European Network of
Transmission System Operators
for Electricity

REGIONAL COORDINATION PROCESSES DATA EXCHANGE SPECIFICATION

2024-05-13

ICTC-SOC APPROVED
VERSION 2.3.0
CONFIDENTIALITY CATEGORY: PUBLIC

This document is maintained by the ENTSO-E CIM WG and relevant SOC task teams responsible for different business processes. Comments or remarks are to be provided at cim@entsoe.eu

NOTE CONCERNING WORDING USED IN THIS DOCUMENT

The force of the following words is modified by the requirement level of the document in which they are used.

- SHALL: This word, or the terms “REQUIRED” or “MUST”, means that the definition is an absolute requirement of the specification.
- SHALL NOT: This phrase, or the phrase “MUST NOT”, means that the definition is an absolute prohibition of the specification.
- SHOULD: This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course.
- SHOULD NOT: This phrase, or the phrase “NOT RECOMMENDED”, means that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
- MAY: This word, or the adjective “OPTIONAL”, means that an item is truly optional.

Version Notes

This document is release 2.3 of the Regional Coordination Processes Data Exchange Specification (RCP DES). It covers the latest v2.3 profile updates, and v2.2 or v2.1 of those that have been stable since their publication.

The document is significantly updated to include explanations on different used cases. Section 7 was rewritten to describe more details and provide CIMXML snippets. Section 8 was updated to align with changes on metadata, common data and reference data. Section 10 is new and provides guidelines on conformity assessment scheme that will need to be developed to validate the implementation of RCP DES and related data exchange profiles. On request by SOC StG REC the document was renamed to Network codes data Exchange Specification to envision that it will cover specifications and implementation guidance for all business processes. SOC confirmed the proposal to widen the content of the document and approved new document title "Regional Coordination Processes Data Exchange Specification". Currently CSA is the main business process that is covered in the document.

This version of the document was reviewed in Feb-Mar 2024 by CSA CC TT, CIM WG, regions and experts contributing to the document development. The approval process included the endorsement of the Steering Group Regional Coordination and a cross-Committee approval by the ICTC (on lead) and the System Operation Committee as consulted Committee. This document and its subsequent revisions will be also used for standard vetting interoperability tests. Therefore, it is considered a public document.

In this version of the NC profiles, based on ICTC decision to prepare for resolvable URL, the namespaces of the profiles and canonical model were changes as follows:

- NC namespace from http://entsoe.eu/ns/nc# to https://cim4.eu/ns/nc# (persistent between versions of extensions)
- CIM namespace from http://iec.ch/TC57/CIM100# to https://cim.ucaiug.io/ns# (persistent between versions of canonical CIM model)
- EU extensions from http://iec.ch/TC57/CIM100-European# to https://cim.ucaiug.io/ns/eu# (persistent between versions of extensions)
- Profile version identifiers follow the pattern {application profile subdomain}/{profile name}/{profile version, only major and minor} (e.g. https://ap.cim4.eu/Contingency/2.3)

The rationale for these changes is:

- to use the https instead of http
- to make them resolvable
- to use the new cim4.eu domain
- to identify that it is a "profile" and be able to make resolvable all artifacts related to a profile
- to align with IEC in the use of subdomains and the new persistent CIM namespace

For additional details on the previous versions of the document, please refer to section 11 (Document Revision History).

CONTENTS

List of figures

List of tables

1 Introduction

The Regional Coordination Processes Exchange Specification (RCP DES) describes the framework for data exchange in business processes utilizing Network Nodes data exchange profiles. The specified business processes encompass Coordinated Security Analysis (CSA), Outage Planning Coordination (OPC), Coordinated Capacity Calculation (CCC), and Short-Term Adequacy (STA). The current iteration of the document predominantly centres on CSA, serving as the first business process to use Network Codes data exchange profiles.

Regular updates to the document will be undertaken to align with the evolution of data exchange profiles and advancements in various business processes. The core objective of the RCP DES is to establish a standardized data exchange based on the Network Codes profiles, thereby mitigating IT implementation costs and fostering interoperability among Transmission System Operators (TSOs) and Regional Coordination Centres (RCCs). The intent is to empower software vendors to create IT applications for TSOs and RCCs that facilitate seamless information exchange across all relevant business processes.

Furthermore, the RCP DES offers guidance on modelling diverse use cases and defines requirements for conformity assessment. These elements are crucial for business stakeholders, providing them with the necessary framework to steer the implementation of data exchange within a business process. In essence, the RCP DES seeks to streamline and enhance the efficiency of data exchange in the realm of TSOs and RCCs.

This document defines a structured way of exchanging the following data:

- Remedial action
- Assessed element
- Contingency
- SIPS configuration
- Security limits and system constraints
- Generation and load shift keys (GLSK)
- Power transfer corridor (PTC)
- Steady state instructions
- Remedial action schedule (to exchange proposed, accepted/rejected, activated remedial action)
- Security analysis result
- Impact assessment matrix
- Remedial action sensitivity matrix
- The redispatch and countertrading cost sharing (in accordance with CACM Article 74(7))

Next releases of the specification will focus on the following items:

- Coverage of other business processes such as OPC, CCC, Regional STA
- CSA methodology amendment, if any impacting changes
- .

The following is out of scope of the current version of the specification:

- The reporting and the monitoring of the CSA (pursuant to SOGL article 17)
- The Probabilistic Risk Assessment (pursuant to Article 44(4) of CSAm)

The following should be taken into account when reading the document:

- Not all use cases are covered in the current version of the specification. The document contains “Expected Use Cases” that can be specified in next versions of the specification in an addition to any other proposed use cases.
- Code snippets are only provided to illustrate and help the implementation. The code provided is not completely functional as it is only small part that focuses on the

presented use case. It could also be the case that not all required attributes are provided.

- Code snippets refer to identifiers that are only used to explain the relationship, i.e. in most cases identifiers are random UUID or strings that shall not be referred as a reference in any implementations of Network Codes profiles. The correct identifiers are to be provided from common and reference data.

- Business Process Model Notation (BPMN) diagrams are taken from the Inter-RSC report[1]. The BPMN diagrams are accompanied with a table describing the "Inputs" and "Outputs" of the process. The business terms used in the Inter-RSC report cannot be linked directly to the terms used in the NC profile specifications and RCP DES.

2 Network Codes Profiles General Implementation Guidance

During the developmental and implementation phases of NC Profiles and RCP DES, numerous activities involve amending methodologies and introducing Regional Operational Security Coordination (ROSC) processes. The progression of these activities necessitates alignment with data exchange profiles, specifications, and guidance. To facilitate the implementation of these complex business processes and related data exchanges, the following general implementation guidance is provided:

- **Individual Release and Versioning**: Network Codes profiles will not be bundled as a package; instead, they will be released individually. Each profile and its accompanying documentation will adhere to Semantic Versioning 2.0.0. For instance, an exchange may utilize RCP DES v2.3.0, Equipment Reliability profile v2.2.0, and Remedial Action Profile v2.3.0. Development will carefully manage dependencies between profiles and ensure that all profiles designed to be compatible use the same namespaces and are derived from the same version of the canonical model. RDCP DES version will be updated every time one of the profiles is changed.
- **Frequent RCP DES Updates**: RCP DES will undergo frequent updates to incorporate additional clarifications, use cases, and coverage of new business processes.
- **Transition**: Business processes should ensure that there is a transition plan to support the transition between versions of different NC profiles and specifications.
- **Understanding Power System Model Dependencies**: Implementing parties (TSOs, RCCs, CCRs, Vendors, etc.) must be aware of dependencies and capabilities related to modelling the power system model (IGM/CGM) using the IEC CGMES set of profiles. The evolving nature of NC profiles and business requirements requires corresponding advancements in the CGMES set of profiles.
- **Feedback and Standard Vetting Interoperability Tests**: Both NC profiles and RCP DES will rely on feedback collected in Standard Vetting Interoperability Tests organized by ENTSO-E annually. This practice aims to enhance the maturity of data exchange specifications and support ongoing implementation efforts.
- **Machine-Readable Artifacts and Namespace/Versioning Information**: Implementors should rely on machine-readable artifacts provided with NC profiles and be prepared for multiple[2] or frequently changing namespace information for different data objects. Changes will be controllable to minimize impacts, with an understanding that these profiles will be proposed as international CIM standards in the coming years. Changes can also happen due to the implementation of common data and reference data (refer to section 8.4) together will the implementation of better approaches to handle metadata between or within different business processes.
- **Persistent Identifiers**: Increased complexity in data exchanges, such as
    - detailed power system modelling,
    - substantial additional information exchange mandated by EU Network Codes,

[1] Report on Inter-RCC and Inter-CCR Coordination for Coordinated Regional Security Analyses V1.2

[2] Multiple namespaces are used in the datasets and in profiles. CIM namespace, ENTSO-E namespace, NC namespace, W3C DCAT namespace, etc.

  - shared data sets across multiple business processes,
  - the dependency on the timeframes,
  - requirements on reporting within business processes and towards external parties such as ACER, etc.,

  requires the implementation of persistent identifiers. This approach optimizes data exchange by transmitting only the most relevant information. Therefore, IT and business implementations should align with this vision.
- **Data Validation:** Development of Data Quality Management Provisions is required by CSAm Art 42(1) and it will be prepared by June 2024 as part of the Regional Coordination Processes Data Quality Management Provisions (RCP DQMP) document. This document will define the data validation framework and business specific constraints (consistency rules) that apply for all regions or are regions specific. Standard or specification related constraints will be part of the NC profiles. Therefore, when data validation is performed it will rely on constraints defined in NC Profiles specifications and in the NC DQMP document. NC DQMP constraints will not contradict the standard NC profile constraints or extend the profiles or canonical model. The constraints will only be more restrictive with the aim of improving data quality and satisfy the business requirements on data consistency as defined in the methodologies.

The overarching goal is to facilitate a seamless and efficient implementation of NC Profiles and RCP DES, ensuring adaptability to evolving requirements and interoperability across diverse stakeholders.

3 References

3.1 Legal References

- Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SOGL);
- Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (CACM);
- All TSOs' proposal for a methodology for coordinating operational security analysis in accordance with Article 75 of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (CSA methodology);
- Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (Clean Energy Package)

3.2 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 61970-301:2021 Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base;
- IEC 61970-600-1:2021 Energy management system application program interface (EMS-API) - Part 600-1: Common Grid Model Exchange Standard (CGMES) - Structure and rules;
- IEC 61970-600-2:2021 Energy management system application program interface (EMS-API) - Part 600-2: Common Grid Model Exchange Standard (CGMES) - Exchange profiles specification;
- IEC 61968-11:2013 Application integration at electric utilities - System interfaces for distribution management - Part 11: Common information model (CIM) extensions for distribution

3.3 Specification Documents References

The following specification documents, in whole or in part, are 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.

Not all profiles are related to a single business process. The usage of the profiles depends on the needs to the business process and covered use cases.

Table 1 specifies the versions of the referenced documents that are considered in the current version of the RCP DES. The version of the RCP DES will be updated any time the versions of the referenced documents change.

