Appendix C

ATC's Planning Criteria has been updated to include criteria for voltage flicker and harmonic distortion.

AMERICAN TRANSMISSION COMPANY PLANNING CRITERIA

This document describes the system planning criteria that ATC will utilize to ensure that the ATC transmission system is adequate to support effective competition in energy markets, reliably deliver power to systems connected to and customers dependent upon ATC's transmission system, provide support to distribution systems interconnected to ATC's transmission system and deliver energy from existing and new generation facilities connected to the ATC transmission system. This document may be revised from time to time in response to new system conditions, new technologies being employed and new operating procedures, as appropriate. The criteria described below may be subject to change by ATC as warranted. Situations that could precipitate such a change could include, but are not limited to, new system conditions, extraordinary events, safety issues, operation issues, maintenance issues, customer requests, regulatory requirements and reliability council or NERC requirements.

The planning criteria is divided into the following categories:

- System Performance Criteria
- Capacity Benefit Margin Criteria
- Transmission Reserve Margin Criteria
- Facility Rating Criteria
- Model Building Criteria
- Facility Condition Criteria
- Planning Zones
- System Alternatives
- Load Forecast Criteria
- Economic Criteria
- Environmental Criteria
- Other Considerations

System Performance Criteria

System performance will be assessed at least annually. Such Assessments will involve steady state simulations and, as appropriate, dynamic simulations. Steady state Assessments will include consideration of the following system load conditions:

1) Summer peak
2) Summer shoulder peak
3) Fall/Spring off-peak
4) Winter peak
5) Hot summer peak

The first three load conditions above will be assessed in most long-range planning studies. The last two load conditions will be considered when more detailed analyses are being conducted of specific alternatives developed to solve a particular problem. The specific criterion associated with each of the load conditions above is provided below under Load Forecast Criteria.

Steady State Criteria

The steady state system performance criteria to be utilized by ATC shall include:

1) No system element (line, transformer, terminal equipment, etc.) should experience loading in excess of its normal rating under normal system conditions, that is, with all transmission facilities in service. This criterion should apply for a reasonably broad range of generation dispatch conditions.
   (Applicable NERC Planning Standard: I.A.S1.M1)
2) Operating procedures (operating guides) may be employed by ATC and/or entities with generation and/or distribution facilities interconnected with the ATC transmission system to avoid transmission facility loadings in excess of normal ratings provided such procedures are practical for sustained periods, that is, such procedures do not impose on personnel or public safety, do not significantly degrade system reliability, do not result in a significant loss of transmission facility life or significant risk of damage to a transmission facility and/or do not unduly burden any entity financially. Manual switching of circuits or other facilities should not normally be utilized in such an operating procedure.
3) No system element should experience overloads in excess of its emergency rating for a single contingency on the transmission system. This criterion should apply for a reasonably broad range of generation dispatch conditions. This criterion can include manual or automatic switching of circuits or other facilities.
   (Applicable NERC Planning Standard: I.A.S2.M2)
4) No voltage levels that could cause damage to ATC or ATC customer facilities should be tolerated on a sustained basis. The acceptable voltage range is 95% to 105% of nominal voltage under normal system conditions. Such measurements shall be made at the high side of transmission-to-distribution transformers.
   (Applicable NERC Planning Standards: I.A.S1.M1, I.D.S1.M1, I.D.S1.M2)
5) Under single contingency conditions, the temporary acceptable voltage range is 90% to 110%. Bus voltages must be restored to within 5% of nominal voltage within 30 minutes.
   (Applicable NERC Planning Standard: I.A.S2.M2)
6) Load shedding will not be utilized in planning studies to relieve an overload of a transmission facility under normal or single contingency conditions.
   (Applicable NERC Planning Standard: I.A.S2.M2)
7) Generation output should not be limited under normal or single contingency conditions. ATC will consider a lower standard of service if requested by a transmission customer.
8) The MAIN Extreme Disturbance Criteria should be used to assess system performance. This Criteria involves examining a prior facility outage plus a new single contingency, loss of all circuits on

a right-of-way and loss of an entire substation, including generation at that substation. This Criteria should be used to determine system vulnerabilities but may not necessarily dictate that potential problems identified need to be remedied with system additions.
(Applicable NERC Planning Standard: I.A.S4.M4)

