



Hazard and operability studies (HAZOP studies)—Application guide



This Australian Standard® was prepared by Committee QR-005, Dependability. It was approved on behalf of the Council of Standards Australia on 20 March 2017. This Standard was published on 8 May 2017.

The following are represented on Committee QR-005:

- Asset Management Council
 - Department of Defence (Australian Government)
 - Engineers Australia
 - Independent Transport Safety and Reliability Regulator
 - Professionals Australia
 - Risk Management Institution of Australasia
 - The University of New South Wales
 - University of Wollongong
-

This Standard was issued in draft form for comment as DR AS/NZS IEC 61882:2017.

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting **www.standards.org.au**

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at **mail@standards.org.au**, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

Australian Standard[®]

Hazard and operability studies (HAZOP studies)—Application guide

Originated as AS IEC 61882—2003.
Second edition AS IEC 61882:2017.

COPYRIGHT

© Standards Australia Limited

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968.

Published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001, Australia

ISBN 978 1 76035 753 5

PREFACE

This Standard was prepared by the Standards Australia Committee QR-005, Dependability, to supersede AS IEC 61882—2003 (R2013), *Hazard and operability studies (HAZOP studies)—Application guide*.

The objective of this Standard is to provide guidance for use of a guide-word-driven risk identification method historically known as HAZOP. It gives guidance on the principles of HAZOP, applications of the technique and the HAZOP study procedure. Traditional applications for safety and operability in the process industries are covered, along with general processes and procedures.

This Standard is identical with, and has been reproduced from IEC 61882:2016, *Hazard and operability studies (HAZOP studies)—Application guide*.

As this Standard is reproduced from an International Standard, the following applies:

- (a) In the source text ‘this International Standard’ should read ‘this Australian Standard’.
- (b) A full point substitutes for a comma when referring to a decimal marker.

None of the normative references in the source document have been adopted as Australian or Australian/New Zealand Standards.

The term ‘informative’ has been used in this Standard to define the application of the annex to which it applies. An ‘informative’ annex is only for information and guidance.

CONTENTS

1	Scope.....	7
2	Normative references	7
3	Terms, definitions and abbreviations	7
3.1	Terms and definitions	7
3.2	Abbreviations	9
4	Key features of HAZOP.....	10
4.1	General.....	10
4.2	Principles of examination.....	11
4.3	Design representation	12
4.3.1	General	12
4.3.2	Design requirements and design intent	13
5	Applications of HAZOP	13
5.1	General.....	13
5.2	Relation to other analysis tools.....	14
5.3	HAZOP study limitations.....	14
5.4	Risk identification studies during different system life cycle stages	15
5.4.1	Concept stage.....	15
5.4.2	Development stage	15
5.4.3	Realization stage	15
5.4.4	Utilization stage	15
5.4.5	Enhancement stage	16
5.4.6	Retirement stage.....	16
6	The HAZOP study procedure	16
6.1	General.....	16
6.2	Definitions.....	17
6.2.1	Initiate the study	17
6.2.2	Define scope and objectives.....	17
6.2.3	Define roles and responsibilities.....	18
6.3	Preparation	19
6.3.1	Plan the study.....	19
6.3.2	Collect data and documentation	20
6.3.3	Establish guide words and deviations	20
6.4	Examination	21
6.4.1	Structure the examination	21
6.4.2	Perform the examination	22
6.5	Documentation and follow up.....	24
6.5.1	General	24
6.5.2	Establish method of recording	25
6.5.3	Output of the study.....	25
6.5.4	Record information.....	25
6.5.5	Sign off the documentation.....	26
6.5.6	Follow-up and responsibilities	26
	Annex A (informative) Methods of recording	27

	<i>Page</i>
A.1 Recording options	27
A.2 HAZOP worksheet.....	27
A.3 Marked-up representation.....	28
A.4 HAZOP study report	28
Annex B (informative) Examples of HAZOP studies	29
B.1 General.....	29
B.2 Introductory example.....	29
B.3 Procedures	34
B.4 Automatic train protection system	37
B.4.1 General	37
B.4.2 Application.....	37
B.5 Example involving emergency planning.....	40
B.6 Piezo valve control system	44
B.7 HAZOP of a train stabling yard horn procedure	48
Bibliography	59
Figure 1 – The HAZOP study procedure	17
Figure 2 – Flow chart of the HAZOP examination procedure – Property first sequence	23
Figure 3 – Flow chart of the HAZOP examination procedure – Guide word first sequence.....	24
Figure B.1 – Simple flow sheet.....	30
Figure B.2 – Train-carried ATP equipment.....	37
Figure B.3 – Piezo valve control system	44
Table 1 – Example of basic guide words and their generic meanings	11
Table 2 – Example of guide words relating to clock time and order or sequence	12
Table 3 – Examples of deviations and their associated guide words.....	21
Table B.1 – Properties of the system under examination.....	30
Table B.2 – Example HAZOP worksheet for introductory example	31
Table B.3 – Example HAZOP worksheet for procedures example	35
Table B.4 – Example HAZOP worksheet for automatic train protection system	38
Table B.5 – Example HAZOP worksheet for emergency planning	41
Table B.6 – System design intent	45
Table B.7 – Example HAZOP worksheet for piezo valve control system.....	46
Table B.8 – Operational breakdown matrix for train stabling yard horn procedure	50
Table B.9 – Example HAZOP worksheet for train stabling yard horn procedure	53

