

VGB Standard

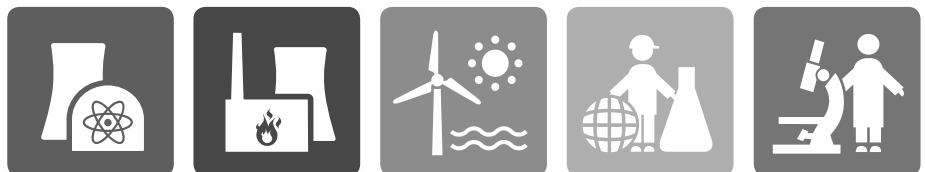
Sampling and Physico-Chemical Monitoring of Water and Steam Cycles

VGB-S-006-00-2012-09-EN

First Edition 2012

Editor:
VGB PowerTech e.V.

Publisher:
VGB PowerTech Service GmbH
Verlag technisch-wissenschaftlicher Schriften
PO Box 10 39 32, 45039 Essen
Tel. +49 201 8128-200
Fax +49 201 8128-329
E-mail: mark@vgb.org
ISBN 978-3-86875-402-5



Any reproduction only permitted
by prior approval of VGB.
www.vgb.org

Important notice – VGB copyright material

VGB-Standards, hereafter referred to as “work”, including all articles and images, are protected by international copyright. VGB PowerTech is responsible to carry out the exploitation of the copyrights.

The term “work“ covers this PDF-file and its content. The copyright covers the work in its entirety and its constituent parts, such as: text, tables, diagrams, photographs and illustrations.

Any use and/or reproduction of this material without the prior written consent of VGB PowerTech e.V., is forbidden and will constitute an infringement of copyright law, liable to prosecution. Any unauthorised reproduction such as: photocopies, reprints, translations, its transfer: onto micro-film, entry into electronic data bases, to the Internet, or to a Web Site, saving onto CD-ROM or other digital media, any and all forms of digital storage and or reproduction will constitute an infringement of copyright.

Disclaimer

VGB-Standards are based on the collective experience and recommendations of PowerTech e.V. and its panel of experts and represent the best knowledge at the time of publication. No claim regarding its completeness is made as a matter of principle because of the numerous factors which must be taken into account and of course due to the dynamic process of continuous development.

VGB-Standards can be used to reach and agree upon detailed specifications between the supplier and the purchaser.

Application of VGB Standards is carried out at the user's own risk. VGB PowerTech e.V and contributors to VGB Standards make no claim regarding its absolute accuracy and therefore accept no legal liability in the event of any claim relating to or resulting from its application.

Treatment of proposing amendments

*Amendments can be sent to the e-mail address **vgb.standard@vgb.org**. The subject line should contain the exact specification of the relevant document in order to clearly assign the e-mail content to the appropriate VGB-Standard.*

Preface

This Standard VGB-S-006-00-2012-09-EN is intended to supplement VGB-S-010-T-00;2011-12.EN [Standard for Feed Water, Boiler Water and Steam Quality for Power Plants / Industrial Plants (formerly VGB Standard VGB-R-450-Le) and to give recommendations for the correct positioning, design and instrumentation as well as for the maintenance of measuring equipment in the water/steam cycle.

This is the first time that comprehensive recommendations for sampling and physico-chemical monitoring of water/steam cycles have been established. Supplementary information relating to chemical monitoring can be found in other rules and standards (cf. Chapter 6).

This VGB standard has been established in close co-operation with power plant users, power plant manufacturers (OEMs for boilers/turbines), measuring instrument manufacturers as well as firms providing analytical services on the power plant sector. This standard represents the state-of-the-art.

The VGB office is looking forward to receiving supplementary information to or proposals for improving this VGB standard to be sent to the following e-mail address vgb.standard@vgb.org indicating the short designation of this document (VGB-S-006-00-2012-09-EN).

Essen, September 2012

VGB PowerTech e.V.

