



10/26/04

Preliminary Powerflow Studies Performed

2009 Summer Peak Base Case with Arrowhead-Weston 345KV line in-service and prior to any Mesaba Project development.

Mesaba Unit 1 with no Reinforcements

Mesaba Unit 1 with 345KV Plan Phase I Reinforcements

Both Mesaba Units with 345KV Plan Phase I Reinforcements

Both Mesaba Units with 345KV Plan Phase I and II Reinforcements

Both Mesaba Units with Modified 345KV Plan Reinforcements

Mesaba Unit 1 with 230KV Plan Phase I Reinforcements

Key Study Findings

- Interconnecting the Project directly to Forbes 500/230KV Substation (POI) results in minimal impact on the underlying Minnesota Power system including the already congested North Shore loop.
- When the first Mesaba unit (Phase I) is added with no reinforcements beyond the generator outlet facilities 66% of the output (365MW) flows south on the 500KV line. The increased loading on the South 500KV line causes the flow on the North 500KV line to drop off by 60-70MW.

Key Study Findings

- Phase I development of either a new 230 or 345KV Forbes to Arrowhead line results in minimal flow on the 500KV line
 - With a new 345Kv line nearly all (455MW) of unit output flows on new line
 - With 230KV line development, increase in 500KV line flow is less 100MW and north 500Kv only backs off ~25MW
- With both Mesaba units in operation (Phase II), the addition of a second 345KV line from Forbes to Arrowhead eliminates any thermal overload issues.

Key Study Findings

- Both the 230KV and 345KV generator outlet configurations performed satisfactorily and demonstrated that the full output of the Project can be injected into either the Forbes 230 or 500KV buses
 - 345KV is recommended based upon the significant savings in losses
- It is possible that no new transmission would need to be developed from Arrowhead south to the Twin Cities for first unit operation and that only one new 345KV line from Arrowhead south would be required for both units

Key Study Findings

- The studies showed that development of 345KV lines into and out of Arrowhead Substations causes the 230KV phase shifter installed to control the flows onto the Arrowhead-Weston 345KV line to become ineffective as the phase shifter is effectively by-passed
 - This issue has been brought to the attention of the project developers-Minnesota Power and American Transmission Company-and is being evaluated*

Special Note

- No stability analysis or fault duty analysis were performed as part of this evaluation. It is possible that stability limits may be more restrictive than thermal limits and therefore additional reinforcements would be required. Likewise the fault duty analysis at and around the Forbes POI may identify over duty on existing substation equipment which would require its upgrading or replacement
- Additional system studies under 'system stress conditions' and with full understanding (modeling) of existing operating guides and special protection systems are necessary

Conclusions

- Forbes Substation is the most logical Point of Interconnection
 - studies indicate that by going directly from the units to Forbes there is minimal impact on the already constrained local transmission network
- Similar high level reliability can be achieved with 'staged' development of either three 230KV or two 345KV outlet lines to Forbes to deliver the output of both units

Conclusions

- Development of a new 230KV line from Forbes to Arrowhead will be required, at minimum, to effectuate delivery from the first unit
- Two new 345KV circuits from Forbes to Arrowhead and at least one new 345KV circuit from Arrowhead south to the Twin Cities will be necessary to deliver both units

Conclusions

- It does appear possible to minimize new ROW by routing the new generator outlet lines and network reinforcements on existing transmission line rights of way (ROWs) by either upgrading the existing lines or rebuilding them as double circuit facilities
- Assuming that the MISO processes are initiated in the fourth quarter of 2004, the preliminary schedule for transmission development indicates that the necessary facilities can be in service to support the first Mesaba unit startup/testing in first quarter of 2010

MISO Generator Interconnection Requested

- PROJECT G477
- Queue Number 38280 0
 - For first unit of 530-550MW in Spring 2010
 - Project location is Cliffs-Erie property (old LTV mining site) north of Hoyt Lakes, MN
 - POI is proposed as Forbes 500/230KV Sub
