



May 16, 2006

Ms. Sandra Paske
Secretary to the Commission
Public Service Commission of Wisconsin
P.O. Box 7854
Madison, WI 53707-7854

RE: Joint Application of Minnesota Power Company and
Wisconsin Public Service Corporation for Authority to
Construct and Place in Service Electric Transmission Lines
And Other Electric Facilities for the Arrowhead-Weston Project,
Located in St. Louis County in Minnesota, and Chippewa, Clark,
Douglas, Lincoln, Marathon, Oneida, Price, Rusk, Sawyer, Taylor,
And Washburn Counties in Wisconsin

Docket 05-CE-113

Dear Ms. Paske:

The Citizens Utility Board is requesting the Public Service Commission of Wisconsin to investigate pursuant to §§196.02 and 196.28 Wis. Stats. whether the Arrowhead-Weston Transmission Line (Arrowhead) has been properly designed to comply with its Orders in this docket and with electric industry standards.

CUB contends that the electrical capacity of Arrowhead is undersized given its location in the transmission network and its long length. The result of being undersized will produce too great a line impedance, which will contribute to voltage stability problems when power flow exceeds a critical limit. Designing a line with voltage instability at expected levels of power flow violates basic principals and standards of electric power system planning.

Proper design of transmission lines must satisfy three basic principles of electric power system planning. During a single-contingency transmission line outage, the emergency power flow over any line shall not exceed its thermal limit, transmission voltages shall not drop below emergency levels, and the generating system shall remain stable. The design of Arrowhead violates the system stability principle.

Another goal in electric power systems planning is to satisfy specific planning standards of the North American Electric Reliability Council. The planning standard in question is that which requires no single contingency line outage to result in system instability. The Arrowhead line violates this standard.

By violating principles and standards associated with voltage stability, the undersized design of the Arrowhead line will likely cause unstable power flows that can inflict damage to power plants and cause blackouts in the upper Midwest.

There are three primary reasons why CUB is filing this request with the Commission:

1. Larry Thiele, CUB's expert witness in the Arrowhead docket when it was re-opened in 2003, is an experienced electrical engineer who has worked for and with Wisconsin utilities in matters of transmission planning. In his testimony in the 2003 Arrowhead proceeding, Mr. Thiele agreed that a new 345 kV transmission connection between the Wisconsin-Upper Michigan System and the Mid-Continent Area Power Pool was appropriate and necessary to ensure reliability. Because of evidence that first became available to CUB just before the hearing in the 2003 proceeding, Mr. Thiele has voluntarily continued examination of the design and expected performance of the Arrowhead line and has brought new concerns to our attention.
2. The information that initiated Mr. Thiele's additional analysis was the discovery that the original design and studies supporting the Arrowhead line resulted in a line that was undersized and, therefore, had too great an impedance, which will give rise to system voltage instability. In addition, the Applicants had modified the design of the line with the addition of a phase shifting transformer. Despite such a critical design change, the Applicants never affirmatively noted nor disclosed in their testimony the reasons for or the fact that such a design modification was required. The discovery of the voltage instability flaw and design change by CUB and other intervenors just prior to the Arrowhead hearing in September 2003 did not allow either adequate consideration of the voltage instability flaw and potential adequacy of the design modification nor allow adequate analysis to be conducted to assess the efficacy of the adopted solution or more appropriate alternatives.
3. CUB and Mr. Thiele have discussed these matters with one of the Applicants, the American Transmission Company (ATC), but were unable to resolve the concerns regarding the design of the Arrowhead line.

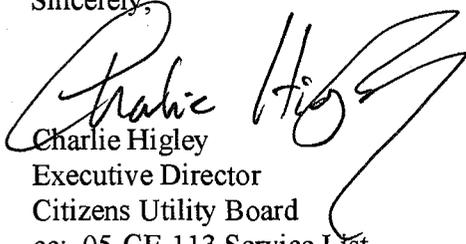
CUB is not in a position to continue an investigation to resolve these issues. Therefore, CUB is asking the Commission to investigate and to take actions to ensure that its orders will result in a proper design of the Arrowhead line.

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Attached is a document written by Mr. Thiele on behalf of CUB, which explains our concerns with the design of the Arrowhead line.

Thank you for your attention to this matter.

Sincerely,



Charlie Higley
Executive Director
Citizens Utility Board
cc: 05-CE-113 Service List

**BEFORE THE
PUBLIC SERVICE COMMISSION OF WISCONSIN**

Joint Application of Minnesota Power Company and Wisconsin Public Service Corporation for Authority to Construct and Place in Service Electric Transmission Lines and Other Electric Facilities for the Arrowhead-Weston Project Located in St. Louis County in Minnesota, and Chippewa, Clark, Douglas, Lincoln, Marathon, Oneida, Price, Rusk, Sawyer, Taylor, and Washburn Counties in Wisconsin

05-CE-113

**REQUEST FOR AN INVESTIGATION OF DESIGN FLAWS IN THE
ARROWHEAD-WESTON TRANSMISSION LINE
BY THE CITIZENS UTILITY BOARD**

I. Statement of the Concerns of the Citizens Utility Board

The joint U.S.-Canada Power System Outage Task Force in its final report on the investigation into the August 14, 2003 blackout emphasized ".....making adherence to high reliability standards paramount in the planning, design, and operation of North America's vast bulk power systems." The North American Electric Reliability Council (NERC) additionally said that actions must be taken to ".....increase public confidence that the reliability of the North American bulk electric system is being protected." Circumstances surrounding the planning, design, and future manner of operation of the Arrowhead-Weston 345 kV transmission line under construction in northwestern Wisconsin have led the Citizens Utility Board (CUB) to believe that project to be in direct conflict with these national goals and not in compliance with the Public Service Commission of Wisconsin's (the Commission) orders granting authority to the applicants Wisconsin Public Service Corp.(WPS), Minnesota Power Company, and American

Transmission Company (ACT) (hereinafter, “the Utilities”) to construct and operate the line.

