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Agricultural machinery and tractors - Safety of partially automated, semi-autonomous and autonomous machinery - Part 4: Verification methods and validation principles (ISO 18497-4:2024)

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 11/24

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Spolu s STN EN ISO 18497-1, STN EN ISO 18497-2 a STN EN ISO 18497-3 ruší
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EUROPEAN STANDARD

NORME EUROPÉENNE

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EN ISO 18497-4

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ICS 65.060.01 Supersedes EN ISO 18497:2018

English Version

Agricultural machinery and tractors - Safety of partially automated, semi-autonomous and autonomous machinery - Part 4: Verification methods and validation principles (ISO 18497-4:2024)

Tracteurs et matériels agricoles - Sécurité des machines partiellement automatisées, semi-autonomes et autonomes - Partie 4: Méthodes de vérification et principes de validation (ISO 18497-4:2024)

Landmaschinen und Traktoren - Sicherheit von teilautomatisierten, halbautonomen und autonomen Maschinen - Teil 4: Verifizierungsmethoden und Validierungsgrundsätze (ISO 18497-4:2024)

This European Standard was approved by CEN on 21 July 2024.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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EN ISO 18497-4:2024 (E)

Contents

Page

European foreword **3**

Annex ZA (informative) **Relationship between this European Standard and the essential requirements of Directive 2006/42/EC aimed to be covered** **4**

European foreword

This document (EN ISO 18497-4:2024) has been prepared by Technical Committee ISO/TC 23 "Tractors and machinery for agriculture and forestry" in collaboration with Technical Committee CEN/TC 144 “Tractors and machinery for agriculture and forestry” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2025, and conflicting national standards shall be withdrawn at the latest by February 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 18497:2018.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users’ national standards body/national committee. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

Endorsement notice

The text of ISO 18497-4:2024 has been approved by CEN as EN ISO 18497-4:2024 without any modification.

Annex ZA
(informative)

Relationship between this European Standard and the essential requirements of Directive 2006/42/EC aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/396 Mandate to CEN and CENELEC for Standardisation in the field of machinery" to provide one voluntary means of conforming to essential requirements of Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2006/42/EC

The relevant Essential Requirements of Directive 2006/42/EC	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
1.1.2. Principles of safety integration	-----	
1.1.2(a)	4	
1.1.2(c)	4	
1.1.2(d)		NOT COVERED
1.1.2(e)		NOT COVERED
1.1.3. Materials and products		NOT COVERED
1.1.4. Lighting		NOT COVERED
1.1.5. Design of machinery to facilitate its handling		NOT COVERED
1.1.6. Ergonomics	4.2, 4.3	
1.1.7. Operating positions		NOT COVERED
1.1.8. Seating		NOT COVERED
1.2. CONTROL SYSTEMS	-----	
1.2.1. Safety and reliability of control systems	4.2, 4.3	
1.2.2. Control devices		NOT COVERED
1.2.3. Starting	4.2, 4.3	
1.2.4. Stopping		NOT COVERED
1.2.5. Selection of control or		NOT COVERED

The relevant Essential Requirements of Directive 2006/42/EC	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
operating modes		
1.2.6. Failure of the power supply	4.2, 4.3	
1.3. PROTECTION AGAINST MECHANICAL HAZARDS	----	
1.3.1. Risk of loss of stability		NOT COVERED
1.3.2. Risk of break-up during operation		NOT COVERED
1.3.3. Risks due to falling or ejected objects		NOT COVERED
1.3.4. Risks due to surfaces, edges or angles		NOT COVERED
1.3.5. Risks related to combined machinery		NOT COVERED
1.3.6. Risks related to variations in operating conditions		NOT COVERED
1.3.7. Risks related to moving parts	4.2, 4.3	
1.3.8. Choice of protection against risks arising from moving parts		NOT COVERED
1.3.9. Risks of uncontrolled movements		NOT COVERED
1.4. REQUIRED CHARACTERISTICS OF GUARDS AND PROTECTIVE DEVICES	----	
1.4.1. General requirements		NOT COVERED
1.4.2. Special requirements for guards		NOT COVERED
1.4.3. Special requirements for protective devices	4.2, 4.3	
1.5. RISKS DUE TO OTHER HAZARDS	----	
1.5.1. Electricity supply		NOT COVERED
1.5.2. Static electricity		NOT COVERED
1.5.3. Energy supply other than electricity		NOT COVERED
1.5.4. Errors of fitting		NOT COVERED

