Procedures for Routine Performance Tests of Steam Turbines

(Not Intended for Acceptance Testing)

ASME PTC 6S Report-1988

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PERFORMANCE TEST CODES

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Please Note: ASME issues written replies to inquiries concerning interpretation of technical aspects of this document. PTC 6S Report-1988 is being issued with an automatic subscription service to the interpretations that will be issued to it up to the publication of the 1992 Edition.

FOREWORD

(This Foreword is not part of ASME PTC 6S Report-1988.)

Users of both large and small turbines have experienced an increasing need for procedures for routine turbine tests which trend performance with time. The use of full-scale ASME Performance Test Code procedures and instrumentation for this purpose is expensive and produces information and accuracy beyond that necessary for periodic monitoring. When ASME Performance Test Code Committee No. 6 was reorganized to revise PTC 6-1949, it was charged also with developing simplified procedures for periodic tests. Because of the routine nature of the tests, these procedures were to emphasize repeatability of results rather than absolute accuracy and thus provide a more economic means of monitoring performance trends.

This Report reflects the consensus of knowledgeable engineers and contains recommended procedures for collecting sufficiently accurate data to permit analyses of performance trends. Recommendations are given which include advance planning, cycle isolation, and suggested presentation of results. Emphasis is placed upon the use of accurate instrumentation, approaching measurement uncertainties required by the Code, for the measurement of critical variables that are part of the heat-rate equation. Other instrumentation is specified to produce results of good accuracy and of a high degree of repeatability. With the application of automatic data-logging and on-line computer systems to the plant cycle, the procedures presented in this Report, when applied to this end, should satisfy the needs of users of both large and small turbines.

Procedures recommended in this Report are not intended to produce abolute levels of performance. If absolute performance level is required, the ASME Test Code for Steam Turbines, PTC 6, 1976, reaffirmed 1985, or the Interim Test Code for an Alternative Procedure for Testing Steam Turbines, PTC 6.1, 1984, should be followed. For other levels of accuracy, where the test instrumentation varies from the Test Code specified procedure, the Report by PTC Committee No. 6 on "Guidance for Evaluation of Measurement Uncertainty in Performance Tests of Steam Turbines," 1985 should be consulted.

Users of this Report are requested to comment and provide to the Committee supporting data obtained with these procedures. Such comment and repeatability data covering long-term and/or extensive experience will provide guidance for subsequent revisions of this Report. User suggestions and data should be submitted to the Secretary, ASME Performance Test Codes Committee, 345 East 47th Street, New York, New York 10017.

This Report was approved by the ASME Board on Performance Test Codes and adopted as a standard practice of the Society on May 8, 1988. It was approved as an American National Standard by the ANSI Board of Standards Review on September 8, 1988.

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(In addition to the above personnel, the Committee is indebted to Ms. E. Pitchford of Lower Colorado River Authority and H. S. Arnold of Public Service Electric & Gas Corp. for their efforts on the early work of this Standard.)

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SECTION 0 — INTRODUCTION

0.1 PURPOSE OF REPORT

This Report provides turbine-test procedures for the analysis and supervision of relative performance throughout the life of the turbine. These procedures will determine trends of operating efficiency, detect trouble, and furnish test data to evaluate efficiency changes in the turbine cycle. These procedures are designed to minimize test instrumentation and personnel. However, precision instrumentation at critical test locations is recommended for reliable results. A high degree of repeatability, rather than the acceptance test level of performance, is sought.

0.2 CONTENT

This Report contains test procedures for recommended instrumentation, planning, conduct, calculation, and evaluation of the test results. Separate procedures are recommended for specific turbine types.

0.3 PURPOSE OF TEST PROGRAM

A routine turbine-performance test program will:

(*a*) provide guidance in scheduling maintenance outages on the basis of performance;

(*b*) provide guidance in establishing the loading sequence of steam turbine-generator units according to their current relative performance;

(*c*) evaluate major modifications of the turbine or turbine cycle, and changes in operating procedure;

(*d*) detect performance changes in specific areas of the turbine or the turbine cycle;

(*e*) check the accuracy of station instruments by comparison with test instruments;

(*f*) train personnel in testing techniques.

0.4 REFERENCES

The ASME Test Code for Steam Turbines, PTC 6-1976, and Interim Test Code for an Alternative Procedure for Testing Steam Turbines, PTC 6.1-1984, are the basic references for this Report. The term "Code" used in this Report refers to these documents. The ASME Code on Definitions and Values, PTC 2-1980 and the applicable supplements of PTC 19 Series, on Instruments and Apparatus, provide supplementary information. A separate report by Performance Test Code Committee No. 6, Guidance for Evaluation of Measurement Uncertainty in Performance Tests of Steam Turbines, should be used to evaluate the level of accuracy afforded by the instrumentation recommended for this Report's test procedures. Whenever PTC 19.1, Measurement Uncertainty, is referenced in this document, 95 percent confidence levels have been used in accordance with accepted practices. Appendix A to Test Code for Steam Turbines, PTC 6A-1982, and Sections 7 through 13 of this Report provide numerical examples of various turbine calculations which should prove useful in applying this Report's procedures.

SECTION 1 — OBJECT, SCOPE, AND INTENT

1.1 OBJECT

The test procedures of this Report are intended for periodic turbine tests and do not supplant the Code as the basic procedure for turbine acceptance tests. The Code is used for the accurate testing of steam turbines to obtain performance level with minimum uncertainty.

1.2 SCOPE

Sections 3 through 5 of this Report present general recommendations for instrumentation and test planning. These recommendations are based on current industry practice for the periodic determination of turbine-cycle performance. Section 6 discusses interpretation of test results and shows typical plots of test data for analysis of turbine performance. Sections 7 through 12 present test procedures for selected types of turbine cycles. Each of these procedures contains specific recommendations for instrumentation and method for testing a selected turbine type. Although all possible turbine types are not covered, some typical examples are presented. Combinations of the types presented may be used to cover other arrangements. For each recommended test procedure, the expected value of repeatability is estimated on the basis of current industry experience. This value of repeatability must be used to judge the significance of the indicated level of performance as compared to the chronological trend of past performance. (See para. 3.8.3 for discussion of repeatability.)

1.3 INTENT

This Report provides procedures to periodically monitor changes in overall turbine cycle performance. Supplementary instrumentation and data may be included in the test procedure to diagnose the causes of changed performance. This supplementary information may assist in evaluating the effect of component changes on the overall performance. Some users may prefer the simplicity of the recommended procedure and then run a second test only when a detailed analysis is required. These procedures define both primary and secondary data for a turbine-performance analysis.

For reference purposes only, Section 13 presents other test procedures for determining turbine-performance trends; however, these procedures may not provide complete data for analysis of all components in the turbine cycle. In special cases, they may provide adequate information and be advantageous due to their low cost and simplicity.

For on-line computer monitoring of steam-turbine performance, the simplified test procedures given in this Report can serve as a basis for choice of instrumentation and development of calculation procedures. The instrumentation is selected to achieve repeatable results consistent with the objective of monitoring the trend of turbine performance.

Diagnostic monitoring systems for vibration, oil cleanliness, rotor crack detection, and solid particle erosion and supervisory systems for differential expansion, bearing metal temperature, bearing wear, turbine load, and speed are not indicators of turbine performance. Analytical techniques using data from these systems can result in early identification of potential problems.