Measure Application Guide

Add Ice Storage Tank Measure

August 2019

Purpose:

This measure is designed to provide maximum flexibility to users in order to simulate the basic design configurations and control schemes delineated in the ASHRAE Cool Thermal Storage Design Guide (2019). This document will provide high-level recipes for implementing the ASHRAE recommendations through this measure.

Available Design Configurations:

1. Chiller Upstream

2. Storage Upstream

3. Multiple Chillers in Parallel

Possible Control Schemes:

1. Full Storage

2. Partial Storage - Load Leveling

3. Partial Storage - Demand Limiting

Possible Partial Storage Discharge Priorities:

1. Chiller Priority

2. Storage (Ice) Priority

Implementing Various Control Schemes:

Full Storage: There are four paths to obtaining full-storage performance from this measure; choose one of the following:

1. Select Full Storage

2. Select Partial Storage, Storage Upstream. Set intermediate setpoint equal to the loop setpoint (e.g. 44F).

3. Select Partial Storage, Chiller Upstream. Set intermediate setpoint equal to the loop setpoint + the loop design temperature difference (e.g. 44F + 10F = 54F).

4. Select Partial Storage, Chiller Upstream. Set chiller limiter equal to 0.

Partial Storage - Load Leveling: There is one method to implement a load leveling strategy. Iteration maybe required to obtain the proper balance between chiller capacity reduction and ice storage capacity.

1. Select Partial Storage. Downsize chiller. Set intermediate setpoint equal to the loop setpoint.

Partial Storage - Demand Limiting: There are two paths to implement this; choose one of the following:

1. Select Partial Storage, Chiller Upstream. Apply a chiller limit fraction. For chiller-priority, set intermediate temperature to loop setpoint. For storage-priority, set intermediate temperature above loop setpoint.

2. Select Partial Storage, Storage Upstream. Set intermediate setpoint to a value between the loop temperature and the design maximum return water temperature (loop temp + design deltaT).

Implementing Discharge Priorities:

The downstream device is treated as priority within the simulation.

1. Chiller Priority: Select Storage Upstream

2. Storage Priority: Select Chiller Upstream

Remarks on Using the Chiller Limiter:

\* This limiter applies only in cases where a partial ice storage discharge is meeting its permitted portion of the cooling load, but the unmet load exceeds a desired maximum demand on the chiller. In this case, the simulation will override and relax the chiller outlet temperature setpoint, thereby increasing the load that must be met by the ice.

\* If the remaining ice storage is insufficient to meet this increased cooling load, the load will remain unmet.

\* Such a limiter would be applied if 1) unused ice is expected at the end of the discharge period and 2) severe penalties exist for exceeding a facility power demand limit.

\* If a chiller limit is used, inspect the results of high cooling days to determine if the loop temperature setpoint is unmet. An output variable called Limit Counter reports the number of simulation (zone) timesteps in which the limiter was applied throughout the entire run period.

Schedule-Based Controls:

Users may manually create a single charge and a single discharge period for the ice as well as a single operating season. They may also select whether the ice is permitted to discharge over weekends. Charging is permitted every day during the specified availability season. If seasonally variable controls are desired, users may create their own schedules within OpenStudio and apply them with this measure.

It is also possible to first apply the measure to create the desired hardware and schedules, and to then manually edit those schedules within the GUI to suit user needs.

It is imperative that the chiller, ice, and availability schedules are synchronized to achieve proper system performance.

Modes of Operation:

If the ice tank is in charge mode, E+/OpenStudio will also allow the loop to meet building cooling loads.

Examples:

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Prerequisites for the measure:

\* Existing building model with plant loop and chiller(s)

\* Any air-cooled, water-cooled, or adsorption chiller object

Limitations of the measure:

\* Won't work with heat pump objects

\* Can't simulate a parallel configuration. This specifically refers to placing an ice storage tank in parallel with a single chiller. Applications of this configuration are limited to partial retrofits constrained by existing hardware limitations.