Table 1 – Document versions

Document	Version
ENTSO-E Assessed element profile specification	2.3.0
ENTSO-E Availability schedule profile specification	2.3.0
ENTSO-E Contingency profile specification	2.3.0
ENTSO-E Equipment reliability specification	2.3.0
ENTSO-E Grid disturbance profile specification	2.3.0
ENTSO-E Impact assessment matrix profile specification	2.3.0
ENTSO-E Monitoring area profile specification	2.3.0
ENTSO-E Object registry profile specification	2.2.0
ENTSO-E Power schedule profile specification	2.3.0
ENTSO-E Power system project profile specification	2.3.0
ENTSO-E Remedial action profile specification	2.3.0
ENTSO-E Remedial action schedule profile specification	2.3.0
ENTSO-E Security analysis result profile specification	2.3.0
ENTSO-E Sensitivity matrix profile specification	2.3.0
ENTSO-E State instruction schedule profile specification	2.3.0
ENTSO-E Steady state hypothesis schedule profile specification	2.3.0
ENTSO-E Steady state instructions profile specification	1.0.0
ENTSO-E Metadata and Header profile specification	2.3.0
ENTSO-E Boundary and reference data exchange application specification	1.0.0

3.4 Other References

- The Harmonised Electricity Market Role Model;
- Report on Inter-RCC and Inter-CCR Coordination for Coordinated Regional Security Analyses V1.2
- CSA Coordination Function – Business Requirements Specification v1.0
- CSA Input Data Consistency Function – Business Requirements Specification v1.0
- CSA Data Classification v1.0
- CGM-RCC Users Group - Business Requirements Specification v1.0
- CGMES profiling user guide v1.0.

4 Terms and Definitions

4.1 Agreed remedial action

Agreed remedial action means a cross-border relevant remedial action for which TSOs in a region agreed to implement or any other remedial action for which TSOs have agreed that it does not need to be coordinated.

[SOURCE: CSAm art. 2.1.19]

4.2 Assessed element

Assessed element is a network element for which the electrical state is evaluated in the regional or cross-regional process and which value is expected to fulfil regional rules function of the operational security limits.

Where necessary, for defining the regional or cross-regional rules for ensuring the system security, assessed elements can be subdivided into two sub-classes – secured elements and scanned elements.

[SOURCE: 2019 Inter-RSC report, BRS CAS consistency function, 4.1]

4.3 Availability schedule

A given availability schedule with a given status and cause that include multiple equipment that need to follow the same scheduling periods

[SOURCE: CSA project group]

4.4 Available remedial action

Available remedial action is a remedial action which is available to solve identified constraints. It includes the needed technical and cost information.

[SOURCE: 2019 Inter-RSC report]

4.5 Capacity Calculation Region

Capacity Calculation Region (CCR) means the geographic area in which coordinated capacity calculation is applied.

[SOURCE: CACM art.2.3]

4.6 Common Grid Model (CGM)

Common Grid Model (CGM) means a Union-wide data set agreed between various TSOs describing the main characteristic of the power system (generation, loads and grid topology) and rules for changing these characteristics during the coordinated capacity calculation process.

[SOURCE: CACM art.2.2]

4.7 Constraint

Constraint means a situation in which there is a need to prepare and activate a remedial action in order to respect operational security limits.

[SOURCE: SOGL art.3.2.2]

4.8 Contingency

Contingency means the identified and possible or already occurred fault of an element, including not only the transmission system elements, but also significant grid users and distribution network elements if relevant for the transmission system operational security.

[SOURCE: CACM art.2.10]

4.9 Contingency analysis

Contingency analysis means a computer-based simulation of contingencies from the contingency list.

[SOURCE: SOGL art.3.2.27]

4.10 Contingency list

Contingency list means the list of contingencies to be simulated in order to test the compliance with the operational security limits.

[SOURCE: SOGL art.3.2.4]

4.11 Countertrading

Countertrading means a cross zonal exchange initiated by system operators between two bidding zones to relieve physical congestion.

[SOURCE: Reg 2019/943 art.2.27]

4.12 Critical Network Element (CNE)

Critical network element means a network element either within a bidding zone or between bidding zones taken into account in the capacity calculation process, limiting the amount of power that can be exchanged.

[SOURCE: Reg 2019/943 art.2.69]

4.13 Coordinated regional operational security assessment (CROSA)

Coordinated regional operational security assessment (CROSA) means an operational security analysis performed by RCCs on a common grid model on a regional level.

[SOURCE: SOGL art.78]

4.14 Cross coordinated regional operational security assessment (CCROSA)

Cross coordinated regional operational security assessment (CCROSA) means an operational security analysis performed by RCCs on a common grid model on a cross-regional level.

[SOURCE: ACER Decision on CSAM art. 33.e]

4.15 Cross-border relevant network element' (XNE)

Cross-border relevant network element' (XNE) means a network element identified as cross border relevant and on which operational security violations need to be managed in a coordinated way.

[SOURCE: ACER Decision on CSAM: Annex I art 2.1.8]

4.16 Cross-border relevant remedial action (XRA)

Cross-border relevant remedial action (XRA) means a remedial action identified as cross border relevant and needs to be applied in a coordinated way.

[SOURCE: CSAm art.2.1.12]

4.17 Curative remedial action

Curative remedial action means a remedial action that is the result of an operational planning process and is activated straight subsequent to the occurrence of the respective contingency for compliance with the (N-1) criterion, taking into account transitory admissible overloads and their accepted duration.

[SOURCE: CSAm art.2.1.24]

4.18 Exceptional contingency

Exceptional contingency means the simultaneous occurrence of multiple contingencies with a common cause.

[SOURCE: SOGL art.3.2.39]

4.19 External contingency

External contingency means a contingency outside the TSO's control area and excluding interconnectors, with an influence factor higher than the contingency influence threshold.

[SOURCE: SOGL art.3.2.24]

4.20 Generation Shift Key

A method of translating a net position change of a given bidding zone into estimated specific injection increases or decreases in the common grid model.

[SOURCE: CACM art.2.12]

4.21 Identified constraint

Identified constraint is a group of elements composed by one or more assessed elements and the contingency leading to a violation of an operational security limit or a function of this operational security limit.

[SOURCE: CSA project group]

4.22 Impact assessment

Impact assessment determines the impact of changes of a grid model on each TSO’s grid and assesses whether this impact qualifies as so significant that the respective TSO is deemed “impacted” by the change.

[SOURCE: CSA project group]

4.23 Individual Grid Model (IGM)

Individual Grid Model (IGM) means a data set describing power system characteristics (generation, load and grid topology) and related rules to change these characteristics during the coordinated security analysis process, prepared by the responsible TSOs, to be merged with other individual grid model components in order to create the common grid model.

[SOURCE: CACM art.2.1]

4.24 Individual action

Individual action is an action that is one of the single remedial actions as defined in Article 22 of the SO Regulation.

[SOURCE: CSAm art.14.2]

4.25 Internal contingency

Internal contingency means a contingency within the TSO's control area, including interconnectors.

[SOURCE: SOGL art.3.2.23]

4.26 Load Shift Key

It constitutes a list specifying those load that shall contribute to the shift in order to take into account the contribution of generators connected to lower voltage levels (implicitly contained in the load figures of the nodes connected to the EHV grid).

[SOURCE: Coordinated Capacity Calculation IG v1.0]

4.27 N-situation

N-situation means the situation where no transmission system element is unavailable due to occurrence of a contingency.

[SOURCE: SOGL art.3.2.3]

4.28 N-1 situation

N-1 situation means the situation in the transmission system in which one contingency from the contingency list occurred.

[SOURCE: SOGL art.3.2.15]

4.29 Normal state

Normal state means a situation in which the system is within operational security limits in the N-situation and after the occurrence of any contingency from the contingency list, taking into account the effect of the available remedial actions.

[SOURCE: SOGL art.3.2.5]

4.30 Ordinary contingency

Ordinary contingency means the occurrence of a contingency of a single branch or injection.

[SOURCE: SOGL art.3.2.54]

4.31 Operational security analysis

Operational security analysis means the entire scope of the computer based, manual and automatic activities performed in order to assess the operational security of the transmission system and to evaluate the remedial actions needed to maintain operational security.

[SOURCE: SOGL art.3.2.50]

4.32 Out of range contingency

Out of range contingency means the simultaneous occurrence of multiple contingencies without a common cause, or a loss of power generating modules with a total loss of generation capacity exceeding the reference incident.

[SOURCE: SOGL art.3.2.55]

4.33 Overlapping zone

A collection of all the overlapping cross border assessed elements which have the same sets of impacted and impacting regions.

[SOURCE: CSA data exchange project group]

4.34 Power transfer corridor (PTC)

A power transfer corridor is defined as a set of circuits (transmission lines or transformers) separating two portions of the power system, or a subset of circuits exposed to a substantial portion of the transmission exchange between two parts of the system.

[SOURCE: CSA data exchange project group]

4.35 Preventive remedial action

Preventive remedial action means a remedial action that is the result of an operational planning process and needs to be activated prior to the investigated timeframe for compliance with the (N-1) criterion.

[SOURCE: CSAm art.2.1.18]

4.36 Proposed remedial action

Proposed remedial action is a remedial action proposed by RCC after remedial action optimization or proposed by TSOs as an alternative for the Rejected RAs. RCC coordinates proposed remedial actions with affected TSOs for intra-CCR and with affected TSOs and RCC for cross-CCR.

[SOURCE: CSA project group]

4.37 Remedial action

Remedial action means any measure applied by a TSO or several TSOs, manually or automatically, in order to maintain operational security.

[SOURCE: CACM art.2.13]

4.38 Remedial action influence factor

Remedial action influence factor means a flow deviation on a XNEC resulting from the application of a remedial action, normalised by the permanent admissible loading on the associated XNE.

[SOURCE: CSAm art.2.1.11]

4.39 Regional Coordination Centre (RCC)

It means regional coordination centre established pursuant to Article 35 of Regulation 2019/943. Most RSCs evolve into RCCs on 1st July 2022.

[SOURCE: Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity]

4.40 Regional Security Coordinator (RSC)

Regional Security Coordinator (RSC) means the entity or entities, owned or controlled by TSOs, in one or more capacity calculation regions performing tasks related to TSO regional coordination.

[SOURCE: SOGL art.3.2.89]

4.41 Restoring remedial action

Restoring remedial action means a remedial action that is activated subsequent to the occurrence of an alert state for returning the transmission system into normal state again.

[SOURCE: CSAm art.2.1.13]

4.42 Scanned element

Scanned element is an assessed element on which the electrical state (at least flows) shall be computed and shall be subject to an observation rule during the regional security analysis process. Such observation rule can be for example avoiding the increase of a constraint or avoiding the creation of a constraint on this element, as a result of the design of remedial actions needed to relieve violations on the secured elements. A scanned element within a CCR can be any element of any CCR (irrespective of any potential qualification as XNE by one or more CCRs).

[SOURCE: CSA project group]

4.43 Secured element

Secured element is an assessed element on which remedial actions are identified to relief violations, when violations of an operational security limit are identified during the regional or cross-regional security analysis. On the CCR context, a secured element is an XNE.

[SOURCE: CSA project group]

4.44 System (integrity) protection scheme

System integrity protection scheme[3] is an automatic protection system designed to detect abnormal or predetermined system conditions and take corrective actions other than and/or in addition to the isolation of faulted components to maintain system reliability. Such actions may include changes in demand, generation or system configuration to maintain system stability, acceptable voltage or power flows.[4]

[SOURCE: North American Electric Reliability Corporation glossary]

Note: SOGL art.37 defines tasks to TSOs which use Special Protection Schemes

4.45 System Operator

A party responsible for operating, ensuring the maintenance of and, if necessary, developing the system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution or transmission of electricity.

