
Carbon dioxide capture —

Part 2:

Evaluation procedure to assure and maintain stable performance of post-combustion CO₂ capture plant integrated with a power plant

Captage du dioxyde de carbone —

*Partie 2: Mode opératoire d'évaluation pour assurer et maintenir une
performance stable du captage du CO₂ post-combustion intégré à une
centrale thermique*

ISO 27919-2:2021

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 265, *Carbon dioxide capture, transportation, and geological storage*.

A list of all parts in the ISO 27919 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Atmospheric carbon dioxide (CO₂) emissions must be reduced to meet climate change mitigation targets. Including carbon dioxide capture and storage (CCS) in current emission reduction approaches increases the probability of meeting these targets at the lowest cost to the global economy. CO₂ capture from gases produced by combustion of carbonaceous fuels is the only technology capable of dealing directly with emissions from power plants and other industrial sectors, such as cement manufacture and fertilizer production.

This document is the second in a series of standards for post-combustion CO₂ capture (PCC) from a power plant using a liquid-based chemical absorption process. Building on ISO 27919-1 on evaluation of key performance indicators (KPIs), this document provides an evaluation procedure to assure and maintain reliable performance of a PCC plant integrated with a power plant. New or revised standards focusing on other CO₂ capture technologies and approaches will be developed later.

PCC is applicable to all combustion-based thermal power plants. A simplified block diagram illustrating the PCC process is shown in [Figure 1](#).

