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**Power systems management and associated information exchange – Data and communications security –
Part 9: Cyber security key management for power system equipment**

**Gestion des systèmes de puissance et échanges d'informations associés –
Sécurité des communications et des données –
Partie 9: Gestion de clé de cybersécurité des équipements de système de
puissance**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Certificate components and verification of the certificate components have been added;
- b) GDOI has been updated to include findings from interop tests;
- c) GDOI operation considerations have been added;
- d) GDOI support for PTP (IEEE 1588) support has been added as specified by IEC/IEEE 61850-9-3 Power Profile;
- e) Cyber security event logging has been added as well as the mapping to IEC 62351-14;

- f) Annex B with background on utilized cryptographic algorithms and mechanisms has been added.

The text of this International Standard is based on the following documents:

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57/2579/FDIS	57/2594/RVD

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The language used for the development of this International Standard is English.

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POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE – DATA AND COMMUNICATIONS SECURITY –

Part 9: Cyber security key management for power system equipment

1 Scope

This part of IEC 62351 specifies cryptographic key management, primarily focused on the management of long-term keys, which are most often asymmetric key pairs, such as public-key certificates and corresponding private keys. As certificates build the base this document builds a foundation for many IEC 62351 services (see also Annex A). Symmetric key management is also considered but only with respect to session keys for group-based communication as applied in IEC 62351-6. The objective of this document is to define requirements and technologies to achieve interoperability of key management by specifying or limiting key management options to be used.

This document assumes that an organization (or group of organizations) has defined a security policy to select the type of keys and cryptographic algorithms that will be utilized, which may have to align with other standards or regulatory requirements. This document therefore specifies only the management techniques for these selected key and cryptography infrastructures. This document assumes that the reader has a basic understanding of cryptography and key management principles.

The requirements for the management of pairwise symmetric (session) keys in the context of communication protocols is specified in the parts of IEC 62351 utilizing or specifying pairwise communication such as:

- IEC 62351-3 for TLS by profiling the TLS options
- IEC 62351-4 for the application layer end-to-end security
- IEC TS 62351-5 for the application layer security mechanism for IEC 60870-5-101/104 and IEEE 1815 (DNP3)

The requirements for the management of symmetric group keys in the context of power system communication protocols is specified in IEC 62351-6 for utilizing group security to protect GOOSE and SV communication. IEC 62351-9 utilizes GDOI as already IETF specified group-based key management protocol to manage the group security parameter and enhances this protocol to carry the security parameter for GOOSE, SV, and PTP.

This document also defines security events for specific conditions which could identify issues which might require error handling. However, the actions of the organisation in response to these error conditions are beyond the scope of this document and are expected to be defined by the organizations security policy.

In the future, as public-key cryptography becomes endangered by the evolution of quantum computers, this document will also consider post-quantum cryptography to a certain extent. Note that at this time being no specific measures are provided.

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.

IEC TS 62351-2, *Power systems management and associated information exchange – Data and communications security – Part 2: Glossary of terms*

IEC 62351-3:—¹, *Power systems management and associated information exchange – Data and communications security – Part 3: Communication network and system security – Profiles including TCP/IP*

IEC 62351-4, *Power systems management and associated information exchange – Data and communications security – Part 4: Profiles including MMS and derivatives*

IEC 62351-5, *Power systems management and associated information exchange – Data and communications security – Part 5: Security for IEC 60870-5 and derivatives*

IEC 62351-6, *Power systems management and associated information exchange – Data and communications security – Part 6: Security for IEC 61850*

IEC 62351-14:—², *Power systems management and associated information exchange – Data and communications security – Part 14: Cyber security event logging*

ISO/IEC 9594-8:2020, Rec. ITU-T X.509 (2019), *Information technology – Open systems interconnection – The Directory: Public-key and attribute certificate frameworks*

ISO/IEC 9594-11:2020, Rec. ITU-T X.510 (2020), *Information technology – Open systems interconnection – The Directory: Protocol specifications for secure operations*