[SOURCE: Harmonized Role Model based on the Directive 2009/72/EC of the European parliament and of the council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, Article 2 (Definitions).

5 Abbreviated Terms

CCR	Capacity Calculation Region
CGMES	Common Grid Model Exchange Standard
CIM	Common Information Model (electricity)
CROSA	Coordinated Regional Operational Security Assessment
CCROSA	Cross Coordinated Regional Operational Security Assessment
CSA	Coordinated Security Analysis
CSAm	Coordinated Security Analysis Methodology
EIC	Energy Identification Codes
ENTSO-E	European Network of Transmission System Operators for Electricity
HVDC	High Voltage Direct Current
IEC	The International Electrotechnical Commission
MAS	Model Authority Set
mRID	CIM Master Resource Identifier
MTU	Market Time Unit
OPC	Outage Planning Coordination
RAO	Remedial Action Optimization
RCC	Regional Coordination Centre
RDF	Resource Description Framework
RDFS	RDF Schema
RefHour	Reference Hour
RSA	Regional Security Assessment
SHACL	Shapes Constraint Language
SO	System Operator
SOC	ENTSO-E System Operations Committee

[3] The system protection scheme (SPS) can be called system integrity protection schemes (SIPS) in some CCRs (e.g. Nordic CCR)

[4] North American Electric Reliability Corporation glossary

SOGL	System Operations Guideline
SIPS	System Integrity Protection Scheme
SPS	Special Protection Scheme (often terms SIPS and SPS are used interchangeably)
STA	Short Term Adequacy
TSO	Transmission System Operator
UCTE DEF	Union for the Coordination of the Transmission of Electricity Data Exchange Format
URI	Uniform Resource Identifier
UUID	Universally Unique Identifier
XML	Extensible Markup Language
XNE	Cross-border relevant Network Element
XNEC	Cross-border relevant Network Element with contingency
XRA	Cross-border relevant Remedial Action
XSD	XML Schema Definition

6 CSA Business Process Overview

This section in only informative and does not specify business requirements. Business requirements are specified in respective network codes, methodologies, or business process documents.

6.1 Introduction

The CSA is a business process defined in the CSA methodology (CSAm), as required in SOGL Article 75. Its primary objective is to uphold the security of the supply within the European electricity grid. The CSA process also includes the regional operational security coordination per CCR (as per SOGL Article 76) as well as the cross-RCC and cross-CCR Coordination (required by the SOGL article 75 and 76). Each CCR has its own regional operational security coordination (ROSC) methodology that has regional scope. Therefore, the CSA process is relying on input data from TSOs that are shared to the RCCs to perform remedial action optimisation for a CCR and in cooperation with the other CCRs. A common data specification shall ensure that each of the functions handling and storing any of the assessed data, will do it in an equally secure and adequate manner.

The cross-RCC Coordination is required by SOGL for RCCs when performing their tasks defined in SOGL (Art 77 to 81) at CCR level. The CSAm provides a set of requirements for TSOs and RCCs, defines the content and objectives of this cross-RCC coordination.

The regional and cross-regional day-ahead process major steps and timings are defined in the CSAm Article 33. When harmonising different versions of Common Grid Model Methodology (CGMM) and including additional requirements ENTSO-E agreed to define Pan-European Operational Processes Timings Framework document to define the timings of the steps for all business processes that use common datasets. This includes the mapping between timings defined in the CSAm Art 33 and the new set of harmonised timings.

The CSA process is divided in four phases as detailed in the Report on Inter-RSC and Inter-CCR coordination for CSA. The T0 to T5 notation is used in the CSAm and the present CGMM versions. However, updates of CGMM and alignment on the timings between different business processes can change these notations. The information provided here is only for information to facilitate the reading of the document.

- **Preparation phase (before T0):** This corresponds to the preparation of the SOs' IGMs and of all relevant information (updates of available remedial actions, contingencies, etc.).
- **Coordination Run 1 phase (from T0 to T2):** This includes steps of the CGM Build process which provides the CGM for 24 hours of next day and the CROSA process related to regional and cross regional security analyses (contingency analysis, remedial action optimization, coordination) and its possible loops.
- **Coordination Run 2 phase (from T2 to T4):** The second coordination run is performed to evaluate the combined effects of all remedial actions preliminary agreed in the first one and to improve/correct where necessary. It also enables benefit from updated forecasts. This coordination run includes steps to provide an updated CGM (for 24 hours of next day, based on updated IGMs) which considers all agreed preventive remedial actions, agreed curative remedial actions, new forecasts, any other changes to the inputs updated and shared from T2 to T3. When CGM is available (max at T3) to T4: all the phases of regional and cross-regional security analyses (contingency analysis, remedial action optimization, coordination) and its possible steps are performed.
- **Final Validation phase (from T4 to T5):** According to Art. 31(1)(f) of CSAm, during the final validation session, TSOs and RCCs shall consolidate the final outcomes of the whole process in a common teleconference involving also the TSOs from impacting CCRs. TSOs shall evaluate the Agreed RAs, in application of Article 78(4) of the SO Regulation. Each TSO shall participate in this session or shall appoint its RCC to represent it at the session while the TSO keeps the legal responsibility to agree on RAs.

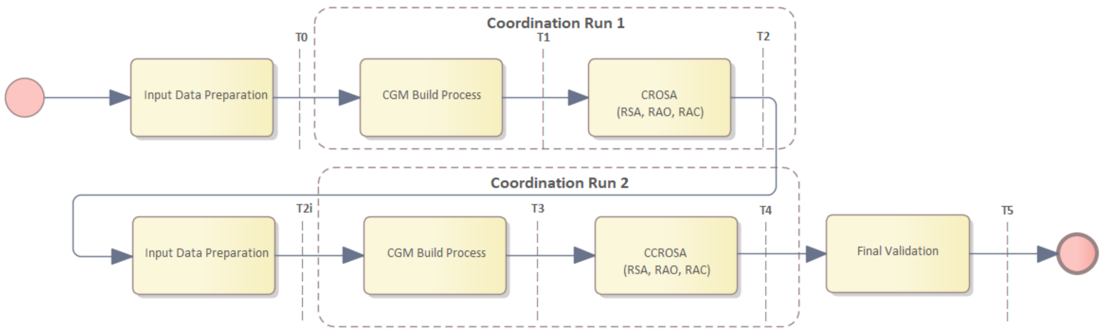


Figure 1 – Day-ahead process, steps and timings (for information only)

Each coordination run includes the building of a CGM model, a regional security analysis and remedial action optimization with a cross-RCC and cross-CCR coordination. Figure 1 depicts the target CSA process that is expected to be implemented across all CCRs in the end. However, this document uses this only to provide background information and not to specify the process. The design and sequence of subprocesses including timings are governed in separate documents that are kept aligned with modifications in CGMM, CSAm and implementation timelines of ROSC process in each CCR. For example, until inter-CCR process is implemented, ROSC process shall include only single CGM build process in Day-ahead timeframe.

For intraday process, steps and timings are described below.

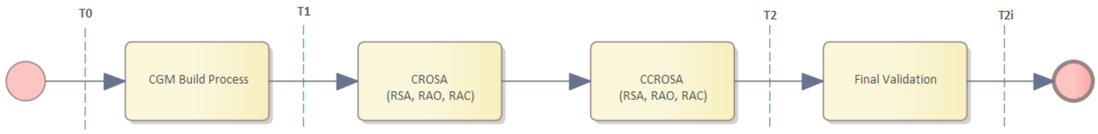


Figure 2 - Intraday process, steps and timings (for information only)

- **Preparation phase:** The IGMs are made available for the following hours, at least from RefHour +1 until RefHour +9 (and preferably until end of the day). The CGM Build process provides the CGM.
- **From T1 to T2:** The regional and cross-regional process are executed.
- **From T2 to T3:** The intraday final validation is executed.

Detailed business process (BPMN) for the day-ahead CSA process.

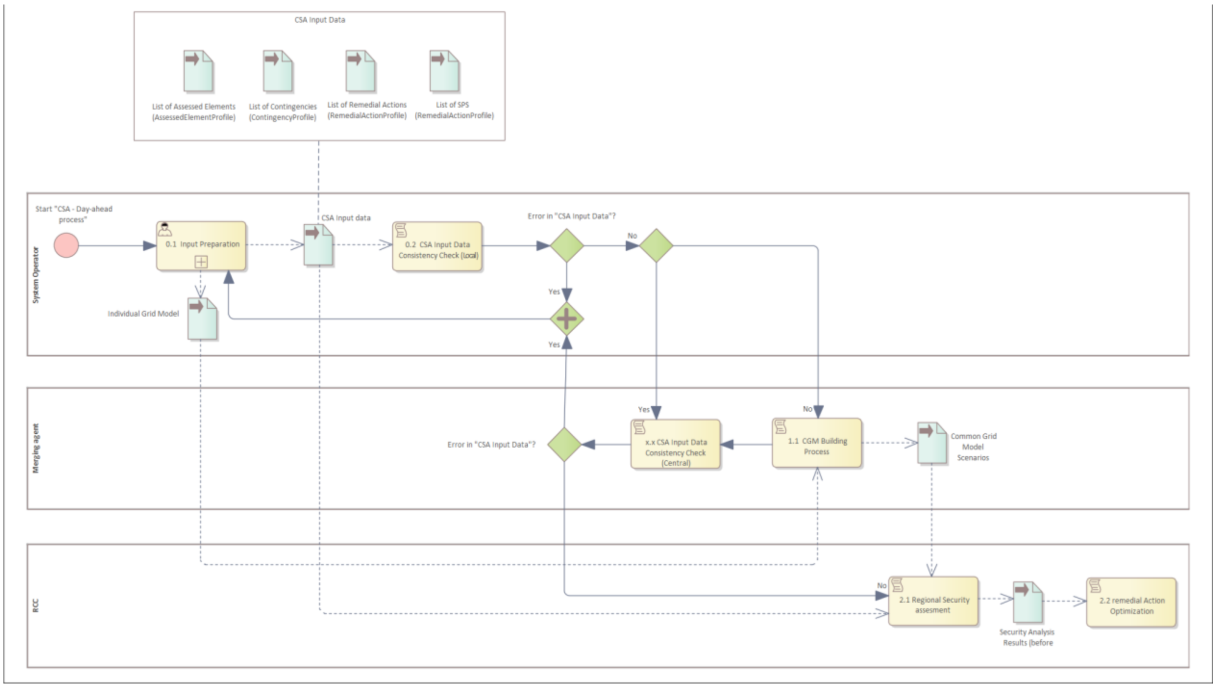
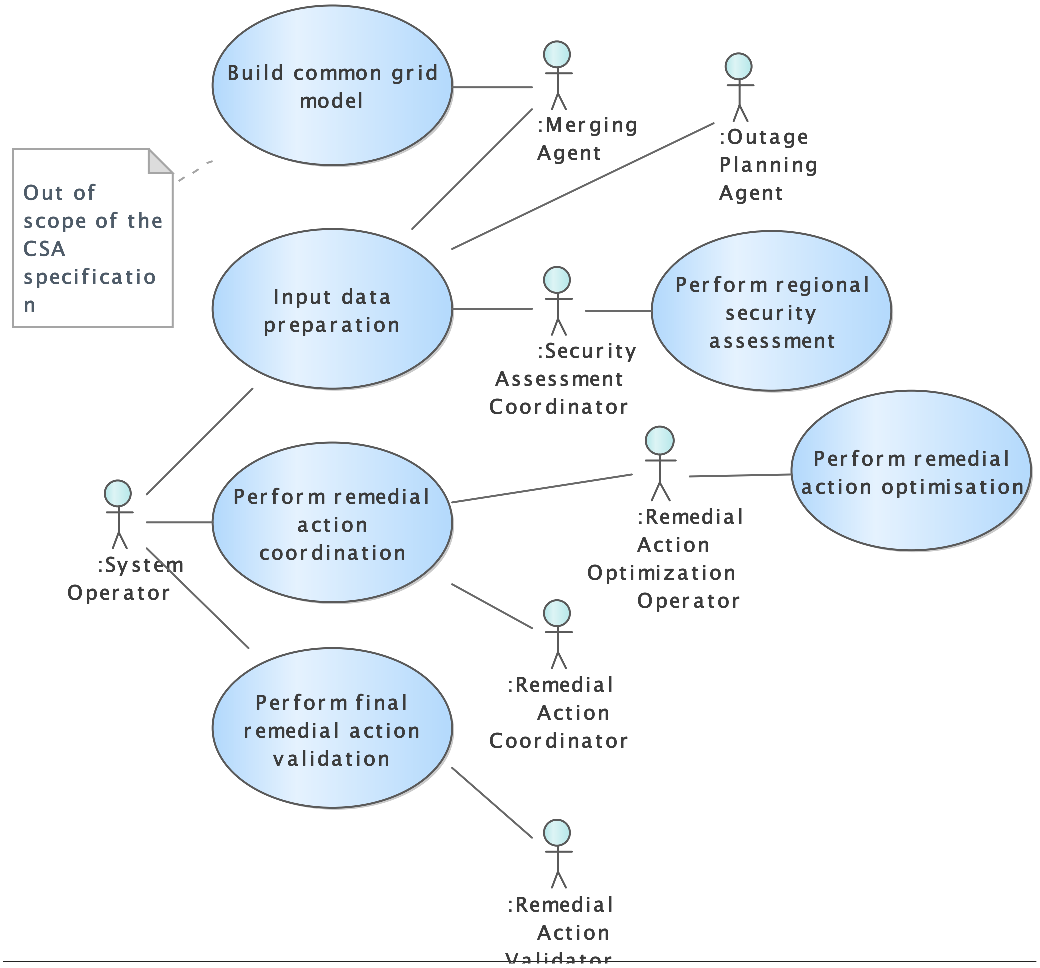