The relevant Essential Requirements of Directive 2006/42/EC	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
1.5.5. Extreme temperatures		NOT COVERED
1.5.6. Fire		NOT COVERED
1.5.7. Explosion		NOT COVERED
1.5.8. Noise		NOT COVERED
1.5.9. Vibrations		NOT COVERED
1.5.10. Radiation		NOT COVERED
1.5.11. External radiation		NOT COVERED
1.5.12. Laser radiation		NOT COVERED
1.5.13. Emissions of hazardous materials and substances		NOT COVERED
1.5.14. Risk of being trapped in a machine		NOT COVERED
1.5.15. Risk of slipping, tripping or falling		NOT COVERED
1.5.16. Lightning		NOT COVERED
1.6. MAINTENANCE	-----	
1.6.1. Machinery maintenance		NOT COVERED
1.6.2. Access to operating positions and servicing points		NOT COVERED
1.6.3. Isolation of energy sources		NOT COVERED
1.6.4. Operator intervention		NOT COVERED
1.6.5. Cleaning of internal parts		NOT COVERED
1.7. INFORMATION	----	
1.7.1. Information and warnings on the machinery	4.2, 4.3	
1.7.1.1. Information and information devices	4.2, 4.3	
1.7.1.2. Warning devices	4.2, 4.3	
1.7.2. Warning of residual risks	4.2, 4.3	
1.7.3. Marking of machinery		NOT COVERED
1.7.4. Instructions	4.2, 4.3	
2.4. MACHINERY FOR PESTICIDE APPLICATION	----	
2.4.2. General		NOT COVERED

The relevant Essential Requirements of Directive 2006/42/EC	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
2.4.3. Controls and monitoring		NOT COVERED
2.4.4. Filling and emptying		NOT COVERED
2.4.5. Application of pesticides	----	
2.4.5.1. Application rate		NOT COVERED
2.4.5.2. Distribution, deposition and drift of pesticide		NOT COVERED
2.4.5.3. Tests		NOT COVERED
2.4.5.4. Losses during stoppage		NOT COVERED
2.4.6. Maintenance	----	
2.4.6.1. Cleaning		NOT COVERED
2.4.6.2. Servicing		NOT COVERED
2.4.7. Inspections		NOT COVERED
2.4.8. Marking of nozzles, strainers and filters		NOT COVERED
2.4.9. Indication of pesticide in use		NOT COVERED
2.4.10. Instructions		NOT COVERED
3.2 WORK POSITIONS	---	
3.2.1. Driving position		NOT COVERED
3.2.2. Seating		NOT COVERED
3.2.3. Positions for other persons		NOT COVERED
3.3 CONTROL SYSTEMS	---	
3.3.1. Control devices	4.2, 4.3	
3.3.2. Starting/moving	4.2, 4.3	
3.3.3. Travelling function		NOT COVERED
3.3.4. Movement of pedestrian-controlled machinery		NOT COVERED
3.3.5. Control circuit failure		NOT COVERED
3.4 PROTECTION AGAINST MECHANICAL HAZARDS	---	
3.4.1. Uncontrolled movements		NOT COVERED
3.4.2. Moving transmission parts		NOT COVERED
3.4.3. Roll-over and tip-over		NOT COVERED
3.4.4. Falling objects		NOT COVERED

The relevant Essential Requirements of Directive 2006/42/EC	Clause(s)/sub-clause(s) of this EN	Remarks/Notes
3.4.5. Means of access		NOT COVERED
3.4.6. Towing devices		NOT COVERED
3.4.7. Transmission of power between self-propelled machinery (or tractor) and recipient machinery		NOT COVERED
3.5 PROTECTION AGAINST OTHER HAZARDS	----	
3.5.1. Batteries		NOT COVERED
3.5.2. Fire		NOT COVERED
3.5.3. Emissions of hazardous substances		NOT COVERED
3.6 INFORMATION AND INDICATIONS	----	
3.6.1. Signs, signals and warnings	4.2, 4.3	
3.6.2. Marking		NOT COVERED
3.6.3. Instructions	----	
3.6.3.1. Vibrations		NOT COVERED
3.6.3.2. Multiple uses		NOT COVERED

