



BSI Standards Publication

Report on the development of cogeneration

National foreword

This Published Document is the UK implementation of IEC TR 63388:2021.

The UK participation in its preparation was entrusted to Technical Committee W/-, Consumer Products and Services Sector Policy and Strategy Committee.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication is not to be regarded as a British Standard.

© The British Standards Institution 2022
Published by BSI Standards Limited 2022

ISBN 978 0 539 17600 1

ICS 27.040

Compliance with a Published Document cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 January 2022.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------



TECHNICAL REPORT



Report on the development of cogeneration

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.040

ISBN 978-2-8322-1058-7

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
1 Background	6
1.1 Task following SMB decision.....	6
1.2 Scope	7
1.3 Purpose	8
2 Terms, definitions and abbreviated terms.....	8
2.1 Terms and definitions	8
2.2 Abbreviated terms.....	10
3 Overview of CHP	10
3.1 What is CHP?	10
3.2 Benefits of CHP	12
3.3 Efficiency of CHP system	13
4 Market situation of cogeneration	14
4.1 Global situation.....	14
4.2 European situation	14
4.3 American situation	15
4.4 Asian situation	15
4.5 Summary	17
5 CHP based on steam turbine	17
5.1 General introduction	17
5.2 Technical characteristics	18
5.2.1 CHP based on extraction turbine	18
5.2.2 CHP based on back pressure turbine.....	18
5.2.3 Low-vacuum heating mode	19
5.2.4 LP cylinder steam bypassed heating mode	20
5.2.5 CHP based on steam turbine with synchro-self-shift clutch	21
5.2.6 Special case: gas-steam combined cycle CHP	22
5.3 Components	23
5.4 Requirements	24
5.5 Summary	26
6 CHP based on other processes	26
6.1 General.....	26
6.2 Technical characteristics	27
6.2.1 Gas turbine CHP	27
6.2.2 Stirling engine CHP	28
6.2.3 Fuel cell CHP	29
6.2.4 ORC CHP	30
6.3 Components	31
6.4 Requirements	32
6.5 Summary	33
7 Standardization demand of CHP	33
7.1 Necessity to develop CHP technical standards.....	33
7.2 Current status of ISO/IEC standards related to CHP	34
7.2.1 General	34
7.2.2 CHP system level	35
7.2.3 CHP communication level.....	35

7.2.4	CHP component level	35
7.3	Summary	40
8	CHP standardization roadmap	40
8.1	Envisaged CHP standard architecture	40
8.2	Description of the standard architecture	41
8.3	Developing the path of future standards	42
8.3.1	Develop path– Start from system to component level.....	42
8.3.2	Work of joint working group	43
8.4	Developing committee recommendations	43
8.5	Summary	43
Figure 1	–CHP based on steam turbine.....	11
Figure 2	– CHP based on combustion turbine or reciprocating engine.....	11
Figure 3	– Example of energy efficiency for different generating systems.....	12
Figure 4	– Proportion of different heating modes in urban areas of northern China	16
Figure 5	– Cogeneration status in Japan by fuel types	17
Figure 6	– Heating system based on extraction steam turbine.....	18
Figure 7	– Back pressure turbine heating system	19
Figure 8	– Typical diagram of a low-vacuum heating system	20
Figure 9	–Schematic of LP cylinder steam bypass heating technology	21
Figure 10	– Heating turbine with synchro-self-shift clutch.....	22
Figure 11	– Schematic diagram of combined cycle unit cogeneration	23
Figure 12	– Typical work flow of CHP system based on steam turbine	23
Figure 13	– Energy efficiency comparison between small-scale CHP system and traditional energy services	27
Figure 14	– CHP system based on micro gas turbine	28
Figure 15	–CHP system based on STIG	28
Figure 16	– Typical Stirling engine CHP unit process	29
Figure 17	– Fuel cell CHP system	30
Figure 18	– ORC CHP system.....	31
Figure 19	– Link between CHP system and user demands	34
Table 1	– Installed capacity of cogeneration units in Japan as of March 2020	16
Table 2	– Status of CHP standards	36
Table 3	– CHP standard architecture	41

INTERNATIONAL ELECTROTECHNICAL COMMISSION

REPORT ON THE DEVELOPMENT OF COGENERATION

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 63388 has been prepared by IEC technical committee 5: Steam turbines. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
5/243/DTR	5/244/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

REPORT ON THE DEVELOPMENT OF COGENERATION

1 Background

1.1 Task following SMB decision

Following the Standards Management Board (SMB) decision 141/10, IEC Technical Committee 5 (Steam Turbine) was tasked to lead a joint working group with related IEC and ISO committees to explore potential standardization opportunities.

