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Memorandum

VIA ELECTRONIC MAIL

DATE: **March 29, 2007**

TO: **Paul Schumacher**

FROM: **David Cullum**

RE: **Presque Isle Remedial Action Tripping Scheme (RATS) Study Results**

Background:
The existing Presque Isle RATS scheme was developed in the early 1990's with the last study performed in 1999. The primary driver for the original RATS installation was to allow a greater transfer of power out of the Marquette Iron Range area while protecting the Presque Isle Power Plant against first swing angular instability. The review study in 1999 gave some consideration to thermal overloads, but again the primary focus was generator stability. Since 1999 system topology has changed, and a restudy was warranted.

As presently configured, RATS will trip generating units at Presque Isle for a fault on any one of twenty monitored transmission elements. The amount of generation tripped is dependent on the fault type and fault location. Three levels of generation tripping are used based on fault severity. The levels are determined by actual system conditions, and the Presque Isle plant operator arms adequate generation for tripping based on communication from the ATC System Control Operator.

On August 1, 2006, the Midwest ISO (MISO) called for load curtailment within its footprint. In response, We Energies curtailed the load at the Empire and Tilden mines from about 225MW to about 25MW. The resulting increased flows from out of the Marquette Iron Range region caused ATC Operations to see a first contingency overload of the Empire – Forysth 138-kV line for loss of the Dead River – Plains 345-kV line. As a result, MISO then backed down Presque Isle generation to resolve the contingent overload.

Preliminary Study Results:
ATC has made a number of system improvements in the area (e.g., re-conductoring the Plains to Stiles 138-kV corridor) resulting in a reduction of system impedance between the Marquette, MI area and the remainder of the transmission network. ATC has examined local transient stability performance with these system changes, primarily to identify if any changes to the existing RATS relay settings are warranted.

The stability study found in all cases that the first swing angular stability of Presque Isle has either remained unchanged or improved. Based on these study results, ATC could modify the RATS relay settings to match the new stability results, which would reduce Presque Isle exposure to generator tripping.

However, another consequence of the reduced system impedance is increased power flows out of the Marquette Iron Range area. The thermal study of 2007 intact system conditions found that the key facility impacted last summer (i.e. Empire-Forsyth 138-kV line for the loss of either Presque Isle-Dead River 138-kV or Dead River-Plains 345-kV transmission lines) is sensitive to both Marquette area export and to Midwest region transfers, whether the power is moving from the Upper Midwest and Illinois to Michigan and the Ohio River valley or vice versa. The thermal study considered the impact of a variety of ATC system load levels, Presque Isle generation output levels, Empire and Tilden mine load levels and Midwest region transfers.

These studies confirmed that the Marquette, MI area 138-kV system may experience next contingency overloads that must be mitigated through either MISO-issued pre-contingency generator redispatch or system improvements, whether this is transmission upgrades, RATS relay setting changes or a combination of these two. However, it should be noted that even system improvements may not mitigate all need for pre-contingency generator redispatch since the thermal study only considered single contingency analysis with an otherwise intact transmission system. As real-time system conditions diverge from those studied (e.g., a prior outage of another transmission element), MISO may be required to implement generator redispatch to mitigate any next contingency violations.

The thermal study shows that the RATS relay settings can be altered to protect the Presque Isle Power Plant from first swing angular instability and mitigate post-contingency thermal violations in the local area. One consequence, however, is that including the post-contingent thermal mitigation into the RATS tripping scheme would significantly increase the likelihood and magnitude of Presque Isle generation tripping, even when an overload would not occur. Since the relays which implement the RATS are unable to detect the system conditions, the trip signal sent to Presque Isle would be the highest level of generation tripping needed under the most severe system condition. A compromise position would be to only implement the required "thermal" RATS trip settings when system conditions warrant. This scheme is described in more detail below and would mitigate, if We Energies chose to request implementation of this scheme, much of the pre-contingency redispatch of the Presque Isle power plant while reducing the likelihood of sending the most severe generation trip signal.