Table ZA.2 — Applicable Standards to confer presumption of conformity as described in this Annex ZA

Column 1 Reference in Clause 2	Column 2 International Standard Edition	Column 3 Title	Column 4 Corresponding European Standard Edition
ISO 12100:2010	ISO 12100:2010	Safety of machinery — General principles for design — Risk assessment and risk reduction	EN ISO 12100:2010
ISO 13849-1:2023	ISO 13849-1:2023	Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design	EN ISO 13849-1:2023
ISO 13849-2:2012	ISO 13849-2:2012	Safety of machinery — Safety-related parts of control systems — Part 2:	EN ISO 13849-2:2012

Column 1 Reference in Clause 2	Column 2 International Standard Edition	Column 3 Title	Column 4 Corresponding European Standard Edition
		Validation	
ISO 18497-1:2024	ISO 18497-1:2024	Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 1: Machine design principles and vocabulary	EN ISO 18497-1:2024
ISO 18497-2:2024	ISO 18497-2:2024	Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 2: Design principles for obstacle protective systems	EN ISO 18497-2:2024
ISO 18497-3:2024	ISO 18497-3:2024	Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 3: Autonomous operating zones	EN ISO 18497-3:2024
ISO 25119-1:2018	ISO 25119-1:2018 ISO 25119-1:2018/A1:2020	Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 1: General principles for design and development	EN ISO 25119-1:2023 EN ISO 25119- 1:2023/ A1:2023
ISO 25119-2:2019	ISO 25119-2:2019	Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 2: Concept phase	EN ISO 25119-2:2023
ISO 25119-3:2018	ISO 25119-3:2018 ISO 25119-3:2018/A1:2020	Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 3: Series development, hardware and software	EN ISO 25119-3:2023 EN ISO 25119-3:2023/ A1:2023
ISO 25119-4:2018	ISO 25119-4:2018 ISO 25119-	Tractors and machinery for agriculture and	EN ISO 25119-4:2023 EN ISO 25119- 4:2023/

Column 1 Reference in Clause 2	Column 2 International Standard Edition	Column 3 Title	Column 4 Corresponding European Standard Edition
	4:2018/A1:2020	forestry — Safety-related parts of control systems — Part 4: Production, operation, modification and supporting processes	A1:2023

The documents listed in the Column 1 of Table ZA.2, in whole or in part, are normatively referenced in this document, i.e. are indispensable for its application. The achievement of the presumption of conformity is subject to the application of the edition of Standards as listed in Column 4 or, if no European Standard Edition exists, the International Standard Edition given in Column 2 of Table ZA.2.

WARNING 1 Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

International Standard

ISO 18497-4

First edition
2024-07

Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery —

Part 4: Verification methods and validation principles

Tracteurs et matériels agricoles — Sécurité des machines partiellement automatisées, semi-autonomes et autonomes —

Partie 4: Méthodes de vérification et principes de validation

Reference number
ISO 18497-4:2024(en)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword ..... **iv**

Introduction ..... **v**

1 Scope **1**

2 Normative references **1**

3 Terms and definition **2**

4 Verification methods and validation principles **2**
4.1 General 2
4.2 Verification methods 3
4.3 Validation principles 5

Annex A (informative) **Information regarding physical properties of objects and humans for use in development of test and simulation verification methods** **6**

Annex B (informative) **Information regarding environmental influences for use in development of test and simulation verification methods** **8**

Annex C (informative) **Information regarding test objects for use in development of test and simulation verification methods** **10**

Annex D (informative) **Information regarding examples of test procedures** **12**

Bibliography **37**

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 document 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 144, *Tractors and machinery for agriculture and forestry,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 18497-4 together with ISO 18497-1, ISO 18497-2 and ISO 18497-3, cancels and replaces ISO 18497:2018, which has been technically revised.

The main changes are as follows:

— verification methods and validation principles were made its own part (i.e. ISO 18497-4) and substantially revised to account for the wide range of functionality and use cases within agricultural machines and tractors.

