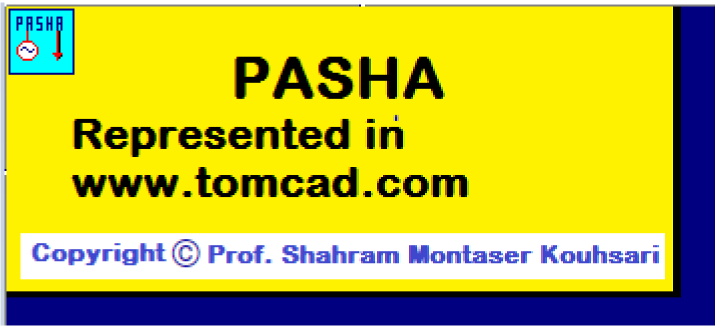

APPENDIX H

QUASI STEADY STATE MODEL FOR RELAY DYNAMIC PERFORMANCE

The time-current characteristics supplied by manufacturers describe the device performance for ideal constant current conditions. However, if a time varying current is assumed to be conditions. However, if a time varying current is assumed to be constant during small time intervals (ie, the integration time step) these curves can be used to determine approximately the change in the condition of the relay for this time step. This approach is based on the assumption that the relay disc has a very low inertia, such that it achieves its steady state speed immediately after any change in the current. Hence, in a transient stability study the position of the disc can be updated at the end of each step according to the corresponding average current. There are three possible cases:

(a) if the current falls within a given "dead band" the disk position does not change;

(b) if the current exceeds the upper limit of this "dead band" the disk travels forward at a speed given by the time-current characteristic. The change in the position angle (DO) expressed is p.u. is given by

$$(DO) / O = (W*DT) / O$$

Where (DT) is the time step length; w is the average speed; and O is the total travel angle for tripping (at the given time setting), which is taken as the base angle. If T is the tripping time read from the relay characteristic, the speed can be expressed as O/T, hence,

$$(DO) / O = DT/T$$

(c) If the current is below the lower limit of the dead band, the relay will travel backwards. In this case, the resetting speed can be approximated as

$$W = (O/T) * (IP^{2} - 1)$$

Where T is the resetting time with no current, and o the disk travel angle at the corresponding time setting. Assuming that this time is approximately proportional to the time setting, the p.u. change in the position angle can be calculated from:

$$(DO) / 0 = (IP^{2} - 1)*(DT) / (TS*TO)$$

Where TS is the time setting and (TO) is the resetting time for the maximum TS (i.e. for full disk travel). Note that angular change in this case will be negative since IP < 1. Therefore, by setting initially all the travel angles to zero and accumulating all the changes during the study, the tripping of a relay will occur when its travel reaches 1.0 p.u..