Since the MISO-issued binding constraint process will adequately address system reliability issues, such as the potential for thermal overloads, ATC is not recommending any change to the existing RATS relay settings other than those warranted by the system stability studies. However, the following section presents the various options for this area considered by ATC during performance of this system study.

Tables summarizing the stability and thermal studies are included as an attachment. Tables 2 and 3 provide the updated RATS relay settings for the various transmission elements in the protection scheme.

Summer 2007 Options Considered:

Several possible near-term options have been considered, including:

1. Make no changes to the RATS relay settings, and if the contingent overload occurs in real time, MISO would bind the constraint and redispatch generation. One possible outcome is Presque Isle generation being redispatched to a reduced output level as was done in 2006. The summer 2006 redispatch occurrence was due to the curtailment of the loads at Empire and Tilden mines. Therefore, the probability of this event re-occurring is a function of how often these mines are expected to be curtailed.

2. Upgrade the Empire – Forsyth 138-kV line. The preliminary gross estimate to increase the rating of this 18 mile line is $2.7M, assuming replacement of some structures to improve clearance but reusing the conductor. This would require significant engineering, construction, and budgetary resources and cannot be completed before summer 2007. In addition, as indicated in the thermal study results, there is the potential for other 138-kV transmission elements to be overloaded for the same contingencies, although to a lesser degree than the Forsyth line. Therefore, upgrading this transmission line would not mitigate all potential constraints in the Marquette Iron Range area.

   Further study of this option is required. Planned system changes and additions in the 2009 to 2010 timeframe may impact the required rating for this line. Therefore, ATC would not initiate a project of this magnitude until the impacts of the future system changes are fully known (see Long Term Considerations below).

3. Implement an automatic runback scheme on the Presque Isle units triggered by loss of the critical corridor. As a stand alone option, the ramp rates of the units are insufficient to reduce the overload in an acceptable period of time. This scheme would likely require wiring and setting changes at ATC's Dead River and Presque Isle facilities as well as at the Presque Isle plant, since the signal to be sent to the Presque Isle plant must be differentiated from the existing trip signals sent. In addition, changes to the ATC Energy Management System (EMS) would be required to calculate and communicate the necessary Presque Isle runback amount to the plant in real-time. ATC estimates that it would be very difficult to install this scheme prior to summer of 2007 due to the engineering required to ensure operation of the system in a secure and reliable manner, along with engineering time needed to physically implement the system.

4. Incorporate the post-contingent thermal mitigation in the RATS relay settings and accept the greater risk of generator tripping for both the Presque Isle-Dead River 138-kV and the Dead River-Plains 345-kV contingencies. Altering the existing relay settings can likely be implemented before summer 2007 at a minimal cost. However, this option is not acceptable since the indiscriminate loss of generation in the Marquette area due to the higher level trip signal sent to Presque Isle can cause overloads in the Fox Valley region under certain system conditions.

5. Provide alternative settings for the RATS scheme that are selectable by the ATC System Control Operator (SCO) to accommodate system conditions. The primary settings would be based on the updated stability study settings and protect the Presque Isle Power Plant from first swing instability. The primary settings would be in use the majority of the

time. The alternate settings would protect the Presque Isle Power Plant from first swing instability and mitigate certain post-contingent thermal overloads on the transmission system in the Marquette Iron Range area. These alternate settings would be enabled during periods of high transfer out of the Marquette Iron Range area when system conditions warrant their selection and would only apply to RATS relaying at Presque Isle and Dead River. The ATC SCO would change from primary to alternate settings when the real-time contingency analysis identifies a first-contingency overload for any loss of the Presque Isle – Dead River – Plains transmission corridor. The transition from the alternate settings back to the primary settings would be done when the first contingency overload disappears from the real-time contingency analysis study results.

The only exceptions to this scheme would be the primary RATS relay settings for the Plains relays monitoring the Plains 345/138-kV transformer and the Dead River relays monitoring the Dead River-Plains 345-kV line, as explained below.