The primary issue prompting this concern was the discovery during the Commission's hearing in this case in September 2003 of a draft Minnesota Power report, “Arrowhead 230 kV Phase Shifting Transformer Requirements,” dated November 5, 2001 (hereinafter, “phase shifter report”), revealing a flaw in the electrical design of the line that could give rise to system instability and blackout of parts of the upper Midwest. The report said this condition would violate Mid-Continent Area Power Pool (MAPP) reliability rules. CUB argued during the hearing that this issue, along with the Utilities’ proposed use of a phase shifting transformer to compensate for the flaw, would create new reliability problems and would not result in a robust strong new interconnection between Minnesota and Wisconsin. Absent any information or evidence brought forth directly by the Utilities or Commission Staff in the hearing addressing the flaw and the phase shifter, the issue remained unresolved but the project was re-approved in December 2003 for continued construction with the flaw intact.

Continuing investigation of this matter by CUB and L.E. Thiele Consulting (LETC) since the 2003 hearing has led to a further understanding that the flaw is significantly more serious than the parties were led to believe at the time of the hearings. The flaw will place into service a transmission line which will be detrimental to the reliability of electric service to Wisconsin and the upper Midwest. In addition, numerous changes have been made by the Utilities to the planned manner of network operations when the line goes into service compared to the goals and intent of the original planning for the line as outlined in the Wisconsin Reliability Assessment Organization (WRAO)

report of June 14, 1999, the accompanying Wisconsin Interface Reliability Enhancement Study (WIRES) Phase II report, and as supporting the basis for the Commission's orders in the case in October 2001 and December 2003. The changes are substantial enough, and being detrimental to the level of reliability expected to be provided, are not in compliance with the Commission's orders. Some of the actions taken by the Utilities to deal with the flaw have been inconsistent with prudent transmission planning practices and national goals. Therefore, CUB requests the Commission to investigate the design of the Arrowhead line, and if necessary, enforce compliance with its orders and require the Utilities to eliminate the flaw from the Arrowhead-Weston project.

II. Summary of Arrowhead-Weston Project Goals Under Question

Even though the primary goal of the project is to reinforce transmission to permit power transfers at the level of 2000 MW from MAPP to eastern Wisconsin simultaneous with transferring 1000 MW from Illinois into eastern Wisconsin, there are other project goals according to WRAO, WIRES, and the Commission orders that need to be satisfied in order to make the project fully compliant. The goals of WRAO and WIRES are goals of the Commission orders since the orders endorsed and adopted the results of those efforts. The conclusions regarding goal-compliance derive from the identification of the instability flaw in the project and the fact that project construction proceeds with the flaw intact. Additional information supporting CUB's assessment of project goals compliance results from a September 2, 2005 meeting between American Transmission Company, CUB, and LETC, plus a follow-up September 26, 2005 letter from CUB to ATC questioning two aspects of the project (attached), and ATC's October 19, 2005 response letter to CUB (attached). The remainder of this section summarizes the project goals under question.

Subsequent sections provide details.

An inherent goal and industry standard is the satisfaction of three basic principles of electric power systems planning. During a single contingency transmission line outage, the emergency flow over any line shall not exceed its thermal limit, transmission voltages shall not drop below emergency levels, and the generating system shall remain stable.

Arrowhead-Weston is violating the system stability principle.

Another inherent goal and industry standard is the requirement that thorough computer simulations must be performed to analyze proposed transmission reinforcements in order to confirm that the basic planning principles will be satisfied. In the case of Arrowhead-Weston, those simulations initially failed to detect system instability and then once instability was eventually identified, apparent solutions were adopted without proper computer simulation verification.

Another inherent goal requires the project to satisfy specific NERC planning standards. The planning standard in question is that which requires no single contingency line outage to result in system instability. The Arrowhead-Weston project violated this NERC standard when first licensed in 2001 and continues to violate the standard with the instability flaw intact.

The Arrowhead-Weston line is intended to provide a new high capacity transmission line directly across the Minnesota-Wisconsin interface and be capable of backing up the 40-year old King-Eau Claire-Arpin (K-E-A) 345 kV line, the only high capacity line currently existing across the interface. An expectation was created that the new line should be at least as capable as the K-E-A line moving power directly across the interface, both normally and during a single contingency line outage emergency.

However, because of the flaw, use of the line will now be restricted at times when needing to back up the K-E-A line.

Several security problems are to be resolved by the project (see Commission December 2003 Order, p. 22). One is the need to provide adequate dynamic and voltage stability performance. This goal is being violated as a result of the instability flaw in Arrowhead-Weston.

There is a goal to resolve the Arpin open-line phase angle problem which prevents reclosing the K-E-A line without damaging the Weston generators. Circumstances which allowed the flaw to initially go undetected and then remain in the project intact up to the present time have resulted in the Utilities incorrectly concluding this problem is resolved.