SMB decision 141/10 reads as follows:

SMB decision 141/10 – SMB AhG 30: Co-generation – IEC involvement in joint work with ISO

The SMB, further to having taken decisions confirming IEC's commitment to providing support to the areas of cogeneration technology within its area of competence in particular aspects related to electrical power generation, decided to instruct IEC TC 5 to be the primary point of contact, to follow this activity in coordination with TC 45 and TC 105.

The SMB requests AhG 30 to submit a final report and recommendations on future work and any future activities by end July 2011, and decided to disband the SMB AhG 30 after submission of the report.

Based on the AhG recommendations, SMB will then communicate an IEC perspective on this matter to ISO.

With the above SMB decision, IEC Technical Committee 5 established Joint Working Group 16 (Cogeneration Combined Heat and Power (CHP)) in 2012-09.

After IEC/TC5/JWG16 was established, working steps were proposed (see 5/168/AC) as follows:

No.	Working step	Remarks
1	Complete an overview on standards related to CHP technology.	Also include standards if they only partly cover CHP aspects
2	Clarification of status and application experience of Manual CWA 45547	Efficiency of CHP solutions is in focus for all applications. The Manual CWA 45547 from 2004 could be a basis for an IEC standardization project. There might be valuable feedback available from application of the Manual.
3	Screening of world-wide applied alternative methods for determination of CHP efficiency	
4	Clarification of the need for standards dealing with aspects different to efficiency such as safety, performance and installation. A differentiation between residential / commercial mass products and power plants should be considered. It should be identified where the current standardisation activities are going on in ISO or IEC and where the need for new coordination between IEC / ISO TCs is suggested.	Consider the different needs for the residential, commercial and industrial needs including the different power sizes. EN 50465:2008 GAS APPLIANCES – COMBINED HEAT AND POWER APPLIANCE OF NOMINAL HEAT INPUT INFERIOR OR EQUAL TO 70 KW? IEC62282 Fuel Cell Technologies Germany: FW308 July 2011 Status per 03-2012: The common aspects of safety related control are already covered by other IEC and ISO standards on Functional Safety. No additional aspects for standardization with respect to CHP identified. The common aspects of application of gas and oil valves are covered by other IEC and ISO standards. No additional aspects for standardization with respect to CHP identified.
5	Clarification if there is any other product/solution specific standardization need in the area of CHP	Possible aspects are also grid parallel operation of the CHP.
6	Update necessary liaisons with other TCs within IEC or ISO	IEC TC45 Nuclear instrumentation? IEC TC105 Fuel cell technologies? ISO TC192 Gas Turbines? ISO TC208 Thermal turbines for industrial application (steam turbines, gas expansion turbines)? Other TCs?
7	Prepare Proposal of standardization Work Item (PWI) for voting in TC5 and relevant other TCs	Proposal might include the target to align the context of the new IEC standard in a way that it later – as an EN IEC standard – can be harmonized with the EC Directive 2004/08 (Combined Heat and Power (CHP) Directive).
8	Clarification of which other IEC or ISO standards have to be adapted, when new IEC standard in CHP efficiency becomes valid. Preparation of requests to other TCs for adaptation/update of other standards.	Chapters on CHP efficiency in other standards for individual applications should be replaced by a reference on the new IEC standard. In C-type standards describing the efficiency of a certain technology relevant to CHP a reference on the new IEC standard on CHP efficiency should be included.
9	Clarification with CEN/CENELEC on withdrawal of Manual CWA 45547	

This technical report is intended to address the above items 1, 3, 4, 5, 7, and 8.

Other items will be addressed depending on the outcome of this report.

1.2 Scope

This document, which is a technical report, introduces the widely used technical scheme of cogeneration (also known as combined heat and power (CHP)), and gives the corresponding cases. The technical schemes of cogeneration covered in this technical report can be divided into two categories. One is cogeneration based on steam turbine, which is generally applied in thermal power plants; The other is cogeneration based on other prime movers, such as fuel cell, micro gas turbine, internal combustion engine, Stirling engine, ORC, etc.