ASME TES-1–2023
(Revision of ASME TES-1–2020)

Safety Standard for Thermal Energy Storage Systems: Molten Salt

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Date of Issuance: December 15, 2023

The next edition of this Standard is scheduled for publication in 2026. This Standard will become effective 6 months after the Date of Issuance.

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FOREWORD

In July 2013, the American Society of Mechanical Engineers (ASME) conducted a survey of industry professionals on thermal energy storage (TES). The results indicated interest in the development of standards or guidance documents for the TES sector. ASME again surveyed industry professionals in May 2014 and determined that the proposed standard or guide should focus on safety related to electrical utility applications, specifically TES systems. The results also suggested that the standard should be suitable for use by manufacturers, owners, designers, and others concerned with or responsible for the application of prescribed safety requirements.

A group was formed from the list of survey respondents to discuss the development of an initial TES standard or guideline. This group met on a monthly basis throughout the latter part of 2014 until June 2015. Based on their efforts, ASME formed a Safety Standards Committee for Thermal Energy Storage Systems (TES Safety Standards Committee) in June 2015. At that time the TES committee charter and membership were approved by ASME.

The purpose of the committee is to develop and maintain safety standards covering the design, construction, installation, inspection, testing, commissioning, maintenance, operation, and decommissioning of TES systems. Recognizing the range of TES technologies, the TES Safety Standards Committee decided to initially focus on one technology, molten salt TES systems. Following the completion of this task, the Committee will address standards or guides for other TES systems.

Since late 2015, the TES Safety Standards Committee has worked to develop a safety standard for molten salt TES systems. ASME TES-1–2020 is the result of these efforts. The American National Standards Institute approved ASME TES-1–2020 as an American National Standard on March 11, 2020.

ASME TES-1–2023 incorporates the revisions shown in the Summary of Changes. The American National Standards Institute approved ASME TES-1–2023 as an American National Standard on August 21, 2023.

ASME TES COMMITTEE
Thermal Energy Storage Systems

(The following is the roster of the committee at the time of approval of this Standard.)

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CORRESPONDENCE WITH THE TES COMMITTEE

General. ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Standard should be sent to the staff secretary noted on the committee's web page, accessible at https://go.asme.org/TEScommittee.

Revisions and Errata. The committee processes revisions to this Standard on a continuous basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published in the next edition of the Standard.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata.

This Standard is always open for comment, and the committee welcomes proposals for revisions. Such proposals should be as specific as possible, citing the paragraph number, the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent background information and supporting documentation.

Cases. The committee does not issue cases for this Standard.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Standard. An interpretation can be issued only in response to a request submitted through the online Interpretation Submittal Form at https://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic e-mail confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Standard requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at https://go.asme.org/Interpretations.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Interpretations are published in the ASME Interpretations Database at https://go.asme.org/Interpretations as they are issued.

Committee Meetings. The TES Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/TEScommittee.

INTRODUCTION

Solar energy may be the leading renewable energy source, but storage challenges have limited its adoption by, among others, utilities. Thanks to innovations in thermal energy storage in megawatt-hour quantities, solar thermal energy has become more feasible for large-scale applications.

Thermal energy can be stored in sensible, latent, or chemical form. The storage of industrial quantities of thermal energy is in a nascent stage and primarily consists of sensible heat storage in nitrate salt eutectics and mixtures. The requirements and guidance described in this Standard are for the safe implementation of thermal energy storage in the generation of electrical power using a sensible heat method.

This Standard describes practices for designing and implementing thermal energy storage (TES) for large applications. These usually involve two-tank sensible heat systems using molten salts. The practices described in this Standard are to be used during factory manufacture and on the jobsite. The team implementing the Standard is expected to have a working knowledge of hydraulics, materials, electrical systems and controls, thermal energy fundamentals, applicable referenced standards, field test measurement methods, and how to use test and measurement equipment needed to meet these requirements.

This Standard was prepared with attention to other standards for energy storage systems. The tests described are useful in establishing compliance with other related standards.

ASME TES-1–2023
SUMMARY OF CHANGES

Following approval by the ASME TES Committee and ASME, and after public review, ASME TES-1–2023 was approved by the American National Standards Institute on August 21, 2023.