There is a goal to reduce the need to rely upon operating guides to handle the Minnesota-Wisconsin interface. There certainly had been no expectation that complex new operating guides would be required with Arrowhead-Weston, but that is now the case.

There is a goal to avoid operating the interface transmission near security limits because of the unacceptable risk of catastrophic system failure that action poses to the region (Commission 2001 Order, p.22). However, because of the flaw in Arrowhead-Weston, the Utilities now plan to operate the line on the verge of instability.

The goal of providing 2000 MW of transfer capability from Minnesota into eastern Wisconsin carried with it no expectation that it would be restricted to a lower level under the condition of simultaneous outage of more than one large generating unit in eastern Wisconsin. However, to avoid power flows over Arrowhead-Weston which can lead to instability, the Utilities now claim the project never intended to support 2000 MW of transfer when more than one large generating unit is out of service.

The Arrowhead-Weston project, by providing a new high capacity link directly across the Minnesota-Wisconsin interface, was not intended to create a new burden on the parallel Iowa/Illinois 345 kV path. However, the Utilities' proposed method of dealing with the instability flaw by restricting flow over Arrowhead-Weston will divert more flow onto the Iowa/Illinois path, thereby increasing its burden.

III. The Flaw Resulted From Mistakes in Planning by the Utilities

The flaw in question is the undersizing of Arrowhead-Weston's line capacity given its location in the network and long length. The result of its electrical design will produce too great a line impedance, thereby allowing it to contribute to system voltage angle instability when its power flow exceeds a critical limit. Every AC transmission line exhibits such a power flow limit or stability limit (directly dependent on its line impedance), which if exceeded, will try to force a difference in voltage phase angle from one end of the line to the other greater than electrically possible, thereby causing nearby generators to go unstable by attempting to adjust their voltage phase angles to satisfy this impossible-to-attain condition. This in turn is accompanied by generator tripping, cascading line outages and network blackout. The stability limit of a new line is normally well above its expected emergency flow level (thermal limit) and generally does not arise as a problem until the line becomes congested, overstressed, and in need of reinforcement. Designing a voltage instability characteristic into a new line such that it creates a problem already at initial installation is an engineering design flaw that violates one of the basic principles of electrical power systems planning (see Section II above) and is, therefore, not accepted industry practice.

There was no expectation in the WIRES planning study nor the Commission's 2001

Order that the Arrowhead-Weston line would operate near its power flow stability limit nor that voltage angle instability would be an issue that must be dealt with. The flaw was mistakenly overlooked in the WIRES study. The Utilities' phase shifter report of November 2001 acknowledges the flaw by stating deficiencies in the WIRES computer studies, ".....solution convergence and undervoltage problems were encountered for a loss of the King-Eau Claire-Arpin (K-E-A) 345 kV transmission line....." It further stated, "At the time, these problems were attributed to higher MAPP export conditions and model differences. No additional investigation was deemed necessary by the study team." However, as a result of the new analyses performed by the Utilities in November 2001, the report also put forth a revised conclusion, ".....it has been determined that the solution convergence and undervoltage problems being encountered in the MAPP model is actually due to voltage instability on the Arrowhead-Weston 345 kV line." The report goes on to say this condition is in violation of MAPP criterion, i.e., MAPP reliability rules.

A new line intended to reinforce the network and enhance reliability rarely encounters a voltage angle instability situation. If the line is radically undersized in capacity, for example designed at too low a nominal voltage and too long in length, it will pick up little power flow in the network because of its excessive impedance and will therefore not operate anywhere near its stability limit nor provide adequate reinforcement. However, if an undersized line is a long line connecting two parts of the network normally operating at widely spaced voltage phase angles and paralleling a very high capacity line normally carrying large power flows, it can experience much higher flow levels that can bring its stability limit into play. That is the case with Arrowhead-Weston, which is being called upon for a K-E-A line outage to parallel the only remaining 345 kV path from

Duluth into eastern Wisconsin, a 750 mile link through southern Minnesota, Iowa, and northern Illinois with widely separated phase angles. In addition Arrowhead-Weston parallels the high capacity Forbes-Chisago 500 kV line connecting Canada to Minneapolis-St. Paul. These unique conditions should have alerted the Utilities of the need to test Arrowhead-Weston for instability, but there is no indication in WIRES they did.

If the flaw would have been properly detected in the course of the WIRES planning study or even during follow-up analysis in preparation for the construction license application to the Commission, the prudent course of action would have been to propose increasing capacity of the line or propose an alternative line to eliminate a voltage instability characteristic anywhere near the expected levels of line power flow. That action would have been consistent with accepted industry transmission planning practices. With respect to the Arrowhead-Weston project, this would normally have included looking at replacing the single-circuit 345 kV line with a double-circuit 345 kV line and extending it to the Forbes 500 kV substation, increasing the nominal design voltage to 500 kV, or choosing an alternative King-Weston 345 kV line along with reterminating the existing King-Eau Claire 345 kV line at a Minnesota substation other than King. None of these actions were taken by the Utilities, neither at the time the flaw was first detected in 2001 just after receiving the Commission license nor up to the present time.