Figure 3 – Detailed BPMN for day-ahead process (for information only)

721 ## 6.2 Use Cases



722

723 **Figure 4 - Use Cases**

Table 2 gives a list of roles involved in the business processes. Some of these roles such as Outage Planning Agent are not strictly part of CSA process.

Table 2 - Role labels and descriptions

Role Label	Role Description
Merging Agent	The Merging Agent is responsible to gather the IGMs from SOs and build the CGM. The Merging Agent provides the CGM to the security assessment coordinator, who uses it as an input to perform the security analysis.
Outage Planning Agent	Outage Planning Agent provides the availability plan to the security assessment coordinator who uses this in case a remedial action would be the cancellation or shortening of an outage plan.
System Operator	SO provides most of the needed inputs to perform the security analysis. This role also participates in the remedial action coordination agreeing or rejecting the remedial actions.
Security Assessment Coordinator	The Security Assessment Coordinator performs the security assessment against contingencies in order to identify potential congestions in the grid and propose to the SO a set of remedial actions to solve the found issues.
Remedial Action Optimization Operator	Remedial Action Optimization Operator performs the remedial action optimization based on security assessment result before RAO and remedial actions defined as part of the structural data.
Remedial Action Coordinator	The Remedial Action Coordinator main task is to get the agreement on all proposed remedial actions identified by the remedial action optimization step and potentially any additional remedial actions specifically requested by a SO.
Remedial Action Validator	The main activity of the Remedial Action Validator during the final validation session is to review unresolved relevant identified constraints (on assessed elements), discuss/find possible follow-up activities by TSOs and RCCs and deliver the conclusions.

Table 3 gives a list of use cases for the CSA business process.

Table 3 - CSA use cases

Use case label	Roles involved	Action descriptions and assertions
Input data preparation	SO, Merging Agent, Outage Planning Agent, Security Assessment Coordinator	In order to allow the representation of the grid as well as the proper assessment of its security and the identification of potential effective and efficient remedial actions for the mitigation of identified constraints, the SO shall provide the list of assessed elements, contingencies, remedial action (including SIPS) and equipment reliability (e.g. Power transfer Corridor, reliability limits, etc), scheduled data and per market time unit data. Optionally Generation and Load Shift keys can be provided. SO shall provide as well its IGM to the Merging Agent, who builds the CGM as input to the business processes. Outage Planning Agent provides the availability plan. Finally, the security assessment coordinator performs a business check on all the received data.

Build common grid model	Merging Agent	Merging agent builds the CGM as the comprehensive aggregation and calculation on the basis of the IGMs and some relevant additional input data (e.g. boundary information, common data, reference data); this is out of the scope of this document and part of the CGM Build Process.
Perform regional security assessment	Security Assessment Coordinator	The Security Assessment Coordinator performs the security assessment against contingencies to identify potential congestions in the grid. This security assessment is run according to rules defined in the CCR Article 76 methodology (at least flows and potentially other aspects of security).
Perform remedial action optimization	Remedial Action Optimization Operator	The Remedial Action Optimization Operator performs the remedial action optimization to select the most suitable remedial actions to operate the network efficiently while ensuring security of supply.
Perform remedial action coordination	SO, Remedial Action Optimization Operator, Remedial Action Coordinator.	The Remedial Action Coordination is divided in two steps. The first step consists of managing the interactions within the CCR. The purpose is to apply rules (According to CSAm Art. 27) to address the cross-impacts between CCRs on the overlapping zones. In the second step, the impact assessment of all proposed and adjusted remedial actions is performed. This impact assessment consists of identifying the affected SOs for each remedial action, based on the rules defined in the CCR Article 76 methodology (qualitative and/or quantitative rules) and rules for cross-CCR impact (to be defined according to the amendment of CSAm Article 27).
Perform final remedial action validation	Remedial Action Validator, SO	The main activity during the final validation session is to review unresolved relevant identified constraints (on assessed elements), discuss/find possible follow-up activities by SO and Remedial Action Validator and record the conclusions. Remedial Action Validator shall provide the results and decisions to the SO.

6.3 Sequence Diagram

Figure 5 shows a sequence diagram with the inputs of the CSA data exchange process. Not all inputs are mandatory for every data exchange.

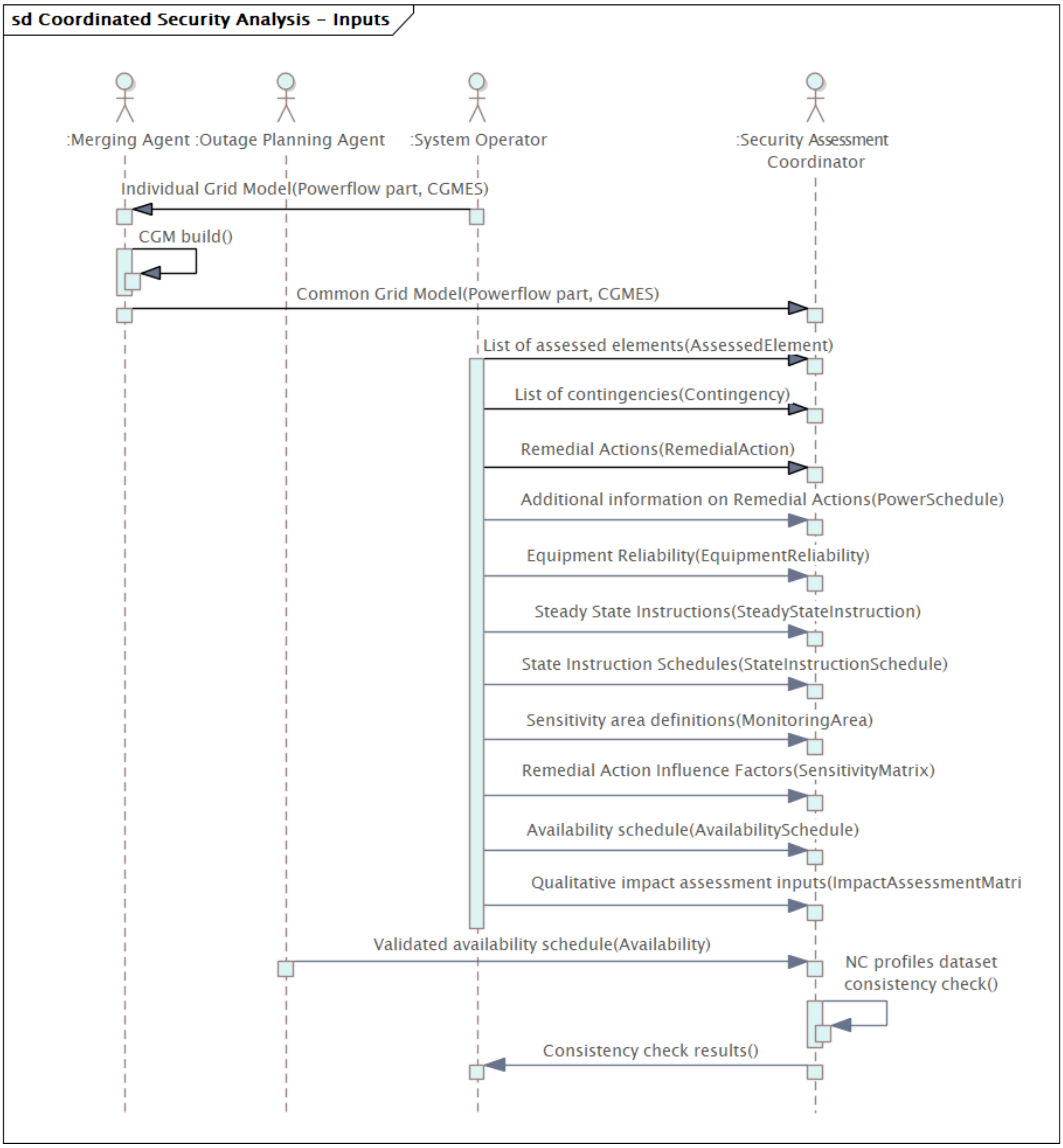


Figure 5 – CSA inputs Sequence diagram

The process starts with the submission of the IGM from each SO to the Merging Agent. Each IGM is composed by at least four datasets conforming to profiles providing data for power flow calculation and its result (e.g. Equipment, Topology, Steady State Hypothesis and State Variables). The frequency of submission of these profiles is different. In the case of equipment and topology and their boundaries have to be submitted when there are equipment or topology changes. For steady state hypothesis and state variables, they will have to be submitted per market time unit (e.g. 1 hour or 15 min resolution). Merging Agent merges all the IGMs and provides the CGM to the Security Assessment Coordinator.