The Plains relays would not need alternate settings and the primary RATS settings would be based on the 2007 thermal study results settings, which are less severe than the existing RATS settings at this location, but are higher than needed based on the updated stability study. The settings of the Dead River relays would store both primary and alternate settings.

The Dead River primary RATS settings would be based on the updated stability settings for all fault types except for a three phase fault within 40% of the line length. This one fault scenario would need to be changed from a mid-level trip signal to a high level trip signal (i.e. more generation will be tripped) to ensure mitigation of next-contingency thermal violations. The alternate RATS settings for Dead River would be based on the 2007 thermal study settings.

The existing RATS relays have the ability to hold two different settings and can change from one to the other through the use of a contact point. In this case, ATC would wire a contact point from the Presque Isle and Dead River station RTUs to the individual RATS relays at these substations. This would allow the ATC SCO to select the primary settings or the alternate settings. It should be noted that this option does not require any physical or operating changes at the Presque Isle Power Plant. The plant operator would continue to arm generation at the plant as directed by the ATC SCO.

The alternate settings would need to be implemented at both the Dead River and Presque Isle ATC facilities to monitor for a loss of the Presque Isle – Dead River 138-kV line or the Dead River – Plains 345-kV line. Under normal operating conditions, the primary settings would be in use. If the real time contingent overload occurs, the ATC SCO would select the alternate settings. When the real-time contingent overload no longer exists, the ATC SCO would select the primary settings.

As noted above, the primary settings would incorporate the tripping requirements from the 2007 stability study, with the exception of a three phase fault on the Dead River – Plains 345-kV line within 40% of the line length from Dead River. This fault would need to trip more generation than is tripped today. Under these fault conditions, the mine load is expected to trip offline due to low bus voltages, resulting in high power flow out of Marquette across the two remaining 138-kV corridors.

If a fault were to occur while the alternate settings were selected, more Presque Isle generation would be tripped than is tripped today for the same fault. However, since no thermal overload would occur in this scenario, there would be no constraint and, therefore, no pre-contingency redispatch of generation.

While the risk of over-tripping can be reduced from option #4 above, a new risk is the loss of communication to Presque Isle and/or Dead River. If the alternate settings cannot be enabled, the constraint would need to be bound as in option #1. Conversely, if the settings cannot be returned to the primary settings, there is a risk of over-tripping generation when it is not needed, similar to option #4. In either failure mode, adequate generation would be tripped at Presque Isle to maintain plant angular stability and system redispatch could be used to mitigate any next-contingency thermal violations.

Long-Term Considerations:

Many transmission system changes impacting system performance of the Marquette Iron Range area are planned in and around Upper Michigan in the next 5 years. These projects and their planned in-service dates are listed below.

- Weston 4 550MW generator (2008).
- 138-kV line from Plains to Conover to Cranberry (2008-2010).
- Second 345/138-kV transformer at Plains (2009).
- 345-kV line from Gardner Park to Highway 22 near Shawano (2009).
- 345-kV line from Werner West to Highway 22 (2009).
- 345-kV line from Highway 22 to Morgan (2009).
- Convert Indian Lake to Hiawatha line from 69-kV to 138-kV operation (TBD).
- 69-kV and 138-kV reactive compensation projects (Various).

Due to these planned transmission projects and other potential system changes (e.g., generation additions or retirements), ATC will begin a study of both the stability and thermal system performance in the Marquette Iron Range area with these system changes during 2007. Presently, this study is planned to begin after the conclusion of the current analysis of 2007 system conditions. Subsequent to this future system analysis, ATC will then review if transmission upgrades, further changes to the Presque Isle RATS relay settings or some combination of the two are warranted.