The industry standard for designing a new line to reinforce the network is to ensure it will satisfy at minimum three primary requirements under the condition of a single contingency line outage: no lines will experience power flows beyond thermal limits, transmission voltages will not drop below emergency levels, and generators will not experience instability accompanied by cascading outages and blackout. Detailed computer

simulations are required to verify proper operation. In the case of Arrowhead-Weston, generator instability could occur following outage of the King-Eau Claire-Arpin 345 kV line. The fact that Arrowhead-Weston may not protect against generator instability is a major engineering design flaw which will result in a significant degradation to system reliability, none of which was contemplated by WIRES nor the Commission orders.

IV. Connecting Arrowhead-Weston to the Network Through 230 kV Lines Was a Mistake in Planning

During the 2003 Commission hearing, no problem was acknowledged by the Utilities associated with connecting Arrowhead-Weston to the 345/500 kV grid in Minnesota through lower voltage 230 kV lines near Duluth. They say further extension of the line to directly connect to the 345 kV or 500 kV grid is unnecessary and would add extra cost. However, the follow-up investigations by LETC now reveal the chosen configuration using the 230 kV lines adds to the voltage angle instability problem by lowering the power flow limit at which instability can be encountered. In addition to every AC transmission line exhibiting a power flow limit beyond which instability occurs, individual paths in the network also exhibit similar power flow limits. Such is the case for the entire path from the 345 kV substation at Weston, across Arrowhead-Weston, and across the Duluth-area 230 kV lines to the nearest 500 kV grid location at Forbes substation about 50 miles northwest of Arrowhead. For the same length line, 230 kV lines present greater impedance compared to 345 kV lines. The additional line impedance presented by the 230 kV lines, when added to the already excessive line impedance of Arrowhead-Weston, lowers the overall power flow limit at which voltage angle instability can occur across this path. Overlooking this engineering design issue was also a mistake by the Utilities in the planning for Arrowhead-Weston.

V. The Arrowhead Phase Shifter Has Not Resolved the Instability Problem

Rather than eliminating the instability flaw in the line's design, the Utilities propose to compensate for Arrowhead-Weston's instability characteristic by installing a phase shifting transformer at Arrowhead to restrict power flow over the line to prevent that flow from exceeding the line's power flow limit and thereby prevent voltage angle instability, despite this not being standard industry practice with respect to installing a new high capacity line. However, the Utilities never performed the appropriate computer dynamics simulations to thoroughly test whether the phase shifter can actually prevent instability. This was confirmed in ATC's October 19, 2005 letter responding to CUB's September 26, 2005 letter questioning when the appropriate computer studies would be performed. Without that analysis the phase shifter's adequate performance and the prevention of instability is only speculation and remains unresolved.

Neither the voltage instability flaw nor a potential phase shifter solution was mentioned in the Commission's October 2001 Order. No information on the voltage instability problem and phase shifter was brought forward by the Utilities in the 2003 Commission hearing. The Utilities' draft phase shifter report was discovered and entered into the record by an intervenor, Save Our Unique Lands (SOUL), and not by the Utilities. There was no sufficient information presented and substantiated by the Utilities to allow a determination that a phase shifter can prevent instability. ATC informed CUB at the September 2, 2005 meeting that they did not finalize the phase shifter report until September 2004, well after the Commission's December 2003 Order reconfirming the project. That shows that at the time of the 2003 hearing, the instability issue and phase shifter solution were still unresolved. In fact, the Utilities could not confirm that the

appropriate computer dynamics analysis to test whether the phase shifter can prevent instability has yet been performed (ATC October 19, 2005 letter to CUB). Deciding on a phase shifter solution without first performing proper computer analyses and then sidestepping this critical issue at the 2003 hearing were imprudent actions that threaten the reliability of Wisconsin's bulk electric system.

A phase shifter can only restrict flow over the line and divert it to alternate paths. It does not remove the instability characteristic from the line, thereby leaving the design flaw intact and the system vulnerable to instability. A critical time when Arrowhead-Weston is most susceptible to creating instability is within the first few seconds immediately following outage of the King-Eau Claire-Arpin 345 kV line, or just the Eau Claire-Arpin section, when the maximum 2000 MW of power is being transferred from northern MAPP into northeastern or north central Wisconsin. The response of generators to the sudden large shift in power flows will likely create a transient disturbance more severe than a fault on the K-E-A line and therefore requires careful computer analysis to verify stability. There is no indication the Utilities performed this analysis.

Using a phase shifter at Arrowhead to restrict power flow on Arrowhead-Weston will divert power flow to the parallel Iowa/Illinois path and therefore place a burden on that path not anticipated in WIRES nor the Commission orders. The goal of substantially increasing Minnesota-to-Wisconsin power transfer capability is, in effect, being advanced at the expense of forcing greater reliance on the Iowa/Illinois path.

VI. The Utilities Plan to Operate Arrowhead-Weston on the Verge of Instability

Based upon the Utilities' November 2001 phase shifter report plus comments

offered by ATC at the September 2, 2005 meeting, the Utilities admit there is a risk of instability and will therefore plan to use the phase shifter to attempt to operate just under the stability limit at times. They have taken this position even without having run the proper computer dynamics analysis to verify the phase shifter can prevent instability.

The phase shifter is most likely to be used to restrict power flow over Arrowhead-Weston in the very situation when the line's capacity is most needed, backing up an outage of the K-E-A line at times when the maximum 2000 MW power transfer is being scheduled from northern MAPP into eastern Wisconsin. It is at these times when Arrowhead-Weston is likely to experience its greatest power flow and could exceed the stability limit. The phase shifter report says Arrowhead-Weston will experience instability at about 740 MW. A simple textbook calculation puts the limit in the 700-750 MW range. The Utilities' plan is to lower the flow level by about 60 MW when K-E-A is outaged. But that is less than a 10 percent reduction with respect to the limit, meaning the line is still very close to the stability limit and will require strict operating guides to prevent an unanticipated flow over the limit.