Dynamic and Steady-State Stability Criteria

The dynamic system performance criteria to be utilized by ATC shall include:

1) For generator transient stability, faults will be modeled near the high side bus at generating plants.
2) Generator transient stability will be maintained for a sustained three phase fault cleared from any line or transformer in primary time with a single existing line or transformer contingency.
(Applicable NERC Planning Standards: I.A.S2.M2, I.A.S3.M3)
3) Generator transient stability will be maintained for a three phase fault cleared in breaker failure backup time with no existing line or transformer contingency.
(Applicable NERC Planning Standards: I.A.S2.M2, I.A.S3.M3)
4) Unacceptable transient stability performance includes the following conditions:
   g) Generating unit is out of step, unless deliberately islanded,
   h) Cascading tripping of transmission line or uncontrolled loss of load,
   i) Voltage excursions outside of 20% of nominal voltage for more than 30 cycles,
   j) Voltage instability at any time after a disturbance,
   k) Voltage recovery of less than 70% of nominal after a disturbance, or
   l) Poorly damped oscillations.
(Applicable NERC Planning Standard: I.A.S2)

The steady-state stability performance criterion to be utilized by ATC will include:

1) With a generating plant at full output, all units will remain steady-state stable with the non-fault opening of any of the transmission circuits interconnected with that plant.
(Applicable NERC Planning Standard: I.A.S2.M2)
2) With a generating plant at full output, all units will remain steady-state stable with the non-fault opening of any two transmission circuits on a common structure that are interconnected with that plant.

Voltage Flicker

The criteria for acceptable levels of voltage flicker are defined by the requirements of regulatory entities in the states in which ATC owns and operates transmission facilities, IEEE recommended practices and requirements, and the judgment of ATC. All customers connected to the ATC system are required to adhere to the following three criteria.

1) *Relative Steady State Voltage Change* is the difference in voltage before and after an event, such as capacitor switching or a large change in load. These events should occur at least 10 minutes apart and take less than 0.2 seconds (12 cycles) to go from an initial to a final voltage level. Relative Steady State Voltage Change is limited to 3%, with rare exceptions, at ATC's engineering judgment, to as little as 1% on stronger portions of the system. Relative Steady State Voltage Change is determined at minimum normal system strength.
2) *Single Frequency Flicker* is created by voltage affecting events that occur at a regular interval and superimpose a single frequency waveform between 0 and 30 Hz on the fundamental frequency 60 Hz voltage waveform. Depending on frequency (the human eye is most sensitive to frequencies in the 5 to10 Hz range) sub-synchronous frequencies with magnitudes from 0.5% to 3% can cause irritable flicker. ATC uses the flicker curve in IEEE Standard 141 (commonly referred to as "The Modified GE Flicker Curve") to determine the acceptability of Single Frequency Flicker. ATC requires all single frequency flicker be below the flicker curve "border line of irritation" under all normal (non-faulted) system operating conditions.
3) *Multiple Frequency Flicker,* the cause of most flicker problems, has the same frequency range as Single Frequency Flicker, but contains multiple flicker frequencies making it much more complex to analyze. By weighting the magnitudes of each flicker frequency component with a flicker weighting curve and taking the square root of the sum of the squares, a single "weighted average flicker," can be calculated. This calculation can become very complicated, as flicker magnitudes and frequencies change over time, and is best done using a Flicker Meter. The IEEE Flicker Standard is scheduled to be completed in 2004. Until then ATC applies a limit based on a weighted average flicker Pst of 1.0 for short-term flicker and Plt 0.65 for long-term flicker using the calculation methods outlined in IEC (International Electrotechnical Commission) standards modified for use on 120 V systems.