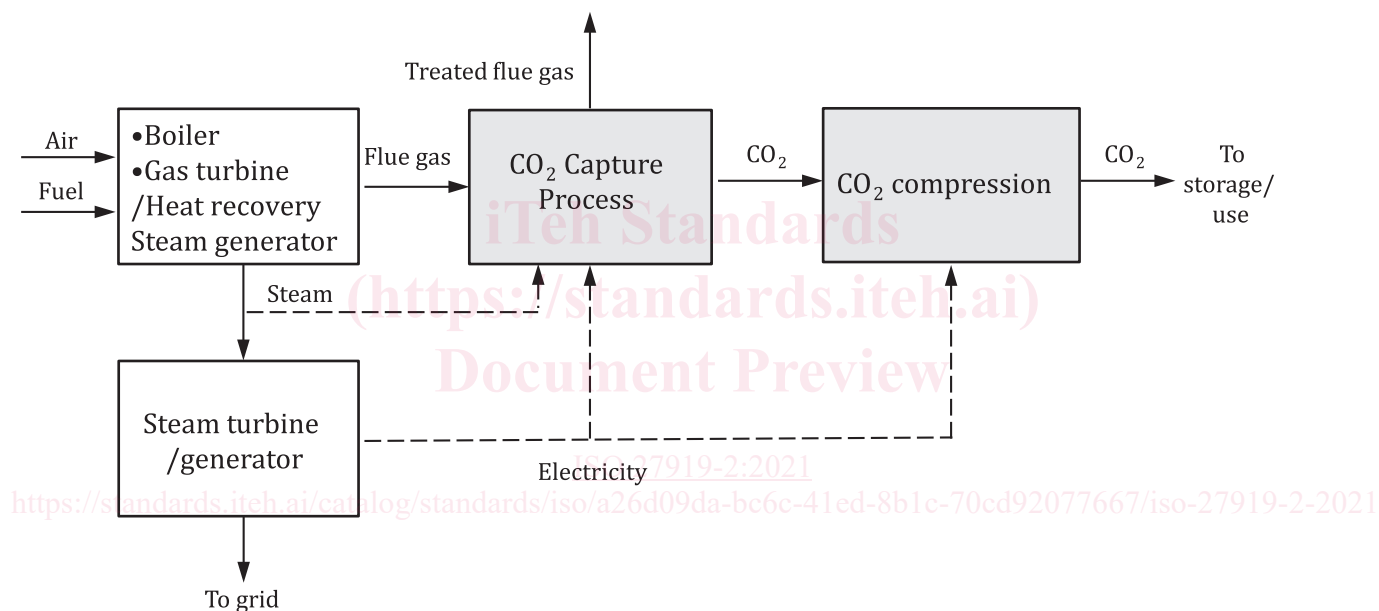


Figure 1 — Simplified block diagram of PCC

In a typical power generation facility, carbonaceous fuel (e.g. coal, oil, gas, biomass) is combusted with air in a boiler to raise steam. The steam drives a turbine or generator to produce power. In a gas-turbine combined-cycle system, the combustion in the gas turbine drives power generation, while steam generated through a heat-recovery steam generator produces additional power. Flue gas from the boiler or gas turbine consists mostly of N₂, CO₂, H₂O and O₂, with smaller amounts of other compounds depending on the fuel used. The PCC process is located downstream of conventional pollutant controls. Chemical-absorption-based PCC usually requires steam to be extracted from the power plant's steam cycle or the use of lower-grade heat sources for absorption liquid regeneration, depending on the absorption liquid and process employed.

The economic and environmental value of a PCC plant is determined by its technical performance, as well as its ability to achieve and maintain stable operation as required by its owners/stakeholders, as follows:

- The owner of the flue gas source has an interest in sustained CO₂-emission reductions.
- The owner of the CO₂-product has an interest being able to supply CO₂ at the desired rate regardless of external conditions.

The CO₂ receiver has an interest in CO₂-product availability for its own operations.

Thus, this document describes a procedure that combines technology item evaluation procedure with reliability, availability, and in some cases maintainability evaluation methods.

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Carbon dioxide capture —

Part 2:

Evaluation procedure to assure and maintain stable performance of post-combustion CO₂ capture plant integrated with a power plant

1 Scope

This document provides definitions, guidelines and supporting information for evaluating and reporting (with respect to the basic design items ongoing, and the operational results of a reference plant or unit as feedback) to ensure the (designed) performance of a PCC plant integrated with a host power plant. The PCC plant separates CO₂ from the power plant flue gas in preparation for subsequent transportation and geological storage. The physical system being addressed is a single power plant, with an optional auxiliary unit to provide thermal energy required for the PCC plant, and a single PCC plant as described in ISO 27919-1.

The formulas and methods to assure and maintain reliable performance, presented in this document, describe issues addressed during the design and construction phases and practices that document reliability and availability during routine operation. These practices would also guide ongoing maintenance programmes.

This document does not provide guidelines for benchmark, comparison or assessment studies for PCC plant operations using different capture technologies (i.e. absorbents), nor does it specify appropriate operating conditions such as temperature etc.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 27919-1, *Carbon dioxide capture — Part 1: Performance evaluation methods for post-combustion CO₂ capture integrated with a power plant*

3 Terms, definitions, abbreviated terms and symbols

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

administrative delay

delay to maintenance incurred for administrative reasons

[SOURCE: IEC 60050-192 (192-7-12), modified — “maintenance action” was changed to “maintenance”]

3.1.2

availability

ability of a *PCC plant* (3.1.20) integrated with the power plant to be in a state to perform as required under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

3.1.3

corrective maintenance

maintenance carried out after fault detection to effect restoration

Note 1 to entry: Corrective maintenance of items disrupts the plant availability.

3.1.4

derated

derating

difference between the maximum and the dependable one, or such a condition

Note 1 to entry: For derated hours, it means operating time with the rated output lowered.

3.1.5

downtime

time interval for which the *item* (3.1.9) is in a state of being unable to perform as required due to internal faults, or *preventive maintenance* (3.1.24)

Note 1 to entry: unavailable time

3.1.6

emergency operation

type of sudden *shut-down* (3.1.36) operation to protect hardware from damage

3.1.7

external influence

critical subjects occurring outside the *PCC plant* (3.1.21) evaluation boundary

3.1.8

failure mechanism

process that leads to failure

Note 1 to entry: The process may be physical, chemical, logical, or a combination thereof.