Neither operating Arrowhead-Weston on the verge of instability nor requiring strict operating guides for a new line were expectations of the WIRES planning study nor the Commission orders. The Commission's October 2001 Order recognizes that stability is a security concern (p 19, paragraph 2) and confirms that position in the December 2003 Order (p. 25, section D). The 2001 Order also states that a compelling case has already been made that continued operation near security limits exposes Wisconsin customers and the entire region to catastrophic system failure (p. 22, paragraph 1). The orders recognize reliance upon operating guides as security concerns (2001 Order, p. 19, section 2,

paragraphs 2-3 and 2003 Order, p. 25, section D) and that Arrowhead-Weston is intended to eliminate the Arpin operating guides and with no expectation to create a need for new operating guides (2001 Order p. 30, last paragraph and 2003 Order p. 25, section D).

The phase shifter cannot be set to divert an arbitrary amount of power flow to the parallel Iowa/Illinois path in an attempt to operate Arrowhead-Weston well below its stability limit. That parallel path also has a stability limit, and in fact that limit is one of the needs requiring the Arrowhead-Weston reinforcement to begin with. The phase shifter, if it is to function properly at all, will need to be carefully controlled with strict operating guides to hold a fine line between instability on either of the parallel paths, an extremely difficult proposition. Without the Utilities having run detailed computer studies, this mode of operation seeking a stable point using two unstable paths strongly suggests the phase shifter will not prevent instability following a K-E-A outage.

VII. The Utilities Have Narrowed the Scope of the Arrowhead-Weston Project

The primary goal of the project is to reinforce transmission to permit power transfers at the level of 2000 MW from MAPP to eastern Wisconsin simultaneous with transferring 1000 MW from Illinois into eastern Wisconsin. However, there are other goals clearly a part of the project scope according to WIRES and the Commission orders as summarized in Section II above. All of these goals must be satisfied to claim the Arrowhead-Weston project is robust and will protect reliability of the bulk system. The Utilities have narrowed the scope of the project by claiming that the project need only satisfy the 2000/1000 MW transfer goal to be successful, disregarding the other established goals.

More recently they have also narrowed their viewpoint of what constitutes a 2000

MW transfer Arrowhead-Weston should accommodate without causing instability. To ensure the proposed project is robust it must avoid system instability under a wide array of most probable conditions. Proper planning would normally identify a worst case condition or set of conditions for which the selected reinforcement must still satisfy the 2000 MW transfer goal along with the other goals of the project. This worst case must satisfy the three basic planning principles for reinforcement: a single contingency line outage should not result in line thermal overloads, transmission voltages below emergency limits, nor system generator instability. In the case of Arrowhead-Weston, WIRES correctly identified the worst case condition as a single contingency outage of the K-E-A line at the time a 2000 MW transfer is in place.

However, there is a vast array of possible conditions surrounding a 2000 MW transfer that also affect determination of what are the appropriate worst cases to accommodate. One very important factor is a locational factor. This involves the location of the generators in MAPP providing the sources for a particular transfer and the location of any outaged generators or generator deficiencies in eastern Wisconsin. This locational factor has a great effect on the maximum level of power flow Arrowhead-Weston will experience during a K-E-A outage and therefore the potential for creating instability. For example, the highest flows over Arrowhead-Weston are generally expected to occur for 2000 MW transfers from generation sources in northern MAPP (Twin Cities, Duluth, northern Minnesota, North Dakota, Manitoba) versus southern MAPP (southern Minnesota, Iowa, South Dakota, Nebraska) and a destination reflecting generator outages or deficiencies in north central and northeast Wisconsin versus southern Wisconsin. WIRES drew its conclusions on scenarios which concentrated on transfers reflecting

generation sources in both southern MAPP and northern MAPP along with reductions from generators concentrated most heavily in southern Wisconsin. Those types of transfers favor greater use of the Iowa/Illinois path and stress Arrowhead-Weston less.

As the Utilities' November 2001 phase shifter report indicates, when Arrowhead-Weston was stressed in the planning studies with transfers primarily from northern MAPP, thereby creating a greater worst case flow over the line, instability resulted. The report indicates WIRES apparently tried to simulate this stress level, but those simulations failed and were ignored and the instability problem eluded detection.

There was no expectation in WIRES that 2000 MW transfers from northern MAPP to cover deficiencies primarily in north central and northeast Wisconsin would not be accommodated. There was considerable emphasis in WIRES and the Commission's orders, including discussion of severe historical generation outage events, of the need for Minnesota-Wisconsin transmission improvement to accommodate events like simultaneous outage of several large generators such as the Kewaunee and Point Beach nuclear units. (See WRAO Report, p.5, Introduction; WIRES Phase II Report, Attachment C; and Commission 2001 Order, p. 4, paragraph 2.)

