

II. PRESENT PRACTICES: DEMAND SIDE MANAGEMENT

Most U.S. utilities practice some form of system voltage reduction as part of System Emergency Procedures for control of short term demand related emergencies. They use single step or multiple step reduction of distribution system voltage such as 2 1/2 % or 3%, 5% and 8% voltage reduction. The scheme used to do this involves communications to automatic voltage regulating relays on LTC Power Transformers and Step-Voltage Regulators. By means of a dry contact closure to the tapchanger control relay, its regulating center band voltage is reduced to a lower level by boosting the sensed voltage level of the voltage regulating relay. This causes an overall reduction in the Distribution System Automatic Regulating Voltage Schedule. Various specific schemes are in practice due to the variety and vintages of Voltage Regulating Relays in service. The Beckwith Electric tapchanger voltage regulating relays all come with on board capability to receive the dry contact closure to implement the customer's desired voltage reduction schedule.

III. ENERGY CONSERVATION MANAGEMENT

The use of reduced voltage schedules for energy conservation continues to some degree even today, but its effectiveness as compared to other alternatives is still questionable. The majority of consumer equipment is designed for ±5% voltage range and the equipment does unusual things if consistently run at -5% or -2.5% voltage levels. Where the nature of the load is constant kVA, higher equipment losses will tend to offset lower equipment energy usage due to I^2R effects.

IV. RESULTS

Utilities have run extensive internal studies on the effects of voltage reduction and some of it gets reported in the technical literature. The real definitive studies are very specific to individual utility load characteristics which differ widely from utility to utility and are not generally available for public viewing. They are regulatory sensitive issues and normally private.

In general, however, the following reductions in Demand result by reducing Distribution System Voltage.

Voltage Reduction %	Unity p.f. Load Reduction	90% p.f. Load Reduction
2%	1.5%	.5%
4%	3.0%	2.0%

TABLE 1

Load Reduction due to voltage reduction is normally only effective for 45 minutes to 1 hour before load diversity is lost. Energy conservation results are less certain.

V. CONCLUSIONS

1. Voltage Reduction schemes used on Automatic Voltage Regulating Relays do effectively achieve reduction in System Demand for short periods of time - less than 1 hour in duration.

2. Voltage Reduction schemes used on Automatic Voltage Regulating Relays don't effectively reduce System Energy consumption over the long haul. Better methods like load management are more effective on energy conservation.

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