INTRODUCTION

This standard describes the principles for and approach to guide word-driven risk identification. Historically this approach to risk identification has been called a hazard and operability study or HAZOP study for short. This is a structured and systematic technique for examining a defined system, with the objectives of:

- identifying risks associated with the operation and maintenance of the system. The hazards or other risk sources involved can include both those essentially relevant only to the immediate area of the system and those with a much wider sphere of influence, for example some environmental hazards;
- identifying potential operability problems with the system and in particular identifying causes of operational disturbances and production deviations likely to lead to non-conforming products.

An important benefit of HAZOP studies is that the resulting knowledge, obtained by identifying risks and operability problems in a structured and systematic manner, is of great assistance in determining appropriate remedial measures.

A characteristic feature of a HAZOP study is the examination session during which a multi-disciplinary team under the guidance of a study leader systematically examines all relevant parts of a design or system. It identifies deviations from the system design intent utilizing a set of guide words. The technique aims to stimulate the imagination of participants in a systematic way to identify risks and operability problems. A HAZOP study should be seen as an enhancement to sound design using experience-based approaches such as codes of practice rather than a substitute for such approaches.

Historically, HAZOP and similar studies were described as hazard identification as their primary purpose is to test in a systematic way whether hazards are present and, if so, understand both how they could result in adverse consequences and how such consequences could be avoided through process redesign. ISO 31000:2009 defines risk as the effect of uncertainty on objectives, with a note that an effect is a deviation from the expected. Therefore HAZOP studies, which consider deviations from the expected, their causes and their effect on objectives in the context of process design, are now correctly characterized as powerful risk identification tools.

There are many different tools and techniques available for the identification of risks, ranging from checklists, failure modes and effects analysis (FMEA) to HAZOP. Some techniques, such as checklists and what-if/analysis, can be used early in the system life cycle when little information is available, or in later phases if a less detailed analysis is needed. HAZOP studies require more detail regarding the systems under consideration, but produce more comprehensive information on risks and weaknesses in the system design.

The term HAZOP is sometimes associated, in a generic sense, with some other hazard identification techniques (e.g. checklist HAZOP, HAZOP 1 or 2, knowledge-based HAZOP). The use of the term with such techniques is considered to be inappropriate and is specifically excluded from this document.

Before commencing a HAZOP study, it should be confirmed that it is the most appropriate technique (either individually or in combination with other techniques) for the task in hand. In making this judgment, consideration should be given to the purpose of the study, the possible severity of any consequences, the appropriate level of detail, the availability of relevant data and resources and the needs of decision-makers.

This standard has been developed to provide guidance across many industries and types of system. There are more specific standards and guides within some industries, notably the process industries where the technique originated, which establish preferred methods of application for these industries. For details see the bibliography at the end of this standard.

AUSTRALIAN STANDARD

Hazard and operability studies (HAZOP studies)—Application guide**1 Scope**

This International Standard provides a guide for HAZOP studies of systems using guide words. It gives guidance on application of the technique and on the HAZOP study procedure, including definition, preparation, examination sessions and resulting documentation and follow-up.

Documentation examples, as well as a broad set of examples encompassing various applications, illustrating HAZOP studies are also provided.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-192, *International electrotechnical vocabulary – Part 192: Dependability* (available at <http://www.electropedia.org>)

3 Terms, definitions and abbreviations**3.1 Terms and definitions**

For the purposes of this document, the terms and definitions given in IEC 60050-192 and the following apply.

NOTE Within this clause, the terms defined are in *italic* type.

3.1.1**characteristic**

qualitative or quantitative property

EXAMPLE Pressure, temperature, voltage.

3.1.2**consequence**

outcome of an event affecting objectives

Note 1 to entry: An event can lead to a range of consequences.

Note 2 to entry: A consequence can be certain or uncertain and can have positive or negative effects on objectives.

Note 3 to entry: Consequences can be expressed qualitatively or quantitatively.

Note 4 to entry: Initial consequences can escalate through knock-on effects.

[SOURCE: ISO Guide 73:2009, 3.6.1.3]