One of the most likely scenarios under which 2000 MW will be transferred from MAPP into eastern Wisconsin is during simultaneous outage of several large generators in eastern Wisconsin. There is no reason to believe that scenario to be significantly less likely compared to simultaneous generation reduction of many smaller generating units as used for the basis of the WIRES study. The Utilities however, have recently claimed (as evidenced by comments made at the September 2, 2005 meeting with ATC) simultaneous outage of multiple large generators in eastern Wisconsin is a scenario more severe than

will be accommodated by Arrowhead-Weston, thereby saying a 2000 MW transfer will be restricted to something lower should that scenario occur and pose a risk of instability on Arrowhead-Weston. This attempt at simply narrowing the project goals allows the Utilities to conveniently claim the worst case flow over Arrowhead-Weston is now anticipated to be low enough such that instability will not occur, dismissing the mistakes in the original project design.

It is not logical that the Utilities would plan to back off from a 2000 MW transfer under the condition of having several large generating units off at the same time. It is likely there would be insufficient other generation to back up the large unit outages and that is a reason for needing to import as much as 2000 MW in the first place.

One of the multiple unit generating unit outage scenarios of great concern with respect to that scenario's effect on creating a high flow level over Arrowhead-Weston and then instability following a K-E-A outage, is the simultaneous outage of Weston Unit #3 and Weston Unit #4. The MVAR reactive power output from these units is a key factor in maintaining stability with the flawed Arrowhead-Weston line. If the flaw remains intact, it is very likely 2000 MW transfers must be restricted whenever both of these units are out of service.

VIII. Arrowhead-Weston Will Be Put Into Service as an Overstressed Line

The thermal rating of Arrowhead-Weston will be 1400 MVA, which will allow for over 1000 MW of emergency line flow. The 40-year-old K-E-A 345 kV line is capable of 1000 MW of flow in an emergency and has already experienced flows at that level. The WIRES study shows that the K-E-A line will actually carry a flow near that level when called upon to back up an outage of the Arrowhead-Weston line with a 2000 MW transfer

in place. On the other hand, Arrowhead-Weston will experience instability somewhere in the 700-750 MW flow range as acknowledged by the Utilities and proven by a simple textbook calculation. It is likely that running proper computer dynamics simulations will show that connecting Arrowhead-Weston through the lower voltage 230 kV lines will further lower the stability limit to the 600-700 MW range. The planned use of a phase shifter to restrict flow over Arrowhead-Weston will itself drop maximum allowed flow to under 700 MW.

These restrictions give Arrowhead-Weston the characteristics of a congested, overstressed line. These are the characteristics of a line in need of reinforcement, not a new line intending to provide major reinforcement, and conflict with the Commission's finding that the project should "mitigate congestion loadings on the existing MAPP-WUMS interface (Commission 2003 Order, p.22, section 9, paragraph 2).

IX. The Arpin Phase Angle Problem Associated With Potential Weston Generator Shaft Damage Has Not Been Resolved

While the WIRES study emphasized the critical nature of eliminating the problem of damaging the Weston generator shafts following reclosure of an outaged K-E-A line, it concluded Arrowhead-Weston would provide only less than a 10 percent improvement to the stress level imposed on the generators. CUB argued in the 2003 hearing this was not a sufficient resolution to the problem and would still leave the Weston generators vulnerable. It is the Utilities' narrowed view of conditions under which a 2000 MW Minnesota-to-Wisconsin transfer will be acceptable that also limits their understanding of the severity of shaft stress following K-E-A reclosure. If transfers under the conditions contemplated in WIRES are expected, it is very likely this problem will remain and will result in continued application of operating guides, including a guide to limit certain 2000

MW transfers. Any such Arpin operating guide having a high likelihood of still needing to be applied is not consistent with the Commission's orders. (Commission 2001 Order p.19, section 2, paragraph 2; 2001 Order p. 30, last paragraph; 2003 Order, p. 22, section 9, paragraph 2.)

Furthermore, the WIRES conclusion with respect to resolving the Arpin phase angle problem was based on incomplete information. By failing to understand that its computer simulations had detected voltage instability in the design of Arrowhead-Weston and therefore disregarding the true meaning of that part of the analysis, WIRES did not thoroughly simulate the Arpin phase angle problem and drew an erroneous conclusion that the problem had been resolved. Flow levels across Arrowhead-Weston that would trigger instability would result in larger open-line phase angles across the outaged K-E-A line and very likely, greater line-reclosure shaft stress at the Weston generators than concluded in WIRES.

A related concern not yet addressed and resolved is the effect of the Utilities' phase shifter solution on the shaft stress issue. At critical times when the phase shifter is used to restrict flow over Arrowhead-Weston in an attempt to avoid instability for a K-E-A outage, the action of the phase shifter to divert more flow onto the Iowa/Illinois path increases the overall voltage phase angle between Duluth and Weston. This also increases the phase angle across the open K-E-A line and is therefore likely to aggravate the shaft stress problem.

The Utilities now say (based upon comments at the September 2, 2005 meeting with ATC) the installation of the new Weston Unit #4 generator currently under construction has been shown to have a dampening effect on the shaft stress problem

because of that unit's greater mechanical inertia. That may be the case when Unit #4 is on line. However, when Unit #4 is out of service the situation with Unit #3 still on line reverts back to the original unresolved problem. The Utilities would need to plan to restrict 2000 MW transfers when Weston #4 is off, an action inconsistent with the goals of WIRES and the Commission's orders expecting that the maximum 2000 MW can be transferred to cover generator outages.

