ASME TDP-2–2012
(Revision of ANSI/ASME TDP-2–1985)

Prevention of Water Damage to Steam Turbines Used for Electric Power Generation: Nuclear-Fueled Plants

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AN AMERICAN NATIONAL STANDARD

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AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

Three Park Avenue • New York, NY • 10016 USA

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The American Society of Mechanical Engineers
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FOREWORD

In the late 1960s, a substantial increase in the number of reported occurrences of steam turbine damage by water induction precipitated design recommendations from the two major U.S. steam turbine manufacturers as an attempt to reduce such incidents. Consequently, utilities and designers began formulating their own design criteria because of the economic need to keep the generating units in service. Realizing the common need for a uniform set of design criteria to alleviate this problem, an ASME Standards Committee was formed, consisting of representatives of utilities, equipment manufacturers, and design consultants, to develop recommended practices for use in the electric generating industry.

ASME TDP-1, resulting from the work and deliberation of the Turbine Water Damage Prevention Committee, was approved as a standard of ASME by the ASME Standardization Committee and the ASME Policy Board, Codes and Standards, on July 26, 1972.

In 1979, the Committee proposed a revision to this Standard to include information on condenser steam and water dumps, direct contact feedwater heaters, and steam generators. This proposed revision was approved by the ASME Standardization Committee on April 25, 1980.

In 1985, it was decided to issue separate documents for fossil-fueled and nuclear-fueled plants. TDP-1, covering fossil-fueled plants, was approved as an American National Standard on September 13, 1985.

ASME TDP-2, written by the same ASME committee, is a comparable document to cover turbines used with light water nuclear-fueled steam supply systems that produce nominally dry-and-saturated steam. This Standard, resulting from the work and deliberation of the Turbine Water Damage Prevention Committee, was approved by the American National Standards Institute on October 15, 1985.

In 1994, the ASME Board on Standardization approved the disbandment of the Committee on Turbine Water Damage Prevention and the withdrawal of TDP-1. This was due to perceived lack of interest/use by the industry.

Subsequent interest from users and potential users for TDP-1 convinced ASME to reconstitute the Committee under the Board on Pressure Technology Codes and Standards in June of 1997. As a result of this committee's work, TDP-1–1985 was revised and approved as an American National Standard on June 17, 1998.

The 2006 version of TDP-1 was issued to incorporate combined cycle, multiple steam generators, cycling, and cogeneration technology and to incorporate the capabilities of modern plant instrumentation and control systems. TDP-1 was approved as an American National Standard on November 6, 2006.

Based on the renewed interest in light water nuclear-fueled steam supply systems, the Committee began work on a revision of TDP-2–1985. This Standard was approved as an American National Standard on March 7, 2012.

ASME TWDP COMMITTEE
Turbine Water Damage Prevention

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

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CORRESPONDENCE WITH THE TWDP COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, TWDP Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

Proposing Revisions. Revisions are made periodically to the Standard 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 periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued for the purpose of providing alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard, the paragraph, figure or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the TWDP Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the TWDP Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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.

Attending Committee Meetings. The TWDP Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the Secretary of the TWDP Standards Committee.

PREVENTION OF WATER DAMAGE TO STEAM TURBINES USED FOR ELECTRIC POWER GENERATION: NUCLEAR-FUELED PLANTS

1 SCOPE

This Standard includes practices that are concerned primarily with the prevention of water damage to steam turbines used for water-cooled nuclear reactor power generation. The practices cover design, operation, inspection, testing, and maintenance of those aspects of the following power plant systems and equipment concerned with the prevention of water induction into steam turbines and the safe removal of water from steam turbines and the following associated systems and equipment:

(a) main steam and bypass systems, piping, and drains
(b) turbine extraction systems, piping, and drains
(c) turbine steam seal systems, piping, and drains
(d) feedwater heaters, piping, and drains
(e) turbine drain systems
(f) condenser steam and water dumps
(g) start-up systems

Any connection to the turbine is a potential source of water either by induction from external equipment or by accumulation of condensed steam. The sources treated herein specifically are those found to be most frequently involved in causing damage to turbines. Although water induction into the high- and intermediate-pressure turbines has historically been recognized as the most damaging, experience has shown that water induction in low-pressure turbines can cause significant damage and should also be taken seriously.

This Standard is not intended to impose new requirements for existing facilities retroactively.

2 CRITERIA

2.1 Basis

2.1.1 The normal practice for the prevention of turbine water damage shall be to

(a) identify systems that have a potential to allow water to enter the turbine
(b) design, control, maintain, test, and operate these systems in a manner that prevents accumulation of water

2.1.2 Because of the lower main steam temperature from these types of steam supply systems, much of the steam path of the turbine contains wet steam. The turbine manufacturer designs for continuous removal of a part of this water at various stages in the turbine. This Standard indicates means of removing water from the turbine and preventing its reintroduction once it is in the external piping. It also indicates means of preventing induction of water into the turbine from external sources, such as the main steam system and feedwater heaters. The methods for preventing turbine water damage due to water induction or accumulation include one or more of the following basic procedures for design where appropriate:

(a) detection of the accumulation of water either in the turbine or preferably external to the turbine before that water has caused damage
(b) isolation of the water by manual or preferably automatic means after it has been detected
(c) disposal of water either by manual or preferably automatic means after it has been detected

2.1.3 No single failure of equipment shall result in water entering the turbine. The failure mode of the various devices used to prevent water induction shall be considered so that a single failure of the signals (loss of air or electrical signal) will not result in water entering the turbine.