Authors

The following ladies and gentlemen participated in the establishment of this standard:

- | | |
|----------------------------|---|
| – Jürgen Brinkmann | RWE Technology GmbH |
| – Andreas Dahlem | Alstom Power GmbH |
| – Thomas Denker | Dr. Thiedig + Co |
| – Dr. Martin Freudenberger | Endress+Hauser Conducta Gesellschaft für
Mess- und Regeltechnik mbH + Co. KG |
| – Ruedi Germann | SWAN Analytische Instrumente AG |
| – Sven Giebing | VGB PowerTech e.V. |
| – Wolfgang Glück | Siemens AG |
| – Andreas Heß | VGB PowerTech e.V. |
| – Christian Hinterstoisser | LINZ Strom GmbH |
| – Christiane Holl | Hydro-Engineering Herbert Schlizio GmbH |
| – Peter Kaminski | SWAN Systeme AG |
| – Ralf Könemann | Knick Elektrische Messgeräte GmbH & Co. KG |
| – Dr. Frank Udo Leidich | Alstom Power GmbH |
| – Steffen Lilienthal | Vattenfall Europe Generation AG |
| – Stefan Martin | Dr. Thiedig + Co |
| – Siegfried Neuhaus | E.ON New Build & Technology GmbH |
| – Lutz Neumann | Siemens AG |
| – Martin Reckers | Fortum Service Deutschland GmbH |
| – Michael Rziha | Siemens AG |
| – Heinz-Peter Schmitz | FDBR Fachverband Dampfkessel-, Behälter- und
Rohrleitungsbau e.V. |
| – Martin Schubert | Hach Lange GmbH |
| – Manuel Sigrist | SWAN Systeme AG |
| – Ulrich Teutenberg | Hitachi Power Europe GmbH |
| – Henry Tittelwitz | Dr. Thiedig + Co |
| – Reinhard Wagener | H. Wösthoff Messtechnik GmbH |
| – Yvonne Walter | EnBW Kraftwerke AG |

We would like to extend our gratitude to all persons involved in the establishment of this standard.

Table of contents

1	Scope and exclusions	9
1.1	Scope	9
1.2	Exclusions	9
1.3	Normative and other references	9
1.4	Legal framework relating to product and operational safety	10
2	Abbreviations and definitions	11
2.1	Definitions	11
2.2	List of abbreviations	14
3	Positioning of sampling points	15
3.1	Make-up water	16
3.2	Condensate	17
3.2.1	Turbine condensate	17
3.2.1.1	Water cooled condenser	17
3.2.1.2	Air-cooled condenser (ACC)	18
3.2.1.3	District heating condenser	19
3.2.2	Process condensate	19
3.2.3	Condensate drains	19
3.2.4	Condensate collecting tanks	19
3.2.5	Cold condensate storage tank	19
3.2.6	Condensate downstream of condensate polishing plant	20
3.2.7	Condensate upstream of de-aerator	20
3.3	Feed water	20
3.3.1	Feed water downstream of de-aerator	20
3.3.2	Feed water at economiser inlet	21
3.4	Boiler water	21
3.4.1	Once-through boilers	21
3.4.2	Natural and assisted-circulation boilers	22
3.4.2.1	Operation with demineralised feed water	22
3.4.2.2	Operation with salt-containing feed water	23
3.4.3	Shell boilers	24
3.4.3.1	Operation with demineralised feed water	24
3.4.3.2	Operation with salt-containing feed water	25
3.5	Steam	25
3.5.1	Saturated steam	25
3.5.2	Superheated steam	25
3.5.3	Steam sampling downstream of reheat system	26
3.6	Typical plant configurations	27