X. The Voltage Instability Flaw Violates NERC Planning Standards

The Utilities November 2001 draft phase shifter report says the voltage instability problem with Arrowhead-Weston violated MAPP reliability rules, and given that MAPP is a regional council within NERC, also violated NERC planning standards. The planning standards in question are those which require no single contingency line outage to result in system instability. The Utilities insist that no NERC planning standards are currently being violated given their position that the proposed phase shifter solution will restrict line flow to avoid instability. However, the lack of a proper computer dynamics simulation to verify the phase shifter's ability to prevent instability leaves that issue unresolved. And with the instability flaw still intact in the line's design, NERC planning standards are currently being violated.

This issue was presented to NERC in February, 2005 by LETC in the form of a 16-page violation report describing in detail the specifics of the Arrowhead-Weston project, the mistakes made in its planning, and a request to urge NERC to investigate the matter to confirm that standards were violated and that compliance should be enforced against the responsible companies constructing the line. NERC had just issued its own 14-point recommendations in response to the August 14, 2003 blackout saying it would be willing

to receive specific information on all violations of NERC standards so it could obtain full compliance with all standards. The recommendations convey a strong message that NERC is committed to maintaining very high standards of quality and integrity in the planning, engineering, and decision making for new transmission facilities to minimize the potential for any future devastating blackouts.

NERC quickly dismissed the complaint without investigation, relying on statements from its regions (MAPP and MAIN) and the Utilities (particularly American Transmission Company) that no violation of standards occurred. Given that NERC is apparently positioning itself to be the organization that will be given federal authority in the near future to enforce mandatory compliance of reliability standards, this was a prime opportunity for NERC to demonstrate its promise to that end. NERC instead backed away and failed to uphold its own stated commitment to ".....increase public confidence that the reliability of the North American bulk electric system is being protected." In addition, in spite of NERC being the country's leading overseer of transmission reliability, NERC abdicated its authority by saying the Wisconsin Commission is the proper forum in which to take up this reliability issue. Violation of NERC planning standards is inconsistent with the goals of WIRES and the Commission's orders.

XI. The Commission is Urged to Act

Arrowhead-Weston is being constructed as a flawed project resulting from several failures in engineering planning and design on the part of the Utilities, including: failure to initially test for and detect a voltage instability characteristic in the line's electrical design, failure to understand that connecting Arrowhead-Weston to the 345 kV grid in Minnesota through lower voltage 230 kV lines will further aggravate the voltage instability

characteristic, failure in proposing a phase shifter solution to compensate for the voltage instability characteristic without ever performing the required computer dynamics analysis to verify that solution will work, and failure to investigate industry-standard alternatives for eliminating any voltage instability characteristic from the project design. The flawed project continues to violate NERC planning standards.

Furthermore, the Utilities have narrowed other project expectations established by WIRES and the Commission orders, including: restricting some conditions of generation outages under which the full 2000 MW maximum power will be transferred, not providing a new line as capable as the existing line it is primarily intended to back up, restricting flow on the line and thereby creating a new line already overstressed at installation, causing new operating guides to be required when the intent was to eliminate operating guides, planning to operate near security limits, not eliminating the Weston generator shaft damage problem, and creating an expanded reliance on the Iowa/Illinois parallel 345 kV path.

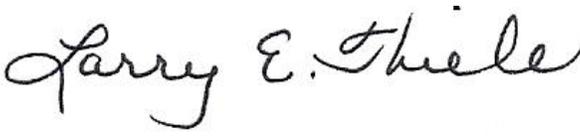
These actions are out of line with national initiatives to advance the quality of transmission planning and will result in an Arrowhead-Weston line which will create a very significant detraction to system reliability improvement. Should the Commission decide not to investigate these concerns, there will be a high risk to Wisconsin consumers that system instability will occur in the future along with possible blackouts. The Commission is also urged to not reopen a hearing for this project just for the purpose of simply redefining the scope and expectation of what the new line should be capable of providing in order to accept the planning and design mistakes made by the Utilities. Instead, the flaws need to be eliminated and compliance with previous orders in this case

need to be enforced. Anything less will erode public confidence that reliability of the bulk electric system is being protected and is not in the best interest of electric consumers and the public in Wisconsin.

Dated this 16th day of May, 2006

Respectfully submitted,

L.E. Thiele Consulting

By: 

On Behalf of the Citizens Utility Board

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September 26, 2005

Don Morrow
American Transmission Company
N19 W23993 Ridgeview Parkway West
P.O. Box 47
Waukesha, WI 53187

Dear Mr. Morrow:

I'd like to thank you, Dale Burmester, and Mike Marz for meeting with me and Larry Thiele on September 2, 2005 to review Larry's concerns regarding the Arrowhead-Weston project. While the meeting was very helpful to our understanding of ATC's position, two issues raised enough further concern to prompt this letter.

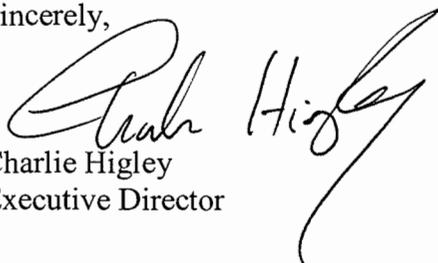
First, we are confused by your discussion of not considering simultaneous unexpected outages of multiple large generating units in eastern Wisconsin when formulating a worst case scenario for which to test the effectiveness of the phase shifter in preventing instability following outage of the King-EauClaire-Arpin line. This was one of the major drivers for the project as emphasized in WIRES. If you are prepared to back off from a 2000 MW MAPP-to-WUMS transfer in such cases if it becomes apparent that the phase shifter may not prevent instability, how does that satisfy the original intent of the project?