Harmonic Distortion

The level of harmonics acceptable on the ATC system is defined by state regulations, IEEE Standard 519-1992 (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) and the judgment of ATC. In general it is the responsibility of the load to meet harmonic current limits and the responsibility of ATC to meet harmonic voltage limits. Usually, if harmonic current limits are met harmonic voltage limits will also be met.
ATC harmonic limits are required to be followed whenever a harmonic related problem is discovered or a new harmonic producing load with a reasonable possibility of causing harmonic problems is connected to the ATC system. The following process is utilized by ATC when managing an existing harmonic-related problem or a new harmonic-producing load:

1) *Existing Problems* When a harmonic related problem is found on the ATC system, it is ATC's responsibility to determine the source of the harmonics. If harmonic current limits are violated, the source of the harmonics will be required to decrease their harmonic currents to below the limits specified in the ATC Planning and Service Guide. If, after the harmonic current has been reduced to an acceptable level, the harmonic voltage is still causing a problem and still above specified levels, it shall be the responsibility of ATC to bring the harmonic voltages within limits. If limits are not violated and there is still a harmonic related problem (an unlikely situation), it is the responsibility of the entity experiencing the problem to harden its equipment to the effect of harmonics or reduce the harmonics at their location. An existing violation of these harmonic limits that is not causing any problems does not necessarily require harmonic mitigation.
2) *New Harmonic Producing Loads* It is the responsibility of any customer wanting to connect a harmonic producing load to the ATC system to determine if the proposed load will violate the harmonic current limits and, if these limits are violated, to determine and implement steps necessary to reduce the harmonic currents to acceptable levels. If harmonic voltage limits are not met after harmonic current limits have been met, it is the responsibility of ATC to determine if the harmonic voltage distortion will cause any system problems and if they will, it is ATC's responsibility to develop and implement a plan to meet the harmonic voltage limits.

Capacity Benefit Margin Criteria

CBM is defined as the amount of firm transmission transfer capability preserved by a transmission provider for load serving entities whose loads are located on that transmission provider's system, to enable access by the LSEs to generation from interconnected systems to meet generation reliability requirements. ATC shall perform import capability studies to ensure that the

simultaneous import capability of eastern Wisconsin (as a sub-region of MAIN) is sufficient to support a minimum reliability criterion. The present reliability criterion of 0.1 day per year Loss of Load Expectation is dictated by MAIN Guide #6. Determination and application of CBM for the ATC system is in accordance with MAIN's Regional Standardized Capacity Benefit Margin Methodology.

Transmission Reserve Margin Criteria

TRM is defined as the amount of transmission transfer capability necessary to provide reasonable assurance that the interconnected transmission network will be secure. TRM accounts for the inherent uncertainty in system conditions and the need for operating flexibility to ensure reliable operation as system conditions change. At this time, ATC employs no TRM in rating transmission facilities or in determining transfer capability.

Facility Rating Criteria

The facility ratings that ATC will utilize initially in system planning, design and operation will initially be based on the current criteria utilized by the former owners of transmission facilities. ATC will develop appropriate facility rating criteria to ensure consistency across its transmission system. ATC's facility rating criteria and resultant facility ratings is being developed. Facility ratings established by ATC will be consistent between ATC planning and operations. To ensure adequate operating flexibility, ATC will use normal facility ratings during routine maintenance periods.

Facilities to be included are line conductors, underground cable, bus conductors, transformers, autotransformers, circuit breakers, disconnect switches, current transformers, potential transformers, relays (overcurrent/directional overcurrent/impedance) and wave traps. ATC facility rating criteria will be consistent with the following NERC Planning Standards: II.C.S1.M1, II.C.S1.M2, II.C.S1.M3, II.C.M4 and II.C.S1.M5.

Model Building Criteria

ATC will strive to develop and maintain consistency in the powerflow models used for its planning efforts and in assessing whether and under what conditions transmission service is available. The starting point for powerflow models used by ATC will be models contained in the NERC and/or MAIN data bank. ATC will utilize load forecasts provided by its end-use load-serving customers in future model building efforts, both internally and in conjunction with MAIN and NERC. All ATC powerflow models will be developed using PTI PSS/E software. All ATC powerflow models will be publicly available; such models will be posted on ATC's OASIS Web site. NERC Planning Standard:

Facility Condition Criteria

The facility condition criteria to be utilized by ATC for system planning purposes will include:

