

Technical Bulletin

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**Implementation of
Group Constraints Phase I
(Revised to include **Phase II**)**

May 4, 2012

Revision History

Date	Version	Description	Author
07/21/2011	1.0	Initial draft that included the items in scope of Phase I of the Group Constraint Enhancements implemented in Fall 2011. This implementation was mainly targeted to address the constraints of a pump storage resource.	ISO
05/04/2012	2.0	Updated the document to include the enhancements for group constraint phase II planned for implementation in 2012.	ISO

Technical Bulletin

Implementation of Group Constraints Phase I (Revised to include phase II)

This bulletin describes the Phase I and Phase II implementations of Group Constraints in the ISO market.

1. Background and details of business need

1.1. Pump Storage (PS) resource

Pump Storage (PS) resources consume energy during pumping operations and generate electricity using the water that was previously pumped.

The ISO Market systems recognize a PS resource as load during the pumping operation and generation during generator operations. In the current implementation of the Pump Storage (PS) resource model, the ISO models each PS resource individually. Each PS resource has its operation constrained by the minimum run time in generation mode, and by its minimum down time between two consecutive operations in generating mode.

1.1.1. Need for unison in operation of more than one PS resources

Within the same group of hydraulically or operationally coupled PS units, individually modeled unit(s) may receive awards in generating mode while others receive awards in pumping mode according to market optimization. However, when such simultaneous operation of pumping and generating are not physically/operationally allowed, the resources need to be modeled either all in generating mode or all in pumping mode.

1.1.2. Need for additional minimum downtimes for PS resources

When an individual unit is switching from one operating mode to another, there is a need to recognize that the minimum downtime, if any, can be different between different operating modes. For example the minimum downtime when switching from turbination (generation) to off to pumping, can be different than the minimum downtime when switching the mode of operation from turbination (generation) to off to pumping. In addition, the minimum run time in pumping mode can also be different from minimum run time in generation mode.

1.2. Group Constraints applicable to all resources

1.2.1. Minimum Lag Time

1.2.1.1. During successive startup and shutdown

Several resources in the ISO market have limitations that requires a minimum lag time between their startup or shutdown and the startup or shutdown of other resources that are operationally coupled. For a PS resource this limitation may exist in either the pumping or generating

mode of operation.

By way of example, please refer to Figure 1.

Resources PS_1, PS_2 and PS_3 belong to the same group. When operating in the pumping mode, any resource in this group can only start only after the previous resource in the same group has operated for at least 100 minutes. PS_2 can only start 100 minutes after the start of PS_1.

Theoretically, the minimum lag time can be different when the PS resources are operating in a pumping mode and generating mode but it will be same for all resources operating in the same mode (i.e. generating or pumping). In the example shown in Figure 1, minimum lag time between successive startup among the resources, when operating in the generation mode is 110 minutes.

1.2.1.2. Between modes of Operations

Additionally, there can be limitations that require a minimum lag time when the last resource in a group was shutdown in pumping mode and the first resource is started in a generating mode and vice-versa. Referring again to Figure 1, the minimum lag time after the last resource in a group is shutdown in pumping mode and before the first resource is started in generating mode is 140 minutes. Similarly the minimum lag time between when the last resource is shutdown in the generating mode and the first resource is started in pumping mode is 90 minutes.

1.2.2. Recognition of order of start-up

There are some resources in the ISO system that cannot start unless another resource has been already started. Please refer to Figure 1. Resources PS_1, PS_2 and PS_3 belong to the same group. A constraint may exist that restricts the start-up of PS_3 only if both PS_2 and PS_1 have already been started. Another constraint may exist that PS_1 has to be started before PS_2, and PS_2 has to be started before PS_3.

Through this technical bulletin, the ISO seeks to inform market participants of its efforts to more realistically and more accurately model the operational constraints described above.

2. Group Constraints Phase I

In phase I of the group constraint enhancements, the ISO implemented the following group constraints to address the concerns described above.