Second, ATC has apparently not performed any dynamics stability study to specifically analyze the potential for system instability with the phase shifter in place during the transient disturbance immediately following outage of K-E-A with a 2000 MW transfer in place, nor any other stability studies specifically testing the effectiveness of the phase shifter. What is your plan for conducting such studies?

Both of these issues speak to two of our greatest concerns at this point: that ATC has not brought forward appropriate information proving that the phase shifter will reliably compensate for the instability characteristic in Arrowhead-Weston; and that numerous changes have been made to the project so that it no longer will perform as intended by WIRES and the Commission order.

CUB remains concerned about the performance of this line if and when it is placed into service. Your response to these concerns would be most appreciated.

Sincerely,



Charlie Higley
Executive Director



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October 19, 2005

Charlie Higley,
Citizens' Utility Board
16 N. Carroll St., Suite 170
Madison, WI 53703

Dear Mr. Higley,

It was our pleasure to meet with you and Mr. Larry Thiele on September 2, 2005 to discuss our Arrowhead -Weston 345kV project. Following that meeting, you sent a letter dated September 26, 2005 raising two follow-up questions about this project. Following are ATC's answers to these questions:

Answer to Question 1: This question implies that Arrowhead -Weston should satisfy undefined conditions that would involve an unspecified number of simultaneous contingencies. The straightforward answer is that ATC cannot warrant that this, or any other project, will achieve design goals beyond the design conditions.

ATC follows specific planning criteria when planning the electric transmission system. Our planning criteria are summarized in the ATC 10-Year Assessment, and may be found at: <http://www.atc10yearplan.com/PF7a.shtml> . These criteria establish the number of credible, simultaneous contingencies that should be considered when studying the system. No project is ever developed to satisfy a large, but unspecified, number of simultaneous outages. Instead, projects are evaluated assuming 1 or 2 simultaneous contingencies (often referred to as "N-1" or "N-2", respectively). If a transmission owner develops projects using a greater than N-1 criterion, they may be open to an accusation of over building the transmission system. (Note: there may be good reasons to go beyond N-1 or N-2, but it is situation dependent.)

In addition to the planning criteria, a project is designed to achieve specific objectives. The Arrowhead-Weston project is designed to achieve an import capability of 2000/2000/3000 (i.e., 2,000 MWs maximum for the South alone/2,000 MWs maximum from the West alone/3,000 MWs maximum combined between both South and West) while withstanding an N-1 contingency outage. This was the objective of the WIRES analysis. Since the case used to simulate an import of up to 3,000 MW has to presume some level of capacity deficiency in the ATC footprint, the analysis is predicated on the loss of some generators. In some ways, this deficiency creates a stressed transmission system to start with and some would argue that this is already an N-1 state. Please note,

though, that ATC has not defined N-1 in this manner. Using the phase shifting transformer, this project achieves the 2000/2000/3000 objective for all N-1 contingencies.

Answer to Question 2: Although final studies have not been completed, ATC has performed both transient and dynamic stability analysis with the Arrowhead PST modeled. Extensive transient analysis with the PST in service was part of the "Arrowhead-Gardner Park Transmission Project Design Requirements" study completed by Teshmont Consultants (latest revision September 9, 2004). This study can be made available to CUB once the appropriate confidentiality agreements have been signed.

Dynamic stability analysis with the Arrowhead PST in service was performed as part of the G144 (Weston 4) generator interconnection study. While this study did not simulate the loss of the King-Eau Claire-Arpin line or specifically look at Arrowhead PST operation, events similar to these were simulated as part of the initial G144 generator interconnection studies. These studies evaluated events such as a fault on the Arpin-Eau Claire line during an outage of the Arrowhead-Weston line. This and similar events were not found to be limiting events for G144 operation and were, therefore, not simulated as part of later G144 report addendums. Similar events are presently being simulated as part of the G523 (Weston 5) generator interconnection study. The G144 studies are available on the MISO oasis at:

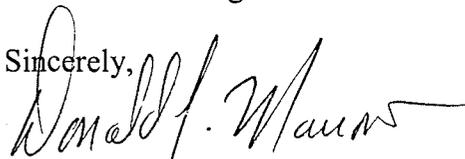
http://oasis.midwestiso.org/documents/ATC/GIC044_Facility_Study_Report.pdf.

The results of the G144 interconnection studies make us confident that the Arrowhead-Gardner Park line will allow us to meet the project's 2000/2000/3000 design goals, especially with the added operational flexibility provided by the PST. To confirm these expectations ATC is working with Minnesota Power to assemble a dynamics ready PSSE model that will be used to evaluate the effect of this project on the dynamic response of the system. This model will more accurately model the proposed Weston 4 generation and the system conditions in both the MAIN and MAPP areas. Once this model has been assembled and tested, we will begin studies to quantify the operational benefits and reliability improvements to the ATC footprint provided by the Arrowhead-Gardner Park line.

I hope that this resolves all remaining concerns you have regarding the Arrowhead-Weston project. If so, I would appreciate a short note back confirming that we have addressed your concerns and ask that you close the loop with PSCW staff so indicating that you're questions have been resolved.

If you still have questions regarding Arrowhead-Weston, please contact me immediately and we will arrange for another face-to-face meeting.

Sincerely,



Donald J. Morrow

Director System Planning & Protection