2.1.4 Steam lines connecting to the steam turbine directly or indirectly shall be designed to ensure that any saturated steam or condensate that may have collected while the line or portion of the line that was out of service is adequately warmed and drained prior to being returned to service.

2.1.5 Any automatic control system used to control steam line drain valves identified in this Standard shall be designed so that the system has a means for initiating valve actuation and a separate means to verify the appropriateness of the automatic action. If an inappropriate action is taken, an alarm shall be provided.

2.1.6 An integrated control system (ICS), such as a distributed control system (DCS), can by its inherent design provide additional control and monitoring capability for power plant systems and equipment. Use of an ICS has been considered as an option for control and monitoring potential sources that might allow water to enter the turbine. If an ICS is available, the additional redundancy and availability of that system shall be used as indicated in this Standard. However, if no ICS is provided, following the non–ICS-specific requirements is intended to still represent a conservative design for protection from water induction.

2.2 Definition of Terms

2.2.1 Systems

auxiliary steam: a steam system that is used outside of the main cycle systems for plant uses, such as equipment power drives, air heating, building heating, start-up heating, etc.

condensate: the main cycle piping system that transports water from the condenser to the deaerator, feedwater system, or steam generator. Heating and purification of the water may be part of this system.

condenser: equipment that condenses low-pressure turbine exhaust steam and thus provides a heat sink for the cycle. Normally, a condenser also serves to collect the condensate into a hotwell to supply the condensate system. Condensers may be of the following types:

air cooled, condenser: the turbine exhaust steam is routed to large heat exchangers arranged so that cooling air passes through them and steam is condensed directly. The condensate is collected in a drain tank that functions as the hotwell for condensate system supply.

auxiliary, condenser: a condenser is designated as auxiliary when it is supplied primarily for steam-turbine-driven auxiliary equipment or for steam dumps.

direct contact, condenser: condensate from the condenser is routed to a closed cooling heat exchanger and then returned, where it contacts the steam to continue the condensing process.

water-cooled, condenser: this condenser, the most common type, is supplied with cooling water from a natural source or a cooling tower.

wet-dry, condenser: a cooling tower combination employs an evaporative cooling system (water-cooled) for a portion of the cooling and includes an air-cooled section for the remaining cooling.

continuous drain: a drain that does not contain a valve, trap, or other device to cycle and pass drains intermittently.

cross-around: a generic term for cross-over or cross-under piping located between the high-pressure turbine exhaust and the moisture separator, or moisture separator/reheater (MS or MS/R) or between the moisture separator, or moisture separator/reheater (MS or MS/R) and the low-pressure turbine inlets as defined above. Cross-around piping could also refer to the piping between the HP turbine exhaust and the LP turbine inlet that is routed alongside the turbine.

cross-over: piping from the high-pressure/intermediate pressure turbine to the low-pressure turbine that is above the turbine deck.

cross-under: piping from the high-pressure/intermediate pressure turbine to the low-pressure turbine that is below the turbine deck.

deaerator (open or direct contact heater): a feedwater heater that functions by mixing the steam with the condensate or feedwater. A contact heater that is especially designed to remove noncondensable gases is termed a "deaerator." These heaters are often provided with a separate storage tank.

drain valve: a block valve used to isolate a steam line drain.

extraction steam (nonautomatic, uncontrolled, or bleed steam): a steam turbine connection (opening) from which steam can be extracted at an uncontrolled pressure. This system may provide steam to feedwater heaters, other plant services, and process steam.

feedwater: the system that transports water from the condensate system, deaerator, or other storage vessel to the steam generator. Heating of the water may be included as part of this system.

gland steam (turbine steam seal): a steam system that provides steam at a pressure slightly above atmospheric conditions to connections at the steam turbine glands (seal area at rotor shaft ends). This is done to prevent air leakage into turbines operating with steam conditions less than atmospheric pressure. The system normally includes piping to route high-pressure gland leakoff steam to the low-pressure turbine glands.

heater drain: this system removes condensate from feedwater heaters in the feedwater and condensate systems. The systems are generally designed to cascade the drains to the next lowest pressure heater, with the heaters in the feedwater system ultimately draining to the deaerator and drains from the heaters in the condensate system to the condenser. The drains may be pumped forward from the feedwater heater to the condensate line downstream of the heaters. The system includes alternate drains to the condenser for start-up, shutdown, and emergency conditions.

level element: a device used directly or indirectly to measure level and provide a corresponding output signal.

main steam: the steam system that connects the nuclear steam supply to the high-pressure turbine.

manual or remote manual valve: a valve that requires operator action to open or close. The valve may have a power operator to allow remote actuation to be initiated by the operator in the control room [see also *automatic valve* in para. 2.2.2 and *power-operated block (or drain) valve*].

nonreturn/check valve: a valve that is designed to prevent a reverse flow in a pipeline. Flow in the desired direction keeps the valve open, while a reversal in flow should close the valve.