2.1. Minimum Down Time.

The ISO has added a new constraint of minimum down time for each of the following four potential switching sequences for PS resources:

- Minimum down time when switching from pumping to off to pumping (MDTpp)

- Minimum down time when switching from pumping to off to generation (MDTpg)
- Minimum down time when switching from generation to off to pumping (MDTgp)
- Minimum down time when switching from generation to off to generation (MDTgg)

2.2. Pumping Minimum Run Time.

The ISO modeled the minimum run time in pumping mode as a separate constraint, i.e. once a PS unit is engaged in pumping mode it has to stay in pumping operation for at least a minimum period of pumping time. Prior to implementing these enhancements in phase I, the minimum run time applied to a PS resource only when it operated in generating mode.

2.3. Minimum Successive Startups/Shutdowns Lag Time.

The ISO also added a new group constraint to enforce minimum time delay between two successive startups or two successive shutdowns within a group of resources. The minimum time delays will be enforced between any pair of resources within the group and, unless exclusively specified, no ordering is assumed among the resources in the group. For PS resources, this time lag constraint shall apply based on the mode of operation, so lag time between consecutive startups can support the lag time within the group between two consecutive startups of resources in generating mode or the lag time within the group between two startups of resources in pumping mode. The ISO will also model analogous constraints for successive shutdowns of resources. This constraint can be used for both generating and pump storage resources.

For a group of n Market resources this constraint can be enforced by introducing new binary variables representing existence of startup in pumping mode within the group, $SUP_{Group,pump}^t$ and existence of startup in generation mode within the group ($SUP_{Group,gen}^t$). The status of group pumping startup variable at time interval t is one if any of the resources is starting up in pumping operation at time interval t . Otherwise it is zero. The status of group generation startup variable is one if any of the resources is starting in generating operation. Otherwise it is zero. The constraint can be written as:

$$\sum_t^{t+T_{SUP}^{pump}} SUP_{Group,pump}^t \leq 1, \quad t \in T;$$

$$\sum_t^{t+T_{SUP}^{gen}} SUP_{Group,gen}^t \leq 1, \quad t \in T;$$

Where T_{SUP}^{pump} and T_{SUP}^{gen} are minimum lag times between consecutive startups

in pumping or generation mode, respectively.

2.4. Unison Operation

The ISO also added new functionality to recognize a constraint when a group of PS resources can only operate in pumping or generating mode but not both at the same time. A new group constraint was added which prevents PS resources within a group of resources from being committed in generating mode if any unit within the group is in pumping mode, or vice versa.

The ISO enforces group constraints of the phase I implementation in both day-ahead and real-time markets.

3. Group Constraints Phase II (new)

3.1. Minimum Lag Time between mode of operation

The ISO will enhance its systems to recognize the minimum lag time between the time when the last PS resource in a group is shutdown in pumping mode and the first resource is started in generating mode and vice versa.

3.2. Recognition of the order of startup of PS resources

The ISO will enhance its systems to recognize the order of start-up among two or more resources that belong to the same group.

Similar to group constraints in phase I, the ISO will enforce group constraints of phase II implementation in both day-ahead and real-time markets.

4. Impact on ISO Market

Group constraints described above will impact a number of market systems. In particular, new Master File data and new SIBR rules will be implemented in order to enable the modeling of these constraints in the ISO market. The actual group constraint will be enforced in the Day-Ahead, and Real-Time market software optimization.

5. Impact on Market Participants

Additional data requirements for Master File have been provided to market participants to facilitate the new group constraints. New SIBR rules for validating the self scheduling bids against the new group constraints has been published. There are no impacts on resources that do not use the new constraints. Market participants who wish to adopt the new group constraints on their resources are required to submit additional Master File data and follow the new constraints as appropriate when submitting self scheduling bids.

In addition to providing the ISO will specific information associated with the group constraints described in this technical bulletin through the Master File Group Constraint registration form, PS and generation resources will need to amend Schedule 1 of their applicable Participating Generator Agreement to refer to these group constraints.

