7. CONCLUSIONS

The work reported in this thesis concerns with a comprehensive investigation of the steady state and transient stability of the Athabasca-Points North System (APNS) in northern Saskatchewan. This chapter presents a brief summary of the work reported in the thesis and important conclusions from the studies.

To carry out steady state and transient stability studies, the following preparation tasks have been accomplished first:

1. the modeling of power components and the network; and
2. the development of a time domain simulation package.

The investigation of the system stability has been accomplished by:

3. eigenvalue analysis and functional sensitivity studies for steady state stability; and
4. time simulations for transient stability studies.

Then, the stabilization of the overall system stability has been realized by:

5. a coordinated PSS application.

The modeling of a power system for stability studies includes two categories, i.e., (i) the modeling of power components which must be described by differential equations; and (ii) the modeling of the network and transformers which can be described by algebraic equations.

The synchronous machine is the most influential power component in stability studies. Its modeling must be sufficiently accurate with as lower order form as possible while the transient and subtransient phenomena must also be incorporated into the model. With all these requirements being considered, a fifth order model was utilized in this thesis and has been discussed in Chapter 2. It has been shown that other simpler models can also obtained from this representation.

Various load models have also been presented in Chapter 2. As the coefficients in the load representations were not available, the constant impedance load model was utilized in the studies reported in this thesis.

In order to perform stability studies of the APNS, a transient stability simulation package was developed. The description of the package has been given in Chapter 3.

Eigenvalue analysis and functional sensitivity studies were carried out to investigate the steady state stability of the system with no power system stabilizers (PSSs) in service. The purpose of this investigation was to identify the best sites for PSS installation. It was found that the system modes were either negatively or poorly damped when no PSS was in service. This is why the system is actually equipped with PSSs to provide positive damping. Detailed discussion has been presented in Chapter 4.

The transient stability of the system depends largely on the disturbance and the operating condition at which the disturbance happens. Any fault that trips one or more sections of the transmission lines from Island Falls to the northern part of the system will separate the system into parts. Some parts may be saved while the rest will be lost. The situation of most concern is that one of the double circuit lines from Island Falls to the Flin Flon is tripped out and the power transfer on the other line may reach its maximum capacity. In this case, low frequency oscillations were observed in time simulation. Detailed results have been presented in Chapter 5.

As has been pointed out in Chapter 6, conventional PSSs are operating point dependent and are designed to damp out particular oscillation frequencies. When the operating condition changes, such a PSS may become inefficient. To overcome these shortcomings, a coordinated PSS design and application procedure was developed based on the concept that it is desirable to use less information that is operating condition dependent and more inherent properties of the system in tuning PSS settings. This idea is realized by utilizing the average natural oscillation frequency of a coherent generation group and a lead/lag time constant spread for PSS tuning. The spread reflects the strength of the system and the type of stabilizer input . The total coupling factors among strongly coupled generators are also used as weighting factors in communication of PSS inputs.

A number of disturbances were applied to the system and their time domain simulations conducted. Selected results have been presented in Chapter 6. The following conclusions can be drawn from the studies reported in this thesis.

1. It has been demonstrated that the system with the existing PSSs in service is stable under common outages.

2. It is beneficial to the system if more positive damping can be provided through excitation control.

3. The studies have shown that for a common asymmetrical disturbance, for instance, single phase to ground fault, if it is allowed to have only

two phases in operation for a short period of time, say a couple of hours, instead of tripping all three phases, the system will be still stable. If the faulted phase can be restored in hours, the system can recover completely by single phase reclosure. This is significant because most system disturbances are single phase fault.

4. Autoreclosure can prevent some instability from happening, especially when the disturbance is temporary. Single phase reclosure can greatly speed restoration of stability.

5. Application of the newly designed PSSs has exhibited promising results: their effectiveness to damp out oscillations and their robustness to different operating conditions, and small and large disturbances.

6. A minimum of one new PSS must be installed in each coherent generation group of the first three groups to maintain stable operation and reasonably good damping.

As has been shown in the thesis, the newly designed PSSs are very powerful in damping low frequency oscillations in computer simulation studies. It might be expected that if these new PSSs could be implemented in the actual system, it would improve the overall stability of the system. Difficulties might also be expected in implementation of the newly designed PSSs, specially in obtaining accurate measurement of the speed deviation.