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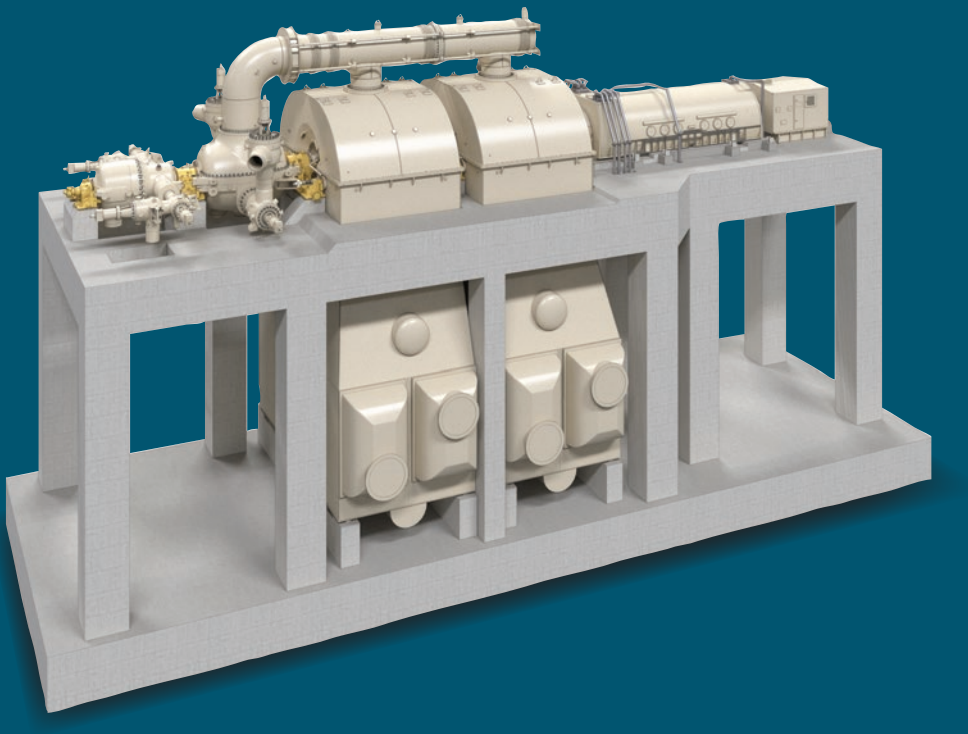

# Concrete Foundations FOR Turbine Generators

## Analysis, Design, and Construction

Prepared by the Task Committee on
Turbine Generator Foundations

Edited by Hongchun Liu, P.E.

ASCE

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Sponsored by the
Energy Division of the
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# CONTENTS

# PREFACE

In 1987, the Task Committee on Turbine Foundations of the Fossil Power Committee and the Nuclear Energy Committee of the Energy Division of the American Society of Civil Engineers (ASCE) published the first guide for the design of large steam turbine generator foundations.

Since the guide's publication, there have been significant changes in design codes, advances in computer analysis, and increased industry pressure to refine foundation designs. A new task committee was formed in April 2014, under the leadership of the ASCE Energy Division chaired by J. G. (Greg) Soules, to address the wide variation of analysis, design, and construction practice that have been applied throughout the industry for turbine generator foundation designs over the past 30 years in the United States.

Designing a turbine generator foundation requires not only advanced technical expertise in structural and soil dynamics, but also close collaboration with machine manufacturers and other disciplines (mechanical, electrical, and plant design). Different manufacturer requirements, and code provisions that are subjected to interpretations when applied to such foundations, present additional challenges to the design engineers.

This document was prepared by the task committee to provide practical guidance in the analysis, design, and construction of turbine generator foundations. It is a result of significant collaborative efforts from all committee members, as well as contributions from other industry experts and professionals.

The intended audience for this document includes structural design engineers, operating company personnel responsible for establishing structural design criteria and construction standards, and local building officials.

For more than three years, a number of key individuals dedicated significant amounts of time and effort to formulating, originating, and reviewing in detail, either the whole document or specific sections thereof. Those members are identified in the Acknowledgments.

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# CHAPTER 1
# INTRODUCTION

## 1.1 BACKGROUND

In 1987, the Task Committee on Turbine Foundations of the Fossil Power Committee and the Nuclear Energy Committee of the Energy Division of the American Society of Civil Engineers published the first guide for the design of large steam turbine generator foundations (ASCE Task Committee on Turbine Foundations 1987). This initial report attempted to organize into a single document all the criteria necessary to analyze and design large steam turbine-generator (STG) foundations.

Since the guide's publication, there have been significant changes in design codes, advances in computer analysis, and increased industry pressure to refine the design of turbine generator (TG) foundations. A new ASCE task committee on TG foundations was formed within the energy division of ASCE in 2014 to review the industry changes and their impact on the design of these large concrete structures.

The new ASCE Task Committee on Turbine Foundations has revised the 1987 guide to address current industry practices and to expand content to include information on these topics:

- Design of combustion turbine generator (CTG) foundations, in addition to steam turbine generator (STG) foundations.
- Development of finite element (FE) analytical models.
- Development of dynamic stiffness and damping for dynamic analyses of soil- and pile-supported STG and CTG foundations.
- Design of embedded items.
- Construction considerations specific to TG foundations.

The Steel Foundations chapter of the 1987 guide is not in the scope of this book, because a vast majority of TG foundations are constructed using reinforced concrete.

The new task committee members are representatives from leading engineering firms involved in the design of power plants, major turbine generator manufacturers, manufacturers of vibration isolation systems, and universities. The diversity of this committee is intended to provide expertise on all aspects of TG foundation design.

## 1.2 PURPOSE

This book is intended as a state of practice guide for practicing engineers and designers responsible for the analysis and design of gas and steam turbine generator foundations. Recommendations for the design, analysis, construction, and other aspects of TG foundations are provided as deemed adequate by the committee. The responsibility for satisfying the manufacturer's criteria for a particular installation is left to the responsible engineers.

This report is not intended to supersede any manufacturer's criteria.

## 1.3 SCOPE AND LIMITATIONS

The scope of this book is limited to the design of the following concrete TG foundations:

- Block Foundation—pedestals, piers, and blocks supported on a common basemat.
- Elevated Space-Frame Pedestal Foundation—tabletop and columns supported on a basemat.
- Vibration Isolated Foundation—equipment or structural elements supported on vibration isolation systems.

This manual of practice does not address steel foundations.

This book is organized into eleven chapters with three appendixes. A brief summary of each chapter is provided as follows.

**Chapter 2: Turbine Generator Equipment.** In Chapter 2, the main components of TG systems are described, including combustion turbines (CT), steam turbines (ST), condensers, and generators. Typical TG system layout configurations are discussed and illustrated. An overview of foundation design, installation, and operation is also presented.

**Chapter 3: Preliminary Turbine Generator Foundation Layout and Sizing.** The objective of Chapter 3 is to provide guidance for preparing the