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# Standard Practice

# Online Monitoring of Cooling Water Systems



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NACE International
1440 South Creek Dr.
Houston, Texas 77084-4906
+1 281-228-6200

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## Foreword

This NACE standard describes a variety of devices used for online monitoring of fouling, corrosion, and other parameters in cooling water systems. Methods are presented for collecting test data to determine fouling and corrosion rates that may be used for, but are not limited to, (1) predicting the expected service life of heat-exchange equipment, (2) optimizing the cooling water system operation, (3) detecting operating problems and upset conditions, (4) monitoring corrective actions taken when such conditions occur, (5) assisting in problem solving, and (6) evaluating alternate chemical treatment programs. This standard is intended for use by operators of cooling water systems and those organizations that supply treatment materials and consulting services to them.

This standard was originally prepared in 1989 by NACE Task Group (TG) T-3T-1, a component of Unit Committee T-3T, "On-Line Monitoring Technology," and revised in 1995 by TG T-3T-4. It was revised in 2002 and 2013 by NACE TG 241, "On-Line Monitoring of Cooling Waters and Cooling Water Test Units." TG 241 is administered by Specific Technology Group (STG) 11, "Water Treatment." This standard is issued by NACE International under the auspices of STG 11.

In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual*. The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

# NACE International
# Standard Practice

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## Section 1: General

1.1 The purpose of this standard is to describe technologies applicable to the online monitoring of cooling water systems. The standard focuses on those technologies that provide data on a short-term basis (minutes to hours) and provide output in a form that may be used by the operator to deal with changing conditions in real time.

1.2 For the purpose of this standard, an online monitor for a cooling water system is defined as a device, or combination of devices, that measures corrosion rates and determines changes in heat transfer coefficients (fouling factors) by measuring pertinent parameters under steady-state conditions that simulate critical conditions in an operating heat exchanger in a reliable and objective manner and with acceptable precision and accuracy.

1.3 References to Existing Publications

1.3.1 ASTM[(1)] G 96[1] covers two techniques for monitoring the corrosion rates of metals—(1) electrical resistance method, and (2) linear polarization resistance (LPR) method. Of the two, the LPR method, which determines instantaneous corrosion rates, has found considerable acceptance compared with other methods for monitoring corrosion rates of metals exposed to cooling waters.

1.3.2 NACE Publication 3T199[2] covers techniques for both direct and indirect monitoring of corrosion and related parameters in field applications.

1.3.3 EPRI[(2)] Report TR-112024[3] covers online monitoring techniques used by utility end users.

1.4 This standard covers simulation of plant heat exchangers with cooling water on the tube side where the monitor incorporates (1) a test surface heated by high-purity steam or an electrical resistance heater of constant heat flux, or (2) pressure-drop methodology, generally unheated to evaluate microbiological growth. However, other heating media such as hot water or a heat transfer fluid have been used as the heat source. When numerical results are given for fouling, they represent only what occurred under a specific set of heat exchanger operating conditions and cooling water quality. Online monitors, such as those covered in this standard, are not designed to model operational problems such as localized hot spots, changing heat flux, localized low-velocity areas, hydraulic shocks, or mechanical cleaning that may occur in operating plant heat exchangers. As with most process modeling, online monitors cannot replicate the total process heat exchanger at one time. Thus, the user must choose the section of the heat exchanger (e.g., inlet, middle, outlet) to be modeled.

1.5 Appendix A (nonmandatory) includes heat transfer nomenclature and equations used in this standard.

## Section 2: Apparatus—Fouling/Deposit Monitors

2.1 Electrically Heated Monitors

2.1.1 Principles of Operation

2.1.1.1 Online monitors are often designed for easy use and simplicity, using an electrical resistance heating element to impose a heat load on the metal surface and measuring the rate of heat transfer from that metal surface into a cooling water stream passing by it (see Figure 1). This enables the heat transfer efficiency and overall cleanliness to be determined. This heat transfer rate is relatively constant as long as the surface remains free of foulant. However, as substances (e.g., hardness salts, oxides and hydroxides of iron, silt, biomass, and process contamination) form deposits on the heated surface, they decrease the overall cleanliness and reduce heat transfer. The heat load is supplied by an electrically heated element that is located near or directly in contact with the metal probe surface.

2.1.1.2 Fouling is a function of cooling water temperature, viscosity, flow characteristics (Reynolds number and shear stress), geometry, materials of construction, and temperature of the heat transfer surface. The levels of dissolved and

(1) ASTM International (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.
(2) Electric Power Research Institute (EPRI), 3420 Hillview Ave., Palo Alto, CA 94304.