In addition, the SO provides all relevant data needed for the business process, e.g. the list of assessed elements, contingencies, remedial actions, power schedule, equipment reliability, steady state instructions, schedules, sensitivity area definitions, remedial action influence factors and availability schedules. Outage planning agent provides the validated availability schedules which is an output of the OPC process.

Validation of consistency between “All relevant data” and CGM is performed as part of the business process, and it is not in scope for the CGM Build process. For details, refer to section 8.1.

Figure 6 shows a sequence diagram of the CSA data exchange process. Note that not all data exchanges shown are mandatory for each variation of the business process.

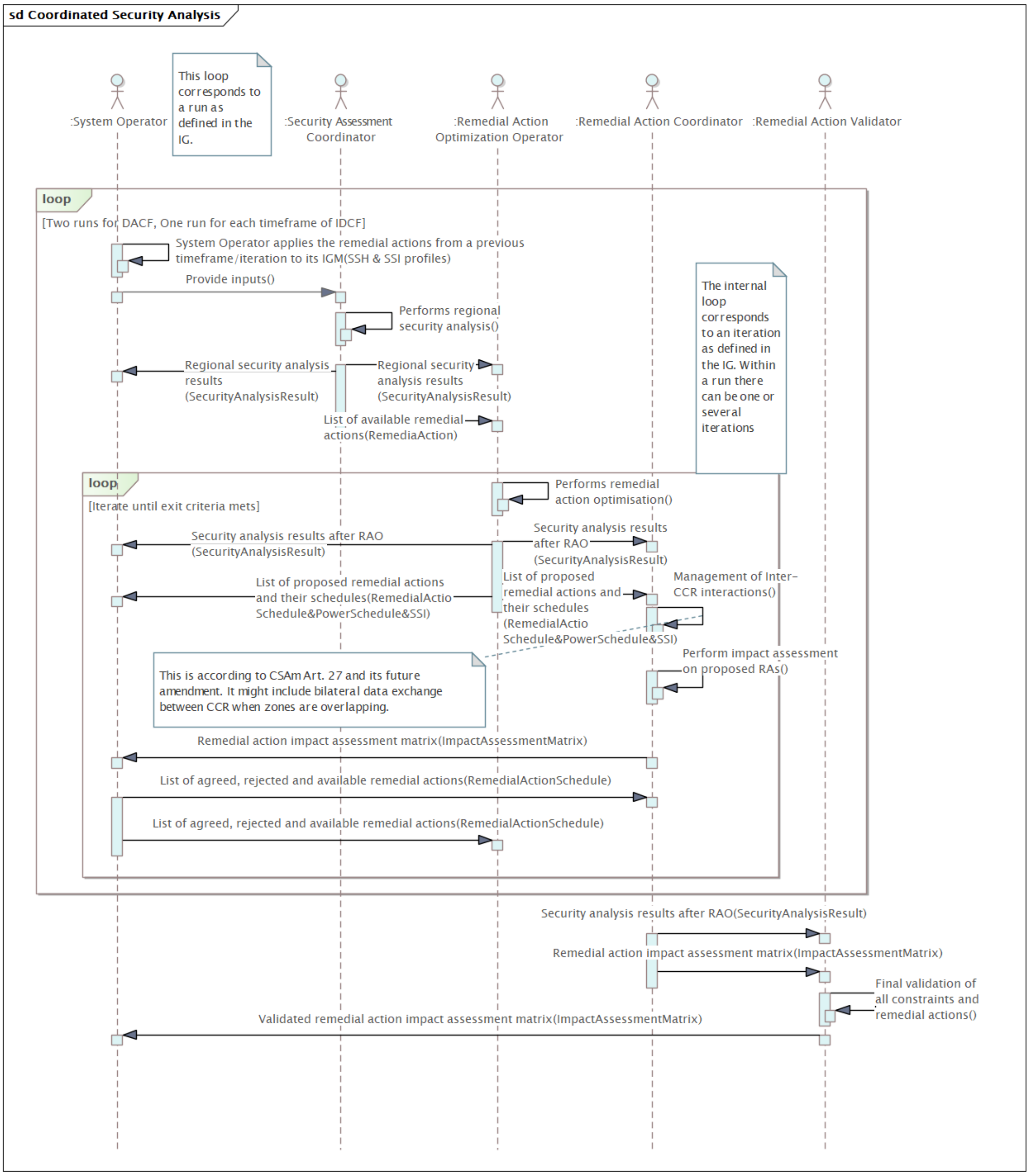


Figure 6 - CSA general sequence diagram

With all the inputs, Security Assessment Coordinator runs the regional security analysis. Basically, the security assessment allows to identify potential congestions in the grid. The result of this contingency analysis contains the identified limit violations in both base case (N situation) and considering contingencies (N-1, N-x situation). Apart from the violations, Security Assessment Coordinator also provides the remedial actions to the Remedial Action

Optimization Operator. These remedial actions are part of the structural data and designed to solve identified constraints.

The remedial action optimization is performed for each Capacity Calculation Region. As a result of the optimisation, the security analysis after RAO and a list of proposed remedial actions together with their schedules are delivered to both System Operator and Remedial Action Coordinator.

After that, Remedial Action Coordinator addresses the cross-CCR interactions which consists in addressing the cross-impacts between CCRs on the overlapping zones. Just after the CCR interactions, remedial action coordinator performs the impact assessment on the proposed remedial actions. The outcome of this process is the impact assessment matrix[5]. The main purpose of the matrix is to identify the affected SOs for each remedial action. The impact assessment matrix is delivered to the SOs. It can also serve as input provided by an SO in case of qualitative assessment process. Each SO shall agree or reject each remedial action by which it is impacted. If a SO rejects a remedial action, it shall provide the reasoning and (optionally) suggest alternative new available remedial actions or modified available remedial actions. Both optimization and coordination are repeated during several iterations until exit criteria is met. The exit criteria can be, for instance, when all the identified constraints have been solved with the agreed remedial actions, or time limit is reached.

The big loop is also defined as run. In Day-Ahead there will be two coordination runs and in Intraday only one. Basically, for the day ahead, the process is repeated twice.

After coordination, a final remedial action validation session is performed by the remedial action validator which receives from remedial action optimization operator the security analysis results and the impact assessment matrix. The main activity during the Final Validation Session is to review unresolved relevant identified constraints (on assessed elements) and discuss or find possible follow-up activities by SOs and Remedial Action Validator. Finally, the validated impact assessment matrix is delivered to the System Operator and the process finishes.

[5] As part of the quantitative assessment. The qualitive assessment already took place before.

7 CSA Subprocesses

The CSA subprocesses are detailed in the following sections.

7.1 Input Data Preparation

7.1.1 Description

In this step the System Operator prepares and provides the input data to be used in the business process (e.g. CSA). An overview of the subprocess is illustrated in Figure 7.

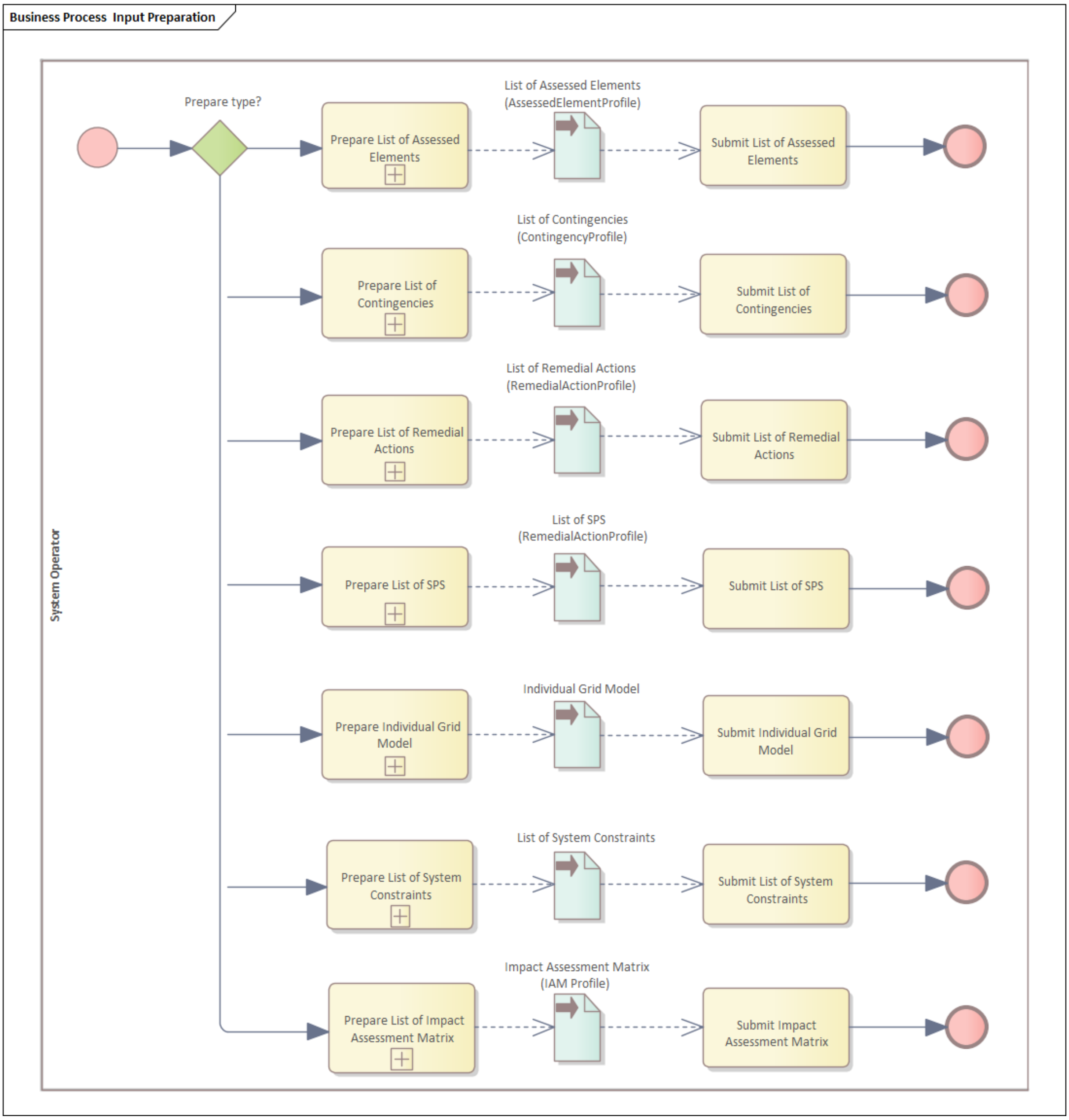


Figure 7 – Input Data Preparation

7.1.2 Inputs and Outputs

The list of Inputs and Outputs that are part of the subprocess is defined in Table 4.

Table 4 – Inputs and Outputs for Input Data Preparation

Inputs	Outputs
	Individual Grid Model (for the studied timeframe)
	List of Assessed Elements
	List of Contingencies
	List of Remedial Actions
	List of SPS (optional)
	List of System Constraints
	Impact assessment matrix

As the Input Data Preparation is considered the start of the business process, the datasets prepared by the TSOs are considered as outputs of this step.

The inputs listed in Table 4 can be provided using different data exchange profiles, according to the process and/or timeframe. The profile dependency and profile hierarchy are explained in § 8.2.