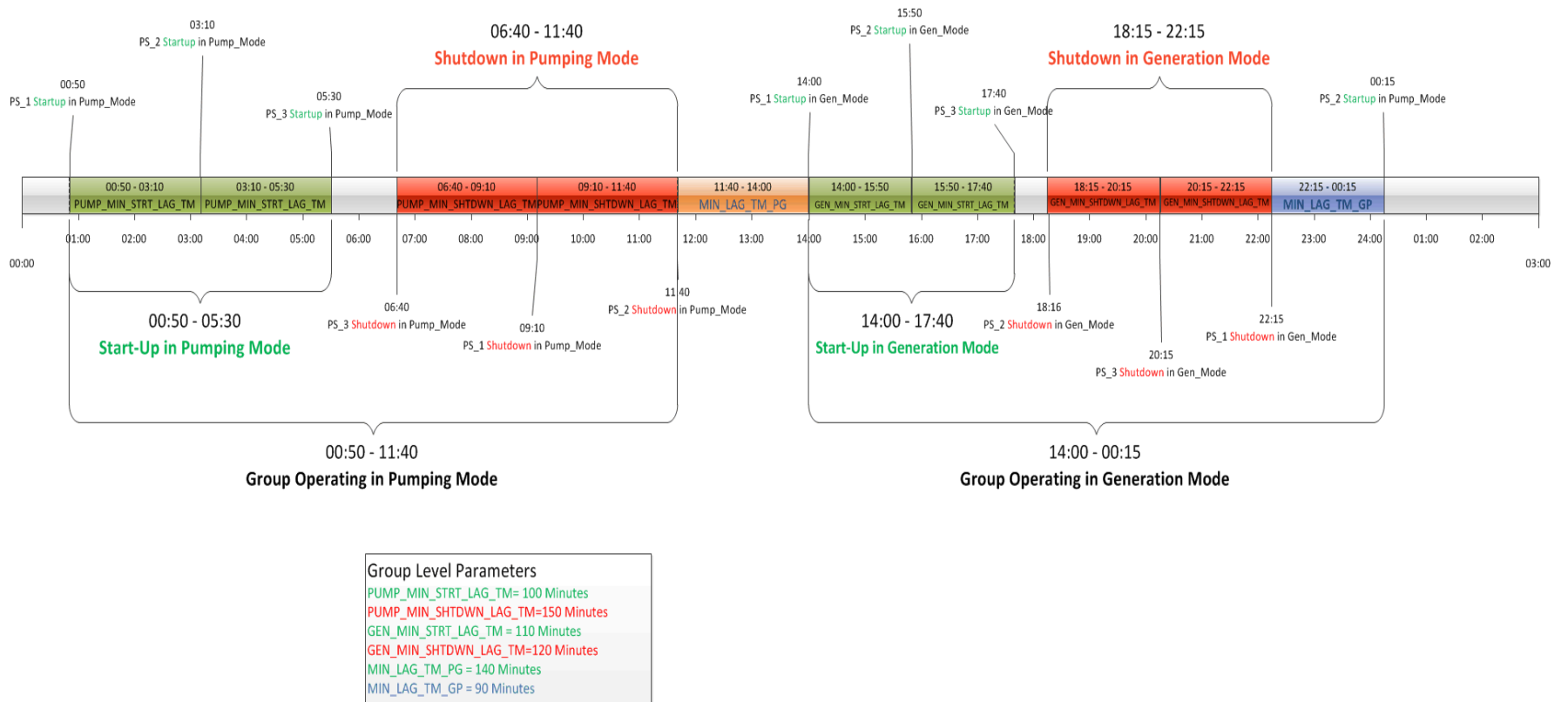


Figure 1: Showing different minimum lag times that are possible for a PS resource. A group of non-PS resources can also take advantage of these minimum lag times in the generation mode