Next Steps:

At this time, ATC does not have a preferred option for year 2007 since the MISO-issued binding constraint process adequately addresses system reliability issues and the existing RATS scheme addresses known stability issues. Absent further comment from We Energies regarding the options for 2007, ATC will begin the analysis of the future system transmission configuration and potential system conditions, similar to the analysis conducted for 2007.

cc: Dale Burmester
Mike Burow
Steve Feak
Patrick Gerum (We Energies)
Nick Giffin
David Smith

Attachment: Summary tables of 2007 stability and thermal studies of the Marquette Iron Range area

Table 1: Trip Signal Level Reference

Level 1	Highest generation tripping scenario
Level 2	Middle generation tripping scenario
Level 3	Lowest generation tripping scenario
Note: Some generation/load configurations require zero MW of Presque Isle generation tripping.	

Table 2: Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Presque Isle to Empire		Presque Isle to National		Presque Isle to Empire	
Fault Location	Fault Type	Existing	New Stability	Existing	New Stability	Existing	New Stability
0-25%	3PG	2	3	2	3	2	3
	2PG	3	3	2	3	3	3
	1PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent
25-100%	3PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	2PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	1PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Presque Isle to Cedar		Presque Isle to Freeman	
Fault Location	Fault Type	Existing	New Stability	Existing	New Stability
0-35%	3PG	2	3	2	3
	2PG	3	3	3	3
	1PG	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent
35-100%	3PG	3	No Trip Sent	3	No Trip Sent
	2PG	3	No Trip Sent	3	No Trip Sent
	1PG	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Presque Isle to Perch Lake	
Fault Location	Fault Type	Existing	New Stability
0-30%	3PG	2	3
	2PG	3	3
	1PG	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent
30-50%	3PG	3	No Trip Sent
	2PG	3	No Trip Sent
	1PG	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent
50-100%	3PG	No Trip Sent	No Trip Sent
	2PG	No Trip Sent	No Trip Sent
	1PG	No Trip Sent	No Trip Sent
	0PG	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Empire to Forsyth	
Fault Location	Fault Type	Existing	New Stability
0-70%	3PG	2	No Trip Sent
	2PG	3	No Trip Sent
	1PG	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent
70-100%	3PG	3	No Trip Sent
	2PG	3	No Trip Sent
	1PG	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Cedar to National		Freeman to Cedar		Cedar to Tilden	
Fault Location	Fault Type	Existing	New Stability	Existing	New Stability	Existing	New Stability
0-100%	3PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	2PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	1PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Tilden to National		Empire to National		White Clay to Morgan	
Fault Location	Fault Type	Existing	New Stability	Existing	New Stability	Existing	New Stability
0-100%	3PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	2PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	1PG	3	No Trip Sent	3	No Trip Sent	3	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	3	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Plains to Arnold		Plains to Amberg		Plains to Nordic	
Fault Location	Fault Type	Existing	New Stability	Existing	New Stability	Existing	New Stability
0-100%	3PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent
	2PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent
	1PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent
	0PG	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent	No Trip Sent

Table 2 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – No Tripping for Thermal Constraints

		Plains to Morgan 345kV	
Fault Location	Fault Type	Existing	New Stability
0-100%	3PG	3	3
	2PG	3	3
	1PG	3	3
	0PG	3	3

Table 3: Comparison of Trip Signal Level by Faulted Element and Fault Location – Includes Potential Tripping for Thermal Constraints

		Presque Isle to Dead River 138kV			Plains 345kV/138kV Xfmr		
Fault Location	Fault Type	Existing	New Stability	Thermal	Existing	New Stability	Thermal
0-100%	3PG	1	1	1	2	No Trip Sent	3
	2PG	1	1	1	2	No Trip Sent	3
	1PG	2	2	1	3	No Trip Sent	3
	0PG	2	3	1	3	No Trip Sent	3

Table 3 (Continued): Comparison of Trip Signal Level by Faulted Element and Fault Location – Includes Potential Tripping for Thermal Constraints

Dead River 345kV to Plains 345kV

Fault Location	Fault Type	Existing	New Stability	Thermal
0-40%	3PG	2	2	1
	2PG	2	2	1
	1PG	3	3	1
	0PG	3	3	1
40-100%	3PG	2	2	1
	2PG	2	2	1
	1PG	3	3	1
	0PG	3	3	1