7.1.3 Input Data Design

The NC profiles are designed to support various use cases and profile flexibility on how the data is defined. There are three main categories of data:

- Structural data: data that is exchanged to define the configuration, the structure, of a given set of information. This data is exchanged only if the configuration is changed.
- Scheduled data: data that includes information for multiple time stamps in a form of a schedule.
- Data per time unit (MTU): data that is updated and exchanged for each market time unit, which can be hourly or less.

Each instance of data is uniquely identified by its identifier. The identifier shall be kept persistent to enable optimal data exchange that relies on the principle to exchange only the necessary data and do not duplicate. Besides the objective to achieve optimal volume of data exchange, it is required to track and report on different outcomes of the business processes, and this can only be achieved if the identifiers are persistent. For instance, to report on the agreement process on a remedial action schedule the identifiers of the RemedialAction, RemedialActionSchedule and the RemedialActionScheduleAcceptance have to be persistent.

By design the NC profiles implement a clear hierarchy between the profiles that govern structural data, scheduled data and data per time unit. For the scope of application of scheduled data and data per time unit, some data (normally has normal values) provided as part of structural data could be updated. The possibility to exchange these values as a schedule is provided by State Instruction Schedule profile (SIS). The possibility to update the values on per time unit basis is provided by Steady State Instruction profile (SSI). There are a couple of options that can be applied when designing the setup of the input data.

- Option 1: Rely on information in structural data.

  This option is applied when the System Operator assesses that some type of data will not be changed so often and there is no need to provide schedule or per time unit exchange. In this case there is no need to use SIS and SSI profiles for this type of data.

- Option 2: Provide default (normal) values in the structural data and supply scheduled information.

  This option is used when the System Operator assesses that there is a need to update or complement the data by using a schedule, i.e. profile the status information for the next 24 hours. The provision of normal values in structural data is optional. Any data for which a schedule exists will override normal values in structural data for this schedule calculation.

- Option 3: Provide default (normal) values in the structural data and supply data on per time unit basis

  This option is used when the System Operator assesses that there is a need to update the information per each market time unit. Any data for which per time unit data is provided exists will override both normal values provided by structural data and scheduled data, if defined – for this very MTU. The provision of normal values in structural data is not required for all properties.

- Option 4: Combine different approaches

  This approach combines different options in order to achieve an optimal data exchange by providing only the information essential for the business process.

- Option 5: Schedulled data provided after per time unit data

  This option is used when the System Operator provides scheduled data after submission of per time unit data. This option requires to also consider the sequence of data submission and give priority to SIS data over the SSI data, which overrules the main principle that SSI data is expected to be more exact. Therefore this option is not recommened and if business processes would like to use it will need to define additional rules.

The receiving systems shall be designed to handle different options taking into account the priority of the profiles. It should be noted that the options may not be applied in a consistent way for the complete dataset and it is allowed to be mixed depending on the nature of the input data. Table 5 illustrates the approach for the enabling of an AssessedElement.

Table 5 – Illustration of input data combinations for enabling of an AssessedElement

Structural data	Scheduled data (SIS)	Per MTU data (SSI)	Result
Provided	Not provided	Not provided	AssessedElement.normalEnabled from structural data applies
Provided	Provided	Not provided	AssessedElementTimePoint.enabled from SIS applies
Provided	Provided	Provided	AssessedElement.enabled from SSI applies
Provided for AE 1, Provided for AE 2 Not provided for AE 3[6]	Provided for AE 1, Not provided for AE 2 Not provided for AE 3	Not provided for AE 1 Not provided for AE 2 Provided for AE 3	AssessedElementTimePoint.enabled from SIS applies for AE 1 AssessedElement.normalEnabled from structural data applies for AE 2 AssessedElement.enabled from SSI applies for AE 3 The rule is: For a given property (value), use SSI if available, otherwise SIS if available, otherwise normal value in structural data.
Provided	Provided but after SSI	Provided	AssessedElementTimePoint.enabled from SIS applies because the data is submitted after the SSI data. This option requires tracing of the submission time.

There could be multiple datasets of the same type for the purpose to separate the usage. For instance, some regions can use metadata to enable the use case of providing a set of

[6] Structural data can optionally exchange normalEnabled (by profile definition), but the value in the normalEnabled is not provided (because optional).

AssessedElement objects for one part of the power system and another set of AssessedElement objects for another part of the power system. This will require that the receiving party understands the metadata provided in the manifest and/or in the dataset header if the party is interested in studying only one part of the power system or performing separate studies.

7.1.4 Conformity Requirements

To be able to support input data preparation the Application shall conform to the following Application functions:

- Import of single dataset
- Export of single dataset
- Structural data setup
- Scheduled data setup.

7.1.5 List of Assessed Elements

The List of Assessed Elements provision is illustrated in Figure 8.

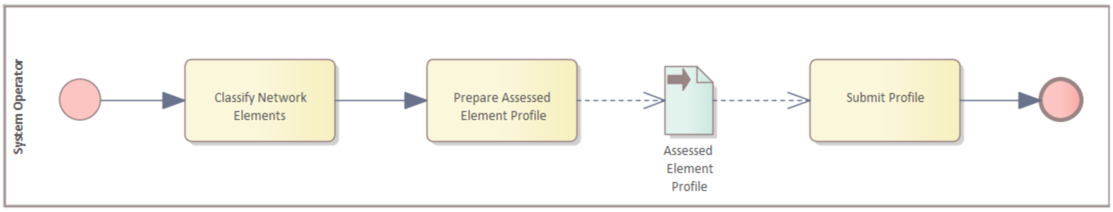


Figure 8 –List of Assessed Elements provision

The first step is to classify the Network Elements in the grid, the network element category diagram is represented in Figure 9.

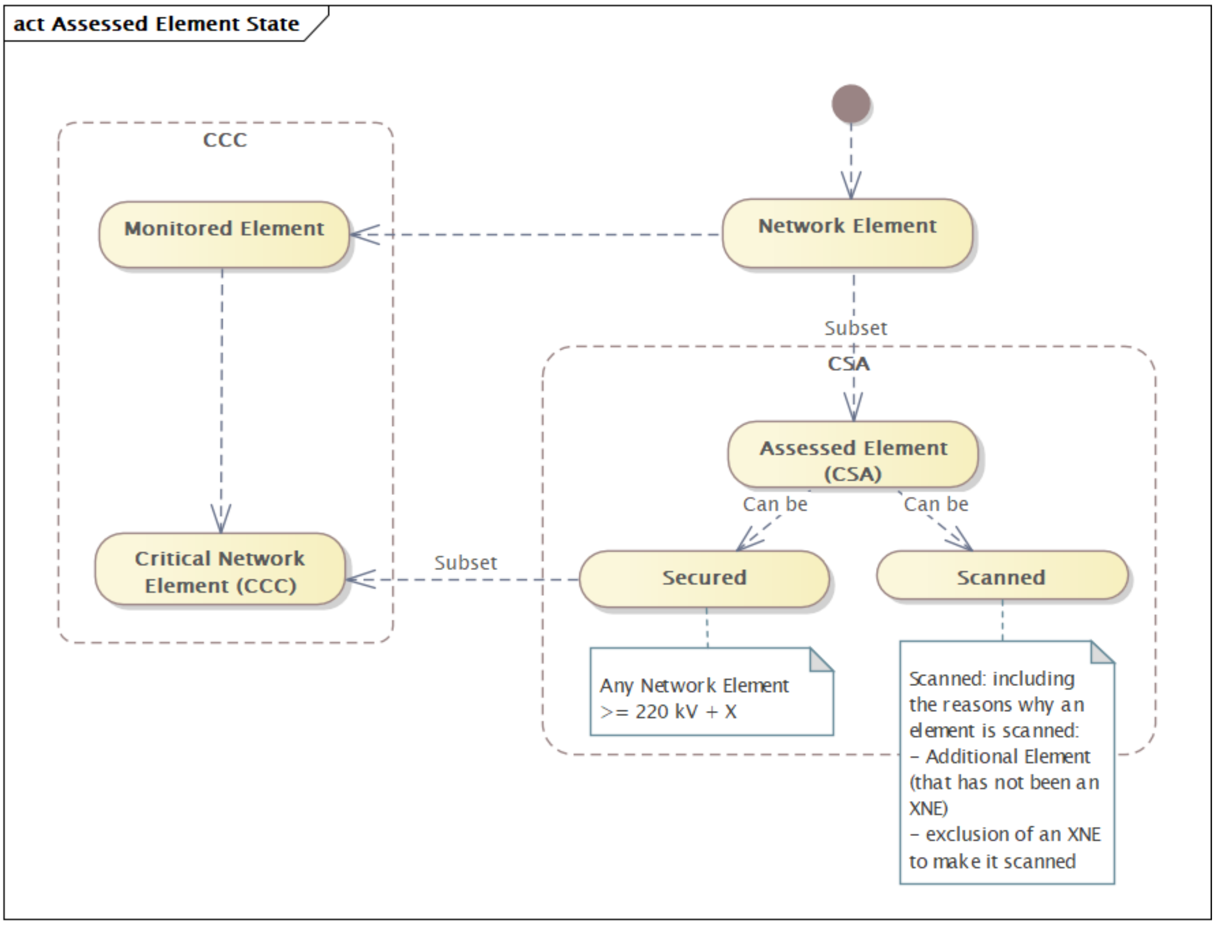


Figure 9 – Network element category diagram

Any network element can be an assessed element in a business process. The decision of which network elements are referred as assessed elements lies with the entity preparing the structural data, e.g. a TSO preparing assessed elements according to the requirements of business processes that perform the assessment. The assessed elements can be secured or scanned. A Secured element is an Assessed Element on which remedial actions are needed to relief violations of an operational security limit identified during the regional or cross-regional security analysis. For instance, a secured element would be a cross-border relevant network element (XNE), which includes all grid elements with a voltage level higher than or equal to 220 kV that are not intentionally excluded.

A scanned element is an Assessed Element on which the electrical state (at least flows) shall be computed and shall be subject to an observation rule during the regional security analysis process. Such observation rule can be for example avoiding the increase of a constraint or avoiding the creation of a constraint on this element, as a result of the design of remedial actions needed to relieve violations on the secured elements. A scanned element could be any grid element (if the grid element is not a CNE).

A critical network element is a network element monitored during the coordinated capacity calculation process. Critical network elements are a subset of the secured elements.

The second step is to provide the list of Assessed Elements using the Assessed Element profile. If an Assessed Element defined in the Assessed Element profile refers to an equipment or its controls that cannot be exchanged using CGMES Equipment profile used in the business process, there is a need to define it in the Equipment Reliability profile in case that profile supports the definition of the new equipment and/or its controls. For instance, Equipment

Reliability profile defines additional equipment and controls on HVDC, limits, reactive capability curves. Figure 43 illustrates the profiles dependencies. The System Operator shall ensure that the Assessed Elements are consistent with the power system model (IGM) valid for the validity period of the Assessed Element data.

