

Owner's Manual

THERMAL ENERGY STORAGE TANK

NATGUN

CONTENTS

SECTION 1

Introduction	1-1
Thermal Energy Storage Tank.....	1-1
Summary	
TES Tank System and How It Works.....	1-1
Operation	1-2
Start-Up.....	1-2
I Pre-filling Requirements.....	1-2
System Cleaning.....	1-2
Water Treatment.....	1-3
II Tank Filling Procedure.....	1-4
III Charging the TES Tank.....	1-5
IV Tank Draining Procedure.....	1-5
Accessories	1-6
Safety	1-7
Maintenance	1-7
<u>SECTION 2</u>	
Thermal Energy Storage Tank Inspection Checklist	2-1

INTRODUCTION:

Thermal Energy Storage Tank

This manual is prepared to assist the owner's operator in the use of the Thermal Energy Storage (TES) systems, specifically the Thermal Energy Storage tank. Utilizing the following suggestions, the TES tank should perform its intended design use without interruptions. The TES tank includes, internal piping, pipe supports, etc.

SUMMARY:

TES Tank System and How It Works

The TES tank system is a naturally stratified tank system utilizing chilled water. Chilled water is a sensible storage medium (remains as a fluid). A naturally stratified TES tank is a simple system requiring reasonable operating strategy, simple controls, simple pipe and valve requirements.

Stratification in the TES tank is accomplished by separating the chilled water (*more dense*) at the bottom of the tank, from the warm water (*less dense*) at the top of the tank, in horizontal layers by its density, a natural phenomenon. A natural barrier is formed separating the chilled water from the warm water by a blended layer referred to as the thermocline.

A properly designed naturally stratified TES tank will achieve the required separation. The lower diffuser is designed to introduce chilled water into the tank with the minimum amount of turbulence. The lower diffuser allows the denser water (water is densest at 4 degrees Celsius or 39.2 degrees Fahrenheit) to flow into the tank creating a density current across the tank bottom, which in turn, results in the horizontal layering of the chilled water.

Each TES tank system is individually designed for the specific facility. Natgun uses an octagonal type diffuser in its TES tank systems. The octagon diffuser design allows Natgun to provide an extremely efficient system for the required load. The internal diffuser system has no moving parts and is made of non-corrosive materials; therefore, its reliability and dependability is excellent. Temperature probes are located in the interior of the tank which transmit data to the control center. At any point in time the chilled water volume is available to provide instantaneous inventory to the operator to assist in load management.

OPERATION

Start-up

I Pre-Filling Requirements

A. System Cleaning

(Source ASHRAE Design Guide for Cool Thermal Storage pg. 2-48)

Starting with a clean system cannot be stated strongly enough. A clean system at startup minimizes problems throughout the life of the system.

Water containing any contaminants, detergents or disinfectants must be drained to an appropriate site. Check with local authorities before draining the system.

Ahlgren (1987) lists the following major steps in preoperational cleaning:

- 1. Remove all extraneous loose debris, construction material, trash and dirt from tanks, piping, filters, etc. Removal of as much dry material as possible prevents transfer to hard to reach portions of the system.*
- 2. Flush water fill line separately to drain. If a new water line has been installed, be sure that rust and debris from it is not washed into the thermal storage system.*
- 3. Fill system with soft, clean, fresh water. Open all system valves and lines to get thorough, high-velocity recirculation. (Refer to Filling Procedure on pg. 1-4)*
- 4. Add prescribed cleaning chemicals to circulating water. Most cleaners are a blend of alkaline detergents, wetting agents, and dispersants. Be sure cleaning chemical is dissolved and distributed thoroughly so that cleaner does not settle out in one part of the system.*
- 5. Circulate cleaning solution for manufacturer's recommended time, frequently 8 to 24h. Check during recirculation for any plugging of filters, strainers, etc.*
- 6. While water is being recirculated at a high rate, open drain valve at lowest points in system and drain cleaning solution as rapidly as possible. Draining while under recirculation will prevent settling of solids in remote portions of system.*
- 7. Open and inspect system for thoroughness of cleaning. Refill with water and start rinse recirculation. If significant amounts of contaminating materials are still present, repeat cleaning and draining procedures.*
- 8. When cleaning has been thoroughly accomplished, refill system with fresh water for recirculation rinse. Drain rinse water and add*

fresh makeup until all signs of cleaning chemicals have been removed.

