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ScienceDirect
Energy Conversion and Management 48 (2007) 1919–1922
ENERGY CONVERSION & MANAGEMENT
www.elsevier.com/locate/enconman

Difference in analysis methods of tap changer instability in link and radial networks

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Received 6 July 2006; accepted 30 January 2007
Available online 27 March 2007

Abstract

One of the diagnosis methods for voltage instability due to tap changer operation is to use conventional power flow results. This paper discusses that divergence of conventional power flow calculations can show tap changer instability only in radial networks (i.e. in bulk power delivery transformers), but for analysis of tap changer instability in link networks (i.e. in transmission transformers), a new type of bus must be defined for those controlled by tap changers and, consequently, new power flow calculations must be performed. A wide range of tap changing is used in this study.

Keywords: Tap changer instability; Loadability; Link and radial networks

1. Introduction

In recent years, voltage collapse has drawn more attention. One of the important reasons for long term voltage instability and collapse is the tap changer operations [1,2]. Up to now, this has been predicted using the divergence of conventional power flow calculations. The tap changer function is voltage control in the buses that are connected to transformers having tap changers. When a disturbance occurs, the voltage decreases in all buses, which causes the tap changers to try to restore the voltage. Because of the voltage dependence characteristic of loads, voltage restoration causes the power consumed by the loads to be restored to the values before disturbance. If the loads are higher than the loadability of the disturbed system, the voltages can not be restored, and the tap changer operations finally cause voltage collapse [3]. For this reason, loadability is known as the voltage stability boundary, and many papers have been presented for fast computation of loadability [4–6]. This paper discusses that loadability is only sufficient to diagnose tap changer instability in radial networks because in link networks, loadability varies when the taps are altered. In Ref. [7], the effects of tap changing in transmission transformers on the degree of voltage stability have been verified. This instability is related to the tap changers in bulk power delivery transformers and not to transmission transformers. In the following, the difference that must be considered in the analysis of tap changer instability in link and radial networks will be explained.

2. Diagnosis of tap changer instability

Voltage control due to tap changer operation causes load characteristics to become constant power. If this power is higher than the system loadability, tap changers can not control voltages, and tap changer instability occurs. In this condition, with an increase of tap value, voltage decreases instead of increasing. Thus, the loadability is a criterion for diagnosis of tap changer instability in a given load. If under load tap changing (ULTC) is in a radial network (Fig. 1a), the loadability does not depend

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doi:10.1016/j.enconman.2007.01.029