A list of all parts in the ISO 18497 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

This document is a type-B1 standard as stated in ISO 12100:2010.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

In addition, this document is intended for standardization bodies elaborating type-C standards.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines which are covered by the scope of a type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

The structure of safety standards in the field of machinery is as follows:

— Type-A standards (basis standards) give basic concepts, principles for design, and general aspects that can be applied to machinery;

— Type-B standards (generic safety standards) deal with one or more safety aspects or one or more types of safeguards that can be used across a wide range of machinery:

  — Type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

  — Type-B2 standards on safeguards (e.g. two-hands controls, interlocking devices, pressure sensitive devices, guards);

— Type-C standards (machinery safety standards) deal with detailed safety requirements for a particular machine or group of machines.

The purpose of the ISO 18497 series is to establish general design principles for partially automated, semi-autonomous and autonomous (see ISO 18497-1:2024, Clause 3) functions of agricultural machinery and tractors.

Manual non-automated functions are addressed in existing agricultural machinery and tractor safety standards. Due to the potential number of different functions of agricultural machinery and tractors and the mixed type and mode to which these functions can exist, it is necessary to establish general design principles. In this way, the combination, operator location, and types of interaction of these functions can be guided so that further type-C safety standards can be developed consistently and explicitly to address the mitigation of risk of injury to operators and bystanders. This is the primary focus of safety standards. Attempting to specify risk mitigation requirements based on combinations of type and mode of functions alone cannot be accomplished accurately for all agricultural machinery and tractors due to the wide variety of the machinery and variety of functionality.

Therefore, the familiar representation of SAE J3016[1] with six levels of automation was deliberately not chosen as a basis for the ISO 18497 series and it is necessary to develop more specific type-C safety standards, using the general design principles of this document, to adequately account for the risks of agricultural machinery and tractors used in a specified way with various types of partially automated, semi-autonomous and autonomous functions.

When the requirements of the ISO 18497 series for partially automated, semi-autonomous and autonomous functions of agricultural machinery and tractors are different from those which are stated in a machine-specific type-C standard dealing with partially automated, semi-autonomous and autonomous functions of agricultural machinery and tractors, the requirements of the machine-specific standard take precedence over the requirements of the ISO 18497 series.

International Standard **ISO 18497-4:2024(en)**

Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery —

Part 4: Verification methods and validation principles

1 Scope

This document specifies principles for verification methods and validation principles of agricultural machinery and tractors that are used in agricultural applications and that have partially automated, semi-autonomous and autonomous functions.

The purpose of this document is to assist in the provision of more specific safety requirements, means of verification and information for use to ensure an appropriate level of safety for agricultural machinery and tractors with partially automated, semi-autonomous and autonomous functions used in a specified way.

This document deals with the significant hazards relevant to agricultural machinery and tractors with partially automated, semi-autonomous and autonomous functions when used as intended and under the conditions of misuse reasonably foreseeable by the manufacturer during normal operation and service.

Applicability of the design principles and any additional requirements, for design, verification, validation or information for use are outside the scope of this document. When risk assessment concludes that hazards are not significant hazards, the principles of this document do not apply.

NOTE Safety requirements for specific non-automated functions of agricultural machinery and tractors can be available in machine-specific type-C standards.

This document is not applicable to:

— forestry applications;

— operations on public roads including relevant requirements for braking and steering systems.

This document is not applicable to agricultural machinery and tractors which are manufactured before the date of its publication, or to systems applied to agricultural machinery and tractors put into use before the date of its publication.

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 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13849-1:2023, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 18497-1:2024, *Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 1: Machine design principles and vocabulary*

ISO 18497-4:2024(en)

ISO 18497-2:2024, *Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 2: Design principles for obstacle protective systems*

ISO 18497-3:2024, *Agricultural machinery and tractors — Safety of partially automated, semi-autonomous and autonomous machinery — Part 3: Autonomous operating zones*

ISO 25119-1:2018, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 1: General principles for design and development*

ISO 25119-1:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 1: General principles for design and development — Amendment 1*

ISO 25119-2:2019, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 2: Concept phase*

ISO 25119-3:2018, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 3: Series development, hardware and software*

ISO 25119-3:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 3: Series development, hardware and software — Amendment 1*

ISO 25119-4:2018, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 4: Production, operation, modification and supporting processes*

ISO 25119-4:2018/Amd 1:2020, *Tractors and machinery for agriculture and forestry — Safety-related parts of control systems — Part 4: Production, operation, modification and supporting processes — Amendment 1*