9. *System is now clean, unprotected state. Fill with makeup water and proceed with passivating steps to develop protective films on all metallic surfaces. Water should be treated as soon as possible after cleaning the system. The cleaning procedure removes any protective films from equipment surfaces, leaving them susceptible to corrosion. Especially, when there is an extended time period between cleaning and actual system startup, corrosion and biofouling can become significant problems if water treatment is not treated promptly.*

B. Water Treatment

Water treatment for cool storage systems is fundamentally no different than water treatment for nonstorage systems, except that generally a greater volume of water must be treated.

Chapter 47 of the 1999 ASHRAE Handbook-Applications covers water treatment in detail. Ahlgren (1987) discusses water treatment specifically for cool thermal storage systems, as well as a chapter on sources of further information and reports on water treatment experience of a number of thermal storage systems. Chemical service companies are also a good source of information on water treatment.

Starting with a clean system, whether in a cool storage or a nonstorage application, is the surest way to avoid future problems. Among the recommendations to ensure clean, trouble-free water in a cool storage system are:

- *A recommended procedure to achieve and maintain a clean system.*
- *Chemical treatment to avoid corrosion, biofouling, scaling and deposits in a cool thermal storage system.*
- *Water treatment reference ASHRAE Design Guide for Cool Thermal Storage Page 2-47.*

NOTE: *Chemical additives (excluding chlorine) should be evaluated for their compatibility with concrete. Some additives have a deleterious effect on various materials in the tank; i.e., concrete, pipes, pipe supports, etc (consult the chemical admixture supplier). Chemical additives may change the characteristics of the water, thereby interfering with the efficiency of the TES design. Maintain a pH balance of the fluids in the tank. Other sources of protective chemical additive information can be found in the American Concrete Institute Guide (ACI 515.1R-79), and the Portland Concrete Association Circular (IS001).*

II Tank Filling Procedure

There is one pipe available to fill the TES tank: The Vent/Fill Line (4-inch) connected to the RW (upper) distribution piping.

Description

There are numerous pipes in the tank differentiated between the distribution (solid) piping and the diffuser (slotted) piping. The distribution piping is either supply or return and the diffuser piping is the octagonal shaped piping at the bottom of the tank and at the top of the tank. The diffuser piping has radial slots allowing the water into the bottom of the tank and the top of the tank. The slots in the bottom diffuser pipe face down and the slots in the top of the diffuser pipe face up.

Step 1 – Fill the tank through the Fill line connected to the RW distribution piping. By filling through the fill line only this will prevent floatation of the CW and RW horizontal distribution pipelines preventing damage to the tank's interior piping, the diffusers (upper and lower) and their associated supports/hangers.

NOTE: Always open and close valves slowly, thereby preventing excess water **hammer** and/or **blow-outs**, to the tank's interior piping.

Step 2 – Continue filling the tank until the water is 6-inches above the top of the upper diffuser pipe (design is 6-inches above the top of the upper diffuser pipe).

NOTE: Water must always be above the top of the upper diffuser pipe array, thus, preventing the introduction of air into the system (during charging cycles).

NOTE: **Make certain all air has been bleed off the system (Tank piping, exterior piping, pumps, etc.) prior to circulating the water.**

III Charging the TES Tank

The initial lowering of the water temperature should be performed in increments thereby reducing the possibility of excessive shrinking of the reinforced concrete floor. The water temperature should be lowered in intervals not to exceed 12°F differential temperature within a two-hour duration. The suggested procedure to initially charge the tank is as follows. e.g., assuming the existing tank water temperature 80°F;