[SOURCE: IEC 60050-192:2015, 192-03-12]

3.1.9

item

subject being considered

Note 1 to entry: An item may be an individual part, component, device, functional or process unit, equipment, subsystem, or system, related with technology.

Note 2 to entry: An item may consist of hardware, software, people or any combination thereof.

[SOURCE: IEC 60050-192:2015, 192-01-01, modified — “functional unit” was changed to “functional or process unit” and “system” was changed to “related with technology” in Note 1. Note 3 to Note 5 were deleted.]

3.1.10

logistic delay

delay, excluding *administrative delay* (3.1.1), incurred for the provision of resources needed for a *maintenance* (3.1.12) action to proceed or continue

[SOURCE: ISO 20815:2018, 3.1.24]

3.1.11**maintainability**

ability to be retained in, or restored to, a state in which the required function can be performed under given conditions

3.1.12**maintenance**

combination of all technical and management actions intended to retain an *item* (3.1.9) in, or restore it to, a state in which it can perform as required

Note 1 to entry: Management is assumed to include supervision activities.

[SOURCE: IEC 60050-192:2015, 192-06-01]

3.1.13**mean downtime****MDT**

average of the *downtime* (3.1.5)

[SOURCE: IEC 60050-192:2015, 192-08-10]

3.1.14**mean time between failures****MTBF**

average time between failures that initiate a forced *outage* (3.1.20), i.e. the quotient of attempted operating hours to the number of forced *outages* (3.1.20)

3.1.15**meantime between maintenance****MTBM**

average time between *maintenance* (3.1.12), i.e. the quotient of attempted operating hours to the number of *maintenance* (3.1.12)

3.1.16**mission time**

duration of the mission

Note 1 to entry: Mission is the state that the equipment or system is 100 % operational.

[SOURCE: ISO 10438-1:2007, 3.1.19]

3.1.17**nominal product CO₂ capacity****NC**

highest continuous flow rate of delivering captured CO₂ under typical representative conditions defined by the plant operator

3.1.18**normal operation**

operation where the product CO₂ is exported to the transporting system maintaining the required performance based on ISO 27919-1

3.1.19**on-stream factor****OSF**

ratio of the summation of all on-stream time to the *reference period* (3.1.31), with both expressed as hours

3.1.20

outage

time interval for which the *item* (3.1.9) is in a state of being unable to perform as required, for any reason

[SOURCE: IEC 60050-192:2015, 192-02-19, modified — “a disabled state” was changed to “a state of being unable to perform as required, for any reason”]

3.1.21

PCC plant

process and associated equipment that produces a CO₂ stream from combustion gases

[SOURCE: ISO 27919-1:2018, 3.1.26]

3.1.22

PCC plant capacity availability

PCA

availability (3.1.2) of *PCC plant* (3.1.21) from a perspective of *product CO₂ amount* (3.1.26) during a *reference period* (3.1.31)

Note 1 to entry: It is mathematically defined by [Formula \(3\)](#).

3.1.23

PCC plant load

ratio of the *product CO₂ capacity* (3.1.27) in operation to the ‘*nominal product CO₂ capacity*’ (3.1.17)

3.1.24

preventive maintenance

maintenance (3.1.12) carried out in accordance with an established time schedule and performed according to a prescribed criterion

Note 1 to entry: See also condition-based maintenance (IEC 60050-192:2015, 192-06-07), and scheduled maintenance (IEC 60050-192:2015, 192-06-12).

[SOURCE: ISO 23815-1:2007, modified — “criteria” was changed to “criterion”. The Note and the following text were deleted: “in order to reduce the probability of failure or the degradation of the functioning of a crane”].