1) Any transmission line on structures that are beyond their design life, any transmission line that has exhibited below average availability or any transmission line that has required above average maintenance will be considered a candidate for replacement. In assessing potential line replacements, consideration will be given to other needs in the area of the candidate line to determine whether rebuilding the line to a higher voltage would fit into the umbrella plan for that planning zone (see **Planning Zones** below). Close coordination with the engineering, operation and maintenance and environmental personnel at ATC will be maintained, and public input solicited, in such Assessments.
2) Any substation bus that is beyond its design life, has exhibited below average availability or has required above average maintenance will be considered a candidate for rebuilding and potential redesign. In assessing potential bus rebuilds, consideration will be given to likely and potential expansion at candidate substations, including consideration of the umbrella plan for the planning zone. Close coordination with the engineering, operation and maintenance personnel at ATC will be maintained in such Assessments.
3) Any substation whose design or configuration prevents maintenance, in a safe manner, on substation equipment or lines terminating at the substation will be considered a candidate for rebuilding and/or potential redesign/reconfiguration. In assessing such rebuilds/redesigns/reconfigurations, consideration will be given to likely and potential expansion at candidate substations, including consideration of the umbrella plan for the planning zone. Close coordination with the engineering, operation and maintenance personnel at ATC will be maintained in such Assessments.
4) Any underground cable that is beyond its design life, has exhibited below average availability or has required above average maintenance will be considered a candidate for replacement. In assessing potential cable replacements, consideration will be given to other needs in the area of the candidate cable to determine whether replacing the cable with a cable of higher ampacity or with a cable capable of a higher voltage would fit into the umbrella plan for that planning zone. Close coordination with the engineering, operation and maintenance personnel at ATC will be maintained in such Assessments.
5) ATC will strive to verify the efficacy of all operating guides that require on-site operations.

Planning Zones

It is ATC's intent to conduct system planning on a long-range basis by developing plans for the ATC transmission system as a whole as well as plans for specified zones within the boundaries of ATC's transmission system. These zones are shown in Figures III-1 through III-6, attached. The idea behind the zone approach to long-range planning is to develop plans that consider all of the needs/problems/developments within each zone. The goal within each zone would be to develop an umbrella plan for the zone, that is, a plan that emphasizes projects that serve multiple purposes or solve multiple problems within the zone. The zone approach is intended to address requirements for support to the local distribution systems in that zone on a least cost basis. It is anticipated, however, that several projects that span more than one zone or possibly even the ATC transmission system boundaries, may evolve. Such projects will likely involve coordination with other transmission owners or regional transmission organizations.

The planning zones shown in Figures III-1 through III-6 deviate significantly from existing control area boundaries and from planning zones traditionally used for joint planning in conjunction with the Wisconsin PSC. The zones were selected considering the need for a manageable number of planning areas and to consolidate areas within the state with similar topology and load characteristics.

System Alternatives

ATC will consider alternatives to transmission-only solutions for problems on the transmission system as appropriate. Such alternatives could include, but not be limited to, distributed generation, load management and conservation measures. ATC will utilize sound judgment and input from others in assessing whether non-transmission solutions are applicable on a case-by-case basis.

Load Forecasting Criteria

ATC will initially utilize load forecasts provided by its end-use load-serving customers. Such customers are required, under ATC's Distribution-Transmission Interconnection Agreements and Network Operating Agreements, to provide ATC with monthly peak demand forecasts for the next 10 years. ATC may, in the future, develop load forecasts either concurrent with or independent of its load-serving customers. In addition, ATC, in coordination with its load-serving customers, may develop representative load duration

curves based on actual and normalized load conditions. The ATC methodology for developing, aggregating and maintaining load forecast information will be in accordance with NERC Planning Standard II.D.S1.
In utilizing or developing load forecasts, the following criteria will be used:

1) Summer peak demand forecasts will be calculated in such a way that there is an almost equal probability of exceeding or falling short of the forecast when average peak making weather does occur.
2) Summer shoulder peak demand forecasts will be developed reflecting moderate weather days (75o-80o). Such forecasts will be based on a load level that, within a reasonable range, captures as many shoulder peak hours within a representative load duration curve of load connected to the ATC transmission system. These demand forecasts will be developed to evaluate high power transfer conditions.
3) Winter peak demand forecasts will be calculated in such a way that there is an almost equal probability of exceeding or falling short of the forecast when average peak making weather does occur.
4) Fall/spring off-peak forecasts will be based on a load level that, within a reasonable range, captures as many off-peak hours within a representative load duration curve of load connected to the ATC transmission system.
5) A hot summer forecast, reflecting above-average summer weather and peak demand conditions, will be developed. This peak demand forecast will be calculated in such a way that there is a 90% probability of falling short of and a 10% probability of exceeding the forecast due to weather conditions.