- lower the CW water temperature to 68°F, allow to set for a minimum of two (2) hours;
- then lower the CW water temperature to 56°F, allow to set for a minimum of two (2) hours;
- then lower the CW water temperature to 44°F, allow to set for a minimum of two (2) hours;
- then finally lower the CW water temperature to 39°F or until the TES tank is fully charged. The TES tank is now available for normal usage operations in accordance with the design criteria

IV Tank Draining Procedure

There are two pipes available to drain the TES tank (*refer to description below*):

1. Cold Water Supply (CW) distribution pipe going to the tank bottom, lower diffuser.
2. Warm Return Water (RW) distribution pipe connected to the tank top, upper diffuser

Description

There are numerous pipes in the tank differentiated between the distribution (solid) piping and the diffuser (slotted) piping. The distribution piping is either supply or return and the diffuser piping is the octagonal shaped piping at the bottom of the tank and at the top of the tank. The diffuser piping has radial slots allowing the water into the bottom of the tank and the top of the tank. The slots in the bottom diffuser pipe face down and the slots in the top of the diffuser pipe face up.

Step 1 – The sequence in removing the water from the tank is through the lower diffuser piping (CW line). Drain the tank until there is minimal water left on the tank floor.

Step 2 – Next drain the RW line. This will prevent floatation of the CW and RW horizontal distribution pipelines preventing damage to the tank's interior piping, the diffusers (upper and lower) and their associated supports/hangers. This will also prevent any floatation of the upper diffuser.

NOTE: Under no circumstances shall the upper diffuser be drained prior to the water level in the tank being 2'-0" below the invert elevation of the CW and RW horizontal distribution pipelines.

NOTE: The tank foundation has not been designed for uplift pressures. If the groundwater is at or above the tank finish floor and the tank is not at full capacity, extensive damage to and failure of the tank may occur.

Accessories.

Temperature Sensors

The temperature sensors that monitor the water temperature are to be located and designed by others.

Level Sensor

The TES tank is a vented atmospheric type containment vessel, i.e., the TES tank is not under pressure and some of the water will evaporate into the atmosphere; therefore, requiring makeup water added to the system. It is imperative that the level sensing control system be calibrated and maintained to assure water level accuracy prohibiting the water elevation of the TES tank to lower, uncovering the upper diffuser piping allowing air into the cooling system piping.

Ladders & Hatch

The exterior ladder is located at the roof hatch. The interior ladder is located directly beneath the roof hatch.

Safety

The TES tank is a confined space structure requiring certain safety procedures to be maintained prior, during and after entering the tank **(a confined space plan may be required to be provided by the owner in accordance with OSHA requirements).**

The interior and exterior ladders shall have fall prevention devices, which utilize a safety belt attachment.

Maintenance

Regular schedule maintenance **not** required
Tank Inspection—Refer to Section 2

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Thermal Energy Storage Tank

Inspection Checklist

The following is a suggested checklist for inspecting a TEStorage tank.

Annually

1. Roof Vent - Inspect vent to insure the screen is intact and no obstructions are limiting airflow through the vent.
2. Roof Hatch - Inspect the roof hatch and safety rail for damage, ease of operation and security, i.e., pad locks.
3. Overflow Pipe - Inspect overflow to insure that there are no obstructions at the inlet or outlet of the overflow, which would restrict flow.
4. Fill and Vent Lines - Inspect the interior fill and vent piping to insure that there are no obstructions, which would restrict flow.
5. Exterior Ladder - Check anchorage to wall, soundness of rungs and handrails.
6. Exterior Walls - Inspect for damaged areas in the insulation.
7. Exterior Roof – Check roof for debris.
8. Interior Tank – Check for loose, bent or missing diffuser pipe hanger rods.

Every Five (5) Years or More

1. Leakage Test - Isolate the tank for a period of 24 hours and measure the water level at the beginning and end of the period to check for leakage.
2. Interior Tank - Check for loose, bent or missing diffuser pipe hanger rods.
3. Ladders - Inspect the interior ladders for safety, i.e., anchors to wall and soundness of rungs.
4. Interior Piping - Inspect all exposed piping in the tank interior. Inspect and clear obstructions, which could restrict flow.