3.1.25

project cycle

series of phases of which a project consists, e.g. basic design, engineering, manufacturing, commissioning and operation

3.1.26

product CO₂ amount

volume, moles or mass of CO₂ resulting from the PCC process

3.1.27

product CO₂ capacity

total flow rate of the captured CO₂ exported

Note 1 to entry: It is generally expressed as product CO₂ amount per hour.

3.1.28

product CO₂ producibility

PCPB

ratio of the *product CO₂ amount* (3.1.26) produced to the *nominal product CO₂ capacity* (3.1.17) accumulated during the *reference period* (3.1.31)

3.1.29

proven technology element

element with low or acceptable uncertainty levels

3.1.30**redundancy**

item (3.1.9) where an equivalent unit can be put online to provide the same function if the *item* (3.1.9) fail to provide the service

Note 1 to entry: Redundancy is related to a strategy of design, where a spare system or component is provided so that, even if one item fails, the spare system or component will operate in place of the deficient item such that plant performance is not affected.

3.1.31**reference period****RP**

period of time between an initial time and an end time over which all historical or projected performance metrics are measured or projected

Note 1 to entry: Reference period is equivalent to period hours.

3.1.32**reliability**

measure of the probability of success for an operation and, the ability of each *item* (3.1.9) to perform its intended function as needed in an assembled *PCC plant* (3.1.20) during a given time interval within the designed conditions without failure

3.1.33**reliable performance**

ability of a *PCC plant* (3.1.21) to function reliably as required

3.1.34**schedule compliance****SC**

ratio of the *product CO₂ amount* (3.1.26) produced to the scheduled *CO₂ product amount requirement met* (historical) or to be met (projected) by the *PCC plant* (3.1.21) within a given time period

3.1.35**service hours**

accumulated period of time during stand-by and *normal operation* (3.1.18) including *start-up* (3.1.39) and *shut-down* (3.1.36) in between[SOURCE: ISO 3977-9:1999, 3.98, modified — "from main flame ignition through to flame extinction" was replaced by "during stand-by and normal operation including start-up and shut-down in between"].

3.1.36**shut-down**

event during which all required function of a *PCC plant* (3.1.21), and its equipment, is brought from an operating state to a stoppage state under the control of a programmed sequence

3.1.37**stand-by state**

non-operating up state ready to start

3.1.38**starting reliability****SR**

probability of successful *start-up* (3.1.39) when the *PCC plant* (3.1.21) is on stream within a specified period

3.1.39**start-up**

act of getting a *PCC plant* (3.1.21) and its equipment from a stoppage state ready to activate its *items* (3.1.9) to an operating state

3.1.40

technical delay

accumulated time necessary to perform auxiliary technical actions associated with the *maintenance* (3.1.12) action itself

3.1.41

time availability

TA
ratio of the subtraction of the summation of each element of the *PCC plant* (3.1.21) unavailable time from the *reference period* (3.1.31) to the *reference period* (3.1.31)

Note 1 to entry: Available time is calculated by subtraction of the unavailable time from reference period.

3.1.42

time reliability

TR
ratio of the subtraction of *PCC plant* (3.1.21) unavailable time from the time between preventative *maintenance* (3.1.12) to the time between preventative *maintenance* (3.1.12)

3.1.43

unavailability

PCC plant (3.1.21) is not in a state to perform as required due to an internal faults or *preventive maintenance* (3.1.24)

3.1.44

uptime

time interval during which a *PCC plant* (3.1.21) is in a state of being able to perform as required

Note 1 to entry: Absence of necessary external resources may prevent operation but does not affect.

Note 2 to entry: Available time.

3.2 Abbreviated terms

CCS	carbon dioxide capture and storage
DSS	daily start-up and stop
EHS	environment, health and safety
KPIs	key performance indicators
MAD	mean administrative delay
MDT	mean downtime
MLD	mean logistic delay
MR	mission reliability
MTBF	mean time between failure
MTPM	mean time to preventive maintenance
MTTR	mean time to repair
NC	nominal product CO ₂ capacity
NPC	nominal product CO ₂