ISO/IEC 9834-1:2012, Rec. ITU-T X.660 (2011), *Information technology – Procedures for the operation of object identifier registration authorities: General procedures and top arcs of the international object identifier tree*

IETF RFC 5272, *Certificate Management over CMS (CMC)*

IETF RFC 5755, *An Internet Attribute Certificate Profile for Authorization*

IETF RFC 5934, *Trust Anchor Management Protocol (TAMP)*

IETF RFC 6407, *The Group Domain of Interpretation*

IETF RFC 6960, *X.509 Internet Public Key Infrastructure Online Certificate Status Protocol – OCSP*

IETF RFC 7030, *Enrolment over Secure Transport*

IETF RFC 8052, *Group Domain of Interpretation (GDOI) Protocol Support for IEC 62351 Security*

¹ Under preparation. Stage at the time of publication: IEC/RFDIS 62351-3:2023.

² Under preparation. Stage at the time of publication: IEC/ACDV 62351-14:2023.

IETF RFC 8263, *Group Domain of Interpretation (GDOI) GROUPKEY-PUSH Acknowledgement Message*

IETF RFC 8894, *Simple Certificate Enrolment Protocol*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

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

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

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

3.1.1

asymmetric keys

two related keys, a public key and a private key, that are used to perform complementary operations, such as encryption and decryption or signature generation and signature verification

3.1.2

authorization and validation list

AVL

signed list containing information to an AVL entity about potential communications entities and possible restrictions on the communications with such entities

[SOURCE: ISO/IEC 9594-8:2020, 3.5.9]

[https://standards.iteh.ai/catalog/standards/sist/d57aa4c9-5283-4548-b3a2-8b199d65a92e/iec-](https://standards.iteh.ai/catalog/standards/sist/d57aa4c9-5283-4548-b3a2-8b199d65a92e/iec-62351-9-2023)

3.1.3

authorization and validation list entity

AVL entity

entity, when acting as a relying party, which is dependent on an AVL issued by a designated authorizer

[SOURCE: ISO/IEC 9594-8:2020, 3.5.10]

3.1.4

authorizer

entity trusted by one or more entities operating as AVL entities to create, maintain and sign authorization and validation lists

[SOURCE: ISO/IEC 9594-8:2020, 3.5.11]

3.1.5

certification path

ordered list of one or more public-key certificates, starting with a public-key certificate signed by the trust anchor, and ending with the end-entity public-key certificate to be validated

Note 1 to entry: All intermediate public-key certificates, if any, are CA certificates in which the subject of the preceding public-key certificate is the issuer of the following public-key certificate.

[SOURCE: ISO/IEC 9594-8:2020, 3.5.21]

**3.1.6
certification request**

request issued when a new public-key certificate or renewal of a public-key certificate is required

[SOURCE: IETF RFC 2986]

**3.1.7
controllership**

intersection of legal ownership, physical control, and logical control over a device or system, in which the nature of any contractual agreements between ownership and control of the device or system is not important in the context

**3.1.8
cryptographic binding**

use of one or more cryptographic techniques by a CKMS to establish a trusted association between a key and selected metadata elements

[SOURCE: NIST SP 800-130]

**3.1.9
dataset**
collection of data**3.1.10
device**

component implementing specific functionalities, which may act as a client (e.g., TLS client) or a server (e.g., key distribution centre for GDOI)

**3.1.11
digital signature**

result of a cryptographic transformation of data that, when properly implemented, provides a mechanism for verifying origin authentication, data integrity, and signatory non-repudiation

[SOURCE: FIPS 186]

**3.1.12
end entity (PKI)**

entity that has been assigned an end-entity public-key certificate, where the private key cannot be used to sign other public-key certificates, but may be used for signing for other purposes

**3.1.13
entity**

generic term that covers human users, automation systems, software applications, communication nodes, field devices, and other types of assets

**3.1.14
fingerprint**

hash result ("key fingerprint") used to authenticate a public key or other data

[SOURCE: IETF RFC 4949]