ASME TES-1–2023 includes the following changes identified by a margin note, **(23)**.

Page	*Location*	*Change*
1	2	Definitions of *storage medium* and *thermal energy storage system* added
1	3	Updated
4	4	(1) In first paragraph, last sentence deleted (2) Step 1 revised
5	4.2.3.1	Subparagraph (g) added and subsequent subparagraphs redesignated
7	4.2.3.4	Subparagraph (b) added and subsequent subparagraphs redesignated
8	4.2.3.7	Revised in its entirety
9	4.2.5	Subparagraph (c) added and subsequent subparagraphs redesignated
9	4.2.7	Subparagraph (b) added and subsequent subparagraphs redesignated
11	5.2.1	(1) In first paragraph, last sentence deleted (2) Subparagraph (c) revised
11	5.2.2	Revised in its entirety
11	6.1	Paragraphs 6.1.1 and 6.1.2 revised
12	6.2.3	Revised

SAFETY STANDARD FOR THERMAL ENERGY STORAGE SYSTEMS: MOLTEN SALT

1 SCOPE

This Standard establishes requirements for the design, construction, installation, inspection, testing, commissioning, maintenance, operation, and decommissioning of molten salt thermal energy storage (TES) systems. Molten salt thermal energy systems include the storage medium and associated storage vessels, controls for the system, and associated system components such as circulation pumps, valves, piping, and heat exchangers that are in contact with molten salt.

The following components are not included within the scope of this Standard:

(a) the solar receiver and parabolic trough system and associated heat transfer fluid piping

(b) solar field

(c) steam and water piping and associated pumps

(d) power block

(e) auxiliary heater

Figures 1-1 and 1-2 provide examples of molten salt TES systems.

(23) 2 DEFINITIONS

cladding: the weather-proof jacketing on the outside of any thermal insulation.

design basis document: the set of instructions establishing the owner-defined criteria (objectives, conditions, needs, requirements, etc.) the design engineering organization takes into account when designing the project.

designer: the person or organization in charge of the engineering design. The designer is responsible for complying with standards and regulations and demonstrating this compliance with equations when such equations are mandatory.

manufacturer: the person or organization responsible for the construction of the structural, mechanical, piping, and/or electrical equipment and components in accordance with the rules of this Standard and the requirements of the design.

molten salt: the liquid state of a salt mixture such as sodium nitrate and potassium nitrate. Molten salts are useful as a thermal storage medium and heat transfer fluid in TES systems.

owner: for the purposes of this Standard, the party ultimately responsible for the operation of a facility. The owner is the party licensed by the regulatory authority having jurisdiction; that is, the party with administrative and operational responsibility for the facility, including the planning activities described in para. 4.1. The owner may hire a third-party service provider to operate and maintain the TES system on its behalf.

purchaser: the owner of the TES system or the owner's designated agent.

storage medium: material used to store energy in the form of heat for use at a later time.

thermal energy storage system: an engineered system that stores energy captured in the form of heat to be used at a later time.

NOTE: A single entity may fill one or more of the roles defined in the Definitions list.

3 REFERENCES (23)

The codes, standards, and specifications listed in this section contain provisions that, to the extent referenced in this Standard, constitute requirements of this Standard.

API 510-2014. Pressure Vessel Inspection Code: In-service Inspection, Rating, Repair, and Alteration. American Petroleum Institute.

API 570-2016. Piping Inspection Code: In-service Inspection, Rating, Repair, and Alteration of Piping Systems. American Petroleum Institute.

API RP 580-2009. Risk-Based Inspection. American Petroleum Institute.

API RP 2003-2015. Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents. American Petroleum Institute.

API STD 610-2010. Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries. American Petroleum Institute.

API STD 620-2013. Design and Construction of Large, Welded, Low-Pressure Storage Tanks. American Petroleum Institute.

API STD 650-2013. Welded Tanks for Oil Storage. American Petroleum Institute.

API STD 653-2014. Tank Inspection, Repair, Alteration, and Reconstruction. American Petroleum Institute.