The following general aspects apply when modelling assessed elements:

- The grid equipment that is assessed is in the Equipment profile dataset and is referenced by its mRID;
- The Region and SystemOperator in which/by which the AssessedElement is assessed are referenced by their mRIDs defined in the common data dataset (see Section 8.4) which conforms to the Equipment Reliability profile.
- When the reference to ConductingEquipment (e.g. a line, a transformer) is defined and there is no reference to OperationalLimit, the assessment is performed for all limits defined at all ends of the equipment. In case an AssessedElement object refers to a ConductingEquipment that has no limits defined in the underlying model the assessment will not be performed. Therefore, this needs to be detected in the consistency checks constraints. The advantage of using reference to OperationalLimit is that the target point of the assessment is defined in an exact way because the OperationalLimit relates to a type (e.g., PATL, TATL, etc.) and location (e.g., terminal at side 1 of the equipment).

7.1.5.1 Secured Assessed Element

This example illustrates how to specify a Secured Assessed Element. Note that the example does not reflect universal way of modelling a secured assessed element and may miss regional specificities.

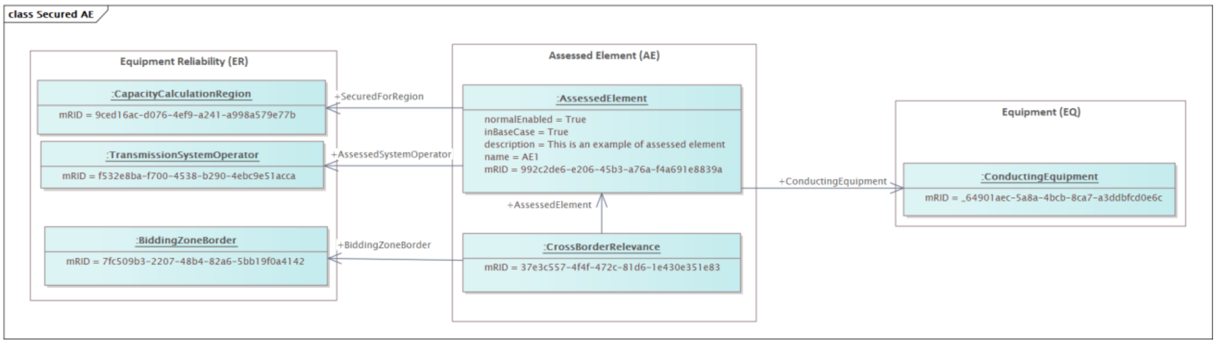


Figure 10 – Secured Assessed Element example.

The corresponding Assessed Element dataset snippet is as follows:

```xml
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.OperationalLimit rdf:resource="#_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3"/>
  <nc:AssessedElement.SecuredForRegion rdf:resource="#_9ced16ac-d076-4ef9-a241-a998a579e77b"/>
  <nc:AssessedElement.AssessedSystemOperator rdf:resource="#_f532e8ba-f700-4538-b290-4ebc9e51acca"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
  <nc:AssessedElement.normalEnabled>true</nc:AssessedElement.normalEnabled>
</nc:AssessedElement>

<nc:CrossBorderRelevance rdf:ID="_37e3c557-4f4f-472c-81d6-1e430e351e83">
  <nc:CrossBorderRelevance.mRID>37e3c557-4f4f-472c-81d6-1e430e351e83</nc:CrossBorderRelevance.mRID>
  <nc:CrossBorderRelevance.AssessedElement rdf:resource="#_992c2de6-e206-45b3-a76a-f4a691e8839a"/>
  <nc:CrossBorderRelevance.BiddingZoneBorder rdf:resource="#_7fc509b3-2207-48b4-82a6-5bb19f0a4142"/>
</nc:CrossBorderRelevance>
```

The following remarks apply to this example:

- In order to indicate that the assessed element should be assessed in the base case the attribute AssessedElement.inBaseCase is set to true.

7.1.5.2 Scanned Assessed Element

This example illustrates how to specify a Scanned Assessed Element which is secured in another Region. Note that the example does not reflect universal way of modelling a scanned assessed element and may miss regional specificities. Additionally, the example only covers how to model the scanned element in one region, however a model of secured element would exist in parallel and would be referencing another region without scanned status set. In other words, in case of modelling an assessed element which is considered scanned in one region ("excluded XNE with status scanned") and at the same moment secured in another region ("XNE"), one has to model two objects with different attributes set (ScannedForRegion, SecuredForRegion and ExclusionReason) but referencing same equipment ID in the grid model.

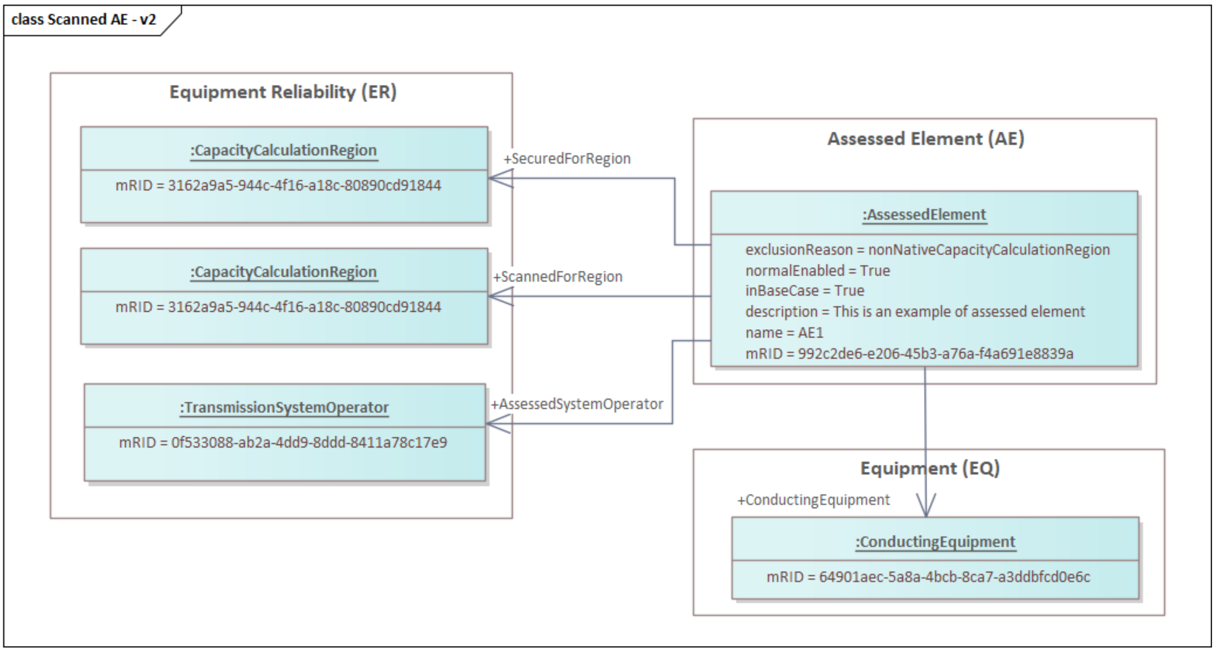


Figure 11 – Scanned Assessed Element example

The corresponding Scanned Element snippet in the Assessed Element dataset is as follows:

```
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.OperationalLimit rdf:resource="#_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3"/>
  <nc:AssessedElement.SecuredForRegion rdf:resource="#_3162a9a5-944c-4f16-a18c-80890cd91844/>
  <nc:AssessedElement.ScannedForRegion rdf:resource="#_3162a9a5-944c-4f16-a18c-80890cd91844"/>
  <nc:AssessedElement.AssessedSystemOperator rdf:resource="#_0f533088-ab2a-4dd9-8ddd-8411a78c17e9"/>
  <nc:AssessedElement.exclusionReason rdf:resource="
https://cim4.eu/ns/nc#SecuredExclusionReasonKind.nonNativeCapacityCalculationRegion"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
</nc:AssessedElement>
```

The following remarks apply to this example:

- In this case the AssessedElement is not assessed in the base case, the attribute AssessedElement.inBaseCase should be set to false.
- Depending on the meaning, if it is meant to be applicable for a secured region (and not for scanned region), the exclusionReason needs to be added.

7.1.5.3 Disable an Assessed Element

An AssessedElement object can be disabled in the structural data and in the scheduled or data per time unit. In case the disabling of the object is done on either scheduled data or per time unit data, this disabling is referred as “Temporary” disabled object. This example is derived from 7.1.5.1 to show how to disable for a specific time in the process an Assessed Element defined in the structural data. This is done by submission of a State Instruction Schedule (SIS) dataset or by submission of a Steady State Instruction (SSI) dataset (details regarding the profiles hierarchy can be found in § 8.2). Guidance on the design is provided in section 7.1.3. In addition, normally in case it is necessary to exclude a secured AssessedElement object a reason for this exclusion needs to be provided.

