

INSTRUCTIONS



OVER/UNDERFREQUENCY LIMITS AND PROTECTIVE TRIP RELAY FOR NYPA FITZPATRICK #1 TB. NO. 170X504

(NEW INFORMATION, OCTOBER 1987)

I. INTRODUCTION AND BACKGROUND

A. GENERAL

The successful operation of a turbine-generator depends in part on prudent operating practices and adherence to proper maintenance procedures. In addition to recommendations now available in the Instruction Book in the Starting and Loading article, we wish to acquaint you with special over/underfrequency operating recommendations.

This article presents operational recommendations and protective over/under relays which will prevent excitation of high order rotor system torsional modes and cautions against maintenance practices which could adversely change the torsional frequency characteristics of the turbine-generator rotor system.

B. TORSIONAL FREQUENCY CONSIDERATIONS

The recent failure of a nuclear turbine-generator was subsequently shown to have been caused by excitation of a very high order rotor system torsional mode of vibration. The involved mode was the 19th and had a measured frequency of 120.5 Hz on the sister unit. Negative-sequence-current-related torques, among other torques, could excite this mode while the unit operated with an electrical frequency of 60.25 Hz.

Recommendations were made to test your unit to determine the exact location of these modes relative to 120 Hz. Based on the results of this recommended test, detuning and/or over/underfrequency trip relays are recommended (if necessary) to provide further protection. This Instruction Book article is provided to give necessary data and recommendations on the values of the measured frequencies and recommended settings for the trip relays. Recommendations are also provided on future special maintenance/tests during the life of the unit.

The Starting and Loading Instructions for this unit (GEK 46385) presented time limits for off-frequency operation. These limits were based on the relative location of long bucket natural frequencies with respect to harmonics of speed which are the frequencies of potential stimuli. These limits did not account for high order rotor system torsional modes and their relationship to twice electrical frequency torques. Accordingly, these instructions are being modified to include this new (presently recognized) phenomenon.

II. TURBINE-GENERATOR MODE TRIP PROTECTION

A. OPERATIONAL RECOMMENDATIONS

Turbine-generator trip protection from extreme variations in system frequency and negative sequence current has been recommended. This protection will prevent torsional response damage to the turbine and generator.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Permanent Protection:

An over/underfrequency protection trip relay has been designed for Fitzpatrick #1. This relay provides for the required protection of the unit while having minimum impact on operation and distribution system flexibility. The relay operation for this unit depends both on the system frequency and the system level of negative sequence current (I_2) as follows:

1. For (I_2) less than 10% and system frequency outside the range of 59.6 to 60.2 Hz for a period longer than 60 sec, the unit is tripped by first closing the main steam valves. After verification of valve closure and negative power (motoring) of the unit, the circuit breaker is opened. This tripping sequence is recommended to prevent the possibility of excessive overspeed in the unlikely event of valve difficulties and/or return flow from extraction lines.
2. For (I_2) equal to or greater than 10% and system frequency outside the range of 59.6 to 60.2 Hz for a period longer than 5 sec, the unit is tripped. The method of tripping is the same as that presented in Case 1. For cases of multiple faults with spikes of I_2 greater than 10%, the 2-sec timer would reset after each spike. The relay circuit will track and accumulate the time during multiple faults.

B. PROTECTIVE RELAY DESIGN AND MAINTENANCE

An Operation Manual which provides circuit description, as well as all data required to fully maintain the constituent components, is provided with the Relay Hardware.

III. INSPECTION OF UNIT

Scheduled maintenance outages provide an opportunity to routinely inspect critical areas of the turbine. We, therefore, recommend that the routine inspections on this unit include ultrasonic inspection of the last-stage bucket dovetails and magnetic particle examination of the alternator shaft.

IV. MAINTENANCE PRACTICES

The torsional frequency characteristics of the turbine (both mode shape and the location of the natural frequencies) are sensitive to the stiffness of the rotor train and the distribution of mass along it. Therefore, changes should not be made to the configuration of the turbine-generator rotor system without prior consultation with Steam Turbine Engineering.