Economic Criteria

ATC will conduct appropriate economic analyses when evaluating transmission additions, replacements and modifications. The criteria to be used in such economic analyses for purposes of system planning will include the following:

1) In developing screening level capital cost estimates for transmission lines and substations, terrain, geology and land use will be considered.
2) In conducting transmission system loss analysis, a sufficient number of powerflow cases will be developed to cover a reasonable range of load conditions from which to assess system losses. In addition, the value of losses shall be projected based on the energy futures market or on a credible energy price forecast.
3) In conducting analysis of generation redispatch precipitated by transmission constraints, a sufficient number of powerflow cases will be developed to in order to reasonably estimate the amount of time that such redispatch may be warranted. In addition, the cost of such redispatch will be projected based on marginal production costs and/or historical redispatch cost data of generating units dispatched to relieve the constraint. ATC will determine the economic feasibility of eliminating generation must-run situations based on these analyses.

Environmental Criteria

The overriding environmental criterion to be used by ATC in system planning is that environmental analyses will be conducted at a screening level for alternatives being considered in high-level evaluations. The goal of such environmental analyses is to identify potential environmental impacts, such as aesthetics, avoid such impacts where possible and, where it is not possible, minimize and mitigate such impacts to the extent possible. More detailed environmental analyses will be undertaken to support an application to siting authorities of specific transmission alternatives.

Other Considerations

Project Constructability

ATC will consider the constructability of proposed additions, replacements or modifications to the transmission system as part of its system planning process. In particular, ATC will consider:

1) whether addition, replacement or modification of a transmission line, transformer or other facility would result in violation of the System Performance Criteria above, and
2) whether addition, replacement or modification of a transmission line, transformer or other facility precludes the ability of ATC Operations to conduct maintenance activities on other transmission facilities.

Multiple Contingency Planning

ATC will conduct its system planning in accordance with the System Performance Criteria above, including planning for single contingency events. There may be circumstances, however, where the risk to ATC and/or ATC customers of a multiple contingency event is sufficiently severe to warrant consideration for planning purposes. Examples of such an event would include (i) the loss of a transmission facility during the period of maintenance or repair of another transmission facility, (ii) a multiple contingency arising from a common cause such as a fire, flood, etc., or (iii) failure of a transmission structure supporting multiple circuits. ATC will evaluate the probability and consequences of certain selected multiple contingency scenarios to determine whether to apply a multiple contingency standard.

Such multiple contingency scenarios may warrant consideration of operating guides. In these circumstances, ATC will document the potential event(s), the associated risks and potential mitigation measures, and will coordinate with affected customers, as appropriate. (Applicable NERC Planning Standard: I.A.S4.M4)

Terminal Equipment Limitations

Substation terminal equipment should not limit transmission facility ratings under normal or single contingency conditions. This criterion would apply to new transmission facilities and should be reviewed when proposing modifications to existing facilities.

Maximization of Existing Rights-of-Way

ATC will maximize use of existing rights-of-ways. Existing electric transmission, gas pipeline, railroad and highway corridors will be identified in all comparisons of alternatives and utilized where feasible. As a starting point in each environmental analysis, ATC will utilize the screening-level environmental review employed for all of the new transmission line alternatives considered in prior Advance Plan processes.

Reduction of Transmission System Losses

ATC will strive to plan its transmission system such that transmission system losses are minimized. ATC will undertake this goal by considering system losses along with all other cost factors in all evaluations of alternative transmission projects or plans. See Economic Criteria.

Operating Flexibility

ATC will strive to plan its transmission system such that operating flexibility is maximized. ATC will accomplish this by considering as wide a variety of scenarios as practical, including maintenance scenarios, when evaluating alternative transmission projects or plans.

Radial Transmission Service

ATC will evaluate the risk of serving customer load from radial facilities. Such evaluations will consider the amount of load being served, the capability of the underlying distribution system and the amount of time that service is likely to be interrupted for the loss/failure of the radial facility.