4	Requirements for sampling systems	33
4.1	Introduction	33
4.2	Sampling points	33
4.2.1	Sampling from single-phase fluids	34
4.2.2	Sampling probes in two-phase fluids (saturated steam)	36
4.2.3	Sampling for the determination of suspended solids	37
4.3	Sampling line	38
4.3.1	Materials and nominal sizes	38
4.3.1.1	Sample temperature < 575°C downstream of sampling point.....	38
4.3.1.2	Sample temperature > 575°C downstream of sampling point.....	39
4.3.2	Routing of sample lines	39
4.3.3	Type of sampling line connections.....	40
4.4	Requirements for planning and location.....	41
4.5	Sample conditioning	43
4.5.1	Preface	43
4.5.2	Functions of sample conditioning system	43
4.5.2.1	Sampling system shut-off(s)	44
4.5.2.2	Flushing of sampling line	44
4.5.2.3	Cooling	46
4.5.2.4	Secondary cooling	48
4.5.2.5	Flow rate (pressure reduction).....	48
4.5.2.6	Filtration.....	48
4.5.2.7	Temperature shut-off valve (TSV).....	49
4.5.2.8	Pressure control.....	51
4.5.2.9	Sample distribution	53
4.5.2.10	Sample discharge	53
4.5.3	Configuration	55
4.5.4	Sampling of low-pressure steam.....	57
4.6	On-line measuring instruments.....	58
4.6.1	Instrument transmitters	58
4.6.2	Flow rate monitoring	59
4.6.3	Conductivity measurement	59
4.6.4	pH measurement	63
4.6.5	Oxygen measurement	64
4.6.6	Sodium measurement.....	65
4.6.7	Silica measurement	65
4.6.8	Sample switching and sequencing.....	66
4.6.9	Additional measurements	66
4.7	Signal transmission.....	66

5	Operation, maintenance and quality assurance	67
5.1	Operation	67
5.1.1	First putting into operation	67
5.1.2	Re-starting upon standstills	67
5.1.3	Normal operation	68
5.1.4	Interruption of operation / standstill.....	68
5.2	Quality assurance	69
5.2.1	Technical measures – plant design	69
5.2.2	Organisational measures.....	69
5.2.3	Verification procedure of online measurements.....	73
6	Applicable legal stipulations, directives and standards	75
6.1	European legal stipulations and directives.....	75
6.2	National law	76
6.3	European Standards (EN ISO) and other technical rules	76
6.4	US American Codes and Standards	78
6.5	VGB Standards, Guidelines and Instruction Sheets	79
6.6	VdTÜV Instruction Sheets	79
7	Literature	80
8	Examples for inadmissible arrangement of sampling equipment.....	82
8.1	Sampling point of evaporator circulation water at drum boiler	82
8.2	Sampling lines to analysis station	82
8.3	Component arrangement on analysis panel	85
8.4	Lacking or unsuited components on analysis panel.....	87
8.5	Poor cooling water quality.....	87

1 Scope and exclusions

1.1 Scope

This standard is aimed at specifying and explaining methods and measuring equipment for analysing make-up water, feed water, boiler water, steam, and condensate during continuous monitoring of water/steam cycles.

This standard also contains instructions and recommendations both for the planning and operating stages. The processes described, equipment and measuring instruments may also be used for monitoring other inlet and outlet flows to the plant and related systems. For specific operational situations such as putting into operation (initial start-up), acceptance/performance tests or operational troubles, an extension of the range of monitoring activities may be useful.

In particular, the following topics are addressed:

- determination and design of sampling points
- design of sampling line from the sampling point to the sampling device/equipment
- sample conditioning (pressure, temperature, and flow rate)
- accessories and protective equipment
- measuring instruments
- processing of measured values and plausibility check

The minimum extent of analytical monitoring is described in VGB-S-010-T-00;2011-12.EN.

1.2 Exclusions

This standard does neither apply to nuclear power plants nor to hot water boilers, district heating grids, nor geothermal plants.

For cooling-water circuits and auxiliary plants (e.g. water treatment systems, flue-gas cleaning plants) the pertinent guidelines/standards shall be observed.

1.3 Normative and other references

This standard contains stipulations from other publications by dated and undated references. The normative references are quoted at the respective text locations and the publications are listed in chapter 6. In the case of dated references, later changes or revisions of such publications are to be considered in this standard only if they have been incorporated by change or revision. In the case of undated references, the last edition of the referenced publication applies.