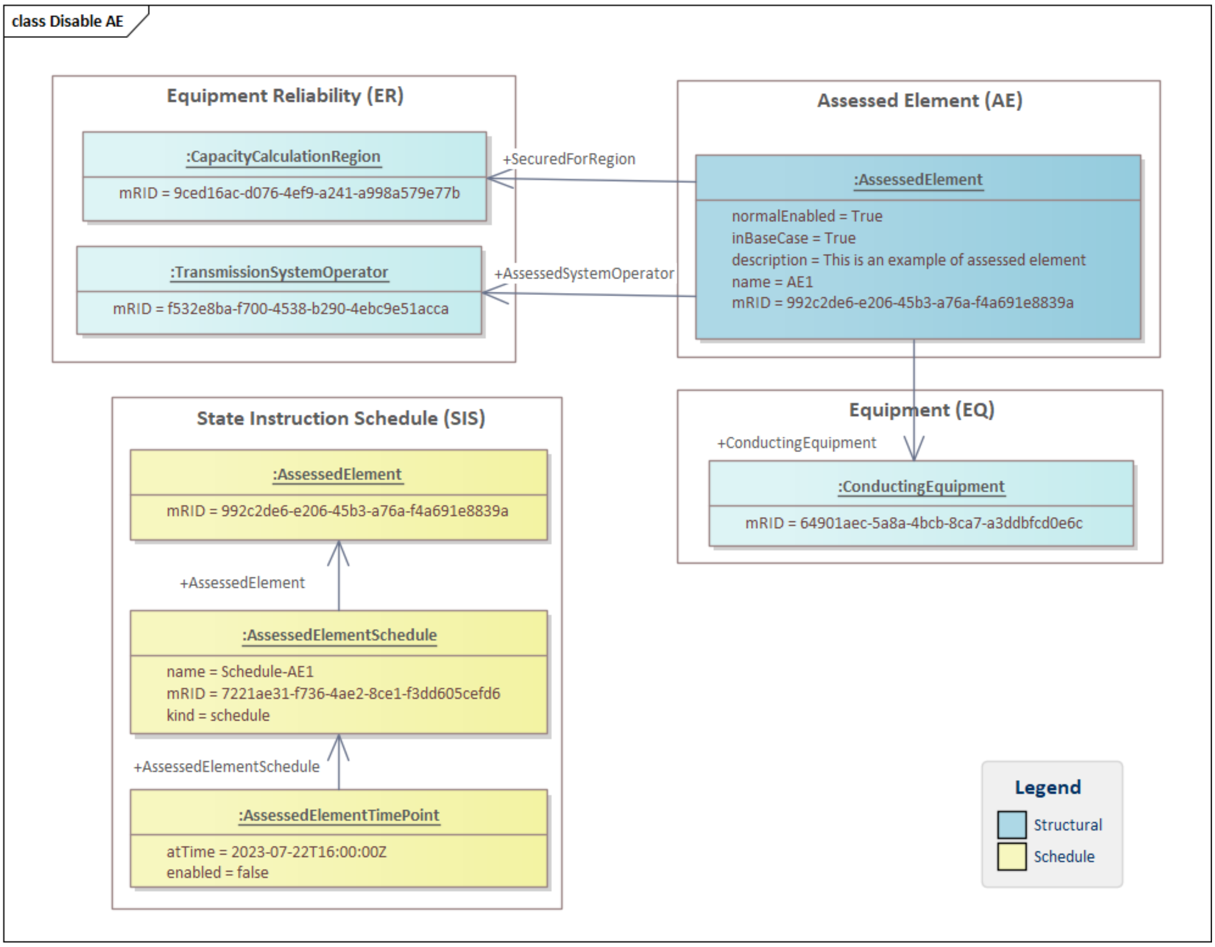


Figure 12 – Example Disable Assessed Element via SIS dataset

The Assessed Element dataset is the same as in 7.1.5.1. The SIS dataset which disables the assessed element from Figure 9 is as follows:

```
<nc:AssessedElementSchedule rdf:ID="_7221ae31-f736-4ae2-8ce1-f3dd605cefd6">
  <cim:IdentifiedObject.name>AES1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element
schedule.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7221ae31-f736-4ae2-8ce1-f3dd605cefd6</cim:IdentifiedObject.mRID>
  <nc:AssessedElementSchedule.AssessedElement rdf:resource="#_992c2de6-e206-45b3-a76a-f4a691e8839a"/>
  <nc:BaseTimeSeries.interpolationKind rdf:resource="https://cim4.eu/ns/nc#TimeSeriesInterpolationKind.none"/>
</nc:AssessedElementSchedule>

<nc:AssessedElementTimePoint rdf:ID="_a26e3ae0-0a7d-4f42-ad64-e9105ec3cd41">
  <nc:AssessedElementTimePoint.AssessedElementSchedule rdf:resource="#_7221ae31-f736-4ae2-8ce1-f3dd605cefd6"/>
  <nc:AssessedElementTimePoint.atTime>2023-06-15T22:30:00Z</nc:AssessedElementTimePoint.atTime>
  <nc:AssessedElementTimePoint.enabled>false</nc:AssessedElementTimePoint.enabled>
```

```
</nc:AssessedElementTimePoint>
```


7.1.5.4 Exclude an Assessed Element

This example shows how to exclude in the process an Assessed Element defined in the structural data. Exclusion allows regional security analysis calculation, but it is not considered in RAO as an element which would be optimized (secured). Excluded elements can be treated as scanned elements (by setting the scanned status via ScannedForRegion reference) or simply be ignored by RAO. .

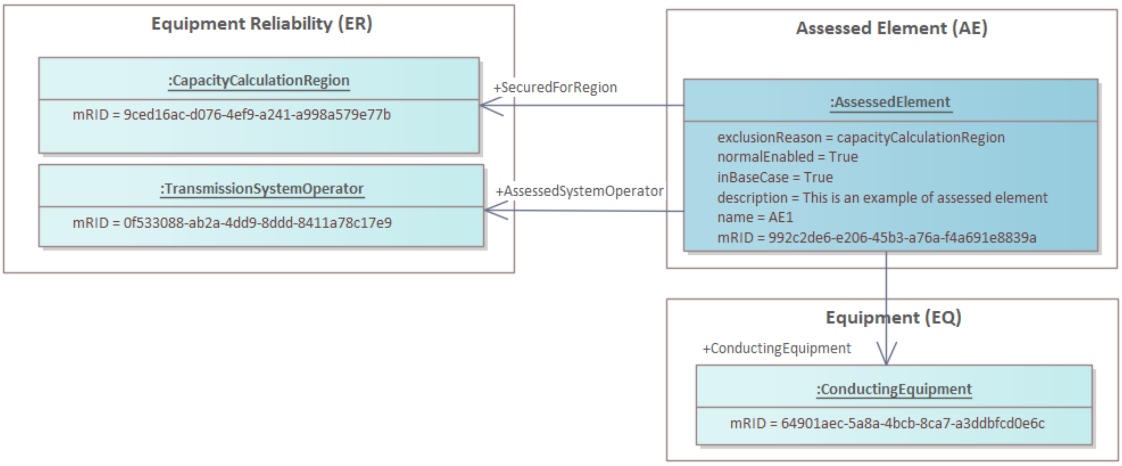


Figure 13 – Exclude Assessed Element example.

The Assessed Element dataset snippet is as follows:


```
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.OperationalLimit rdf:resource="#_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3"/>
  <nc:AssessedElement.SecuredForRegion rdf:resource="#_9ced16ac-d076-4ef9-a241-a998a579e77b"/>
  <nc:AssessedElement.exclusionReason rdf:resource="https://cim4.eu/ns/nc#capacityCalculationRegion"/>
  <nc:AssessedElement.AssessedSystemOperator rdf:resource="#_0f533088-ab2a-4dd9-8ddd-8411a78c17e9"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
</nc:AssessedElement>
```


7.1.5.5 Assessed Element with Contingency

This section presents examples to illustrate how to cover different use cases that require specification of an Assessed Element (AE) with a Contingency (CO). The following uses cases are covered:

1) **Full scope**: An AE is considered for all contingencies.

2) **Limited exclusion**: An AE is considered for all but few contingencies. For instance, an “AE1” is excluded, i.e., not considered, when “CO1” or “CO2” are performed.

3) **Limited inclusion**: An AE is considered only for limited number of contingencies. For instance, an “AE1” for the equipment "Line1" (considering the operational limit "CurrentLimit1") is checked only after the “CO1” and after the “CO2”. In addition, any remedial action can be used to solve the constraint except the ones that are associated to a particular assessed element (see section 7.1.5.6).

The following general remarks apply to the design of the included or excluded assessed elements:

- By providing a mechanisms of inclusion and exclusion, the data exchange specification aims at enabling sending party to reflect on specific situations, to minimize the data exchanged for the business process, to give guidance to the RAO which as a side effect helps the performance of the business process.

- The AE has an attribute isCombinableWithContingency. If this is set to True, RSA and RAO would consider this AE available for combinations with all defined contingencies. If this is the desired behaviour there is no need to define all pairs by using AssessedElementWithContingency. If this is set to False, RSA and RAO would expect to find instructions on concrete pairs (combinations) that are valid to be studied for this AE.

- The AssessedElementWithContingency provides information on the combination between an AssessedElement and a Contingency. This combination can have the meaning of “inclusion” or “exclusion”. If a combination is included RSA and RAO will include it when performing the analysis. It does not make sense to define an included combination for an AsessedElement that has the attribute isCombinableWithContingency set to True as this will result in duplicated combinations. The usage of “inclusion” has a meaning only when used for assessed elements that are constrained, i.e., isCombinableWithContingency attribute is set to False. On the other hand, the usage of “exclusion” of a combination only makes sense when isCombinableWithContingency attribute is set to True, as RSA and RAO would implicitly define all combinations between assessed elements and contingencies and will exclude the combinations that are provided in the data exchange.

- When defining an AssessedElement the System Operator can create multiple AssessedElements objects that refer to same limit or equipment. This approach helps in cases where it is required to combine the “inclusion” and the “exclusion” approach which targets assessment of the same equipment. This is also required to address the case in which TSO belongs to more than one CCR.

- The data model used for the exchange provides means to enable or disable a combination defined by AssessedElementWithContingency at structural data level. This can be done at structural data level, the schedules or in the data exchange that is per time unit. Therefore, RSA and RAO shall take into account all inputs when setting up the combinations that would apply for a study of a timestamp. For example, an “AE1” is defined in the structural data as combinable (isCombinableWithContingency set to True). There are 2 AssessedElementWithContingency defined – “AE1-CO1” and “AE1-CO2” that are both enabled in the structural data as “exclusion”. The SIS dataset disables “AE1-CO1” and “AE1-CO2” for hour 1 and hour 2, but SSI dataset enables “AE1-CO1” for hour 1. Therefore, when RAO prepares the study of hour 1, the “AE1” will be assessed for all enabled contingencies for hour 1 except “CO1" as the “exclusion” “AE1-CO1” is enabled in SSI dataset and the “exclusion” “AE1-CO2” remains disabled by SIS dataset.

In addition, the AssessedElement contain information on the kind of assessed element with contingency often referred as network element with contingency. The enumeration NetworkElementContingencyKind is used as follows:

- validation – if the AssessedElement is not Critical Network Element and Contingency (CNEC) and it is not Monitored Network Element and Contingency (MNEC)

- monitored - if the AssessedElement is not CNEC and it is MNEC

- critical - if the AssessedElement is CNEC and it is not MNEC

- criticalAndMonitored - if the AssessedElement is CNEC and it is MNEC

This together with the Individual Adjustment Value (IVA) and Common Adjustment Value (CVA) are used for the intraday capacity calculation and it is provided to flow-based calculation method. In the flow-based methodology IVA share is modified by TSOs during their security analysis. This part of the business process is where those parameters should be defined in the AE profile but might need SIS for updates. The current version of NC integration, IVA updates are not included in the scope. This is why for now, only structured data for adjustment values is needed. Updates are expected in next versions.

A. Scenario 1 – Full scope: Modelling of AssessedElement implicitly combined with all Contingencies

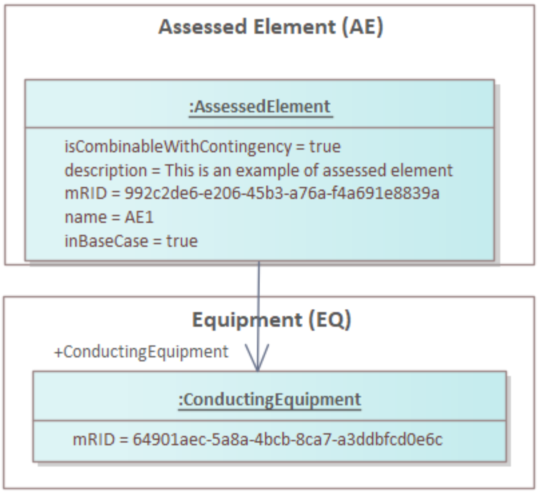


Figure 14 – Assessed Element with Contingency – Scenario 1.

The corresponding dataset snippet for scenario 1 is as follows:

```
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
  <nc:AssessedElement.isCombinableWithContingency>true</nc:AssessedElement.isCombinableWithContingency>
</nc:AssessedElement>
```

The following remarks apply to this example:

- In this case the AssessedElement is assessed in the base case as the attribute AssessedElement.inBaseCase is set to true.
- The scenario covers the case where an AE is considered for all contingencies (Full scope). The attribute AssessedElement.isCombinableWithContingency is set to true, which means that RSA and RAO will assess this AssessedElement for all contingencies defined in the structural data and enabled for the timestamp that is studied.

B. Scenario 2 – Limited exclusion: Modelling of AssessedElement with Contingency

Scenario 2 occurs in cases where an assessed element is set as combinable with all Contingency objects defined and enabled for the timestamp that is studied, but a combination with particular Contingency is excluded from the study. The example focuses on OrdinaryContingency but can be applied for any other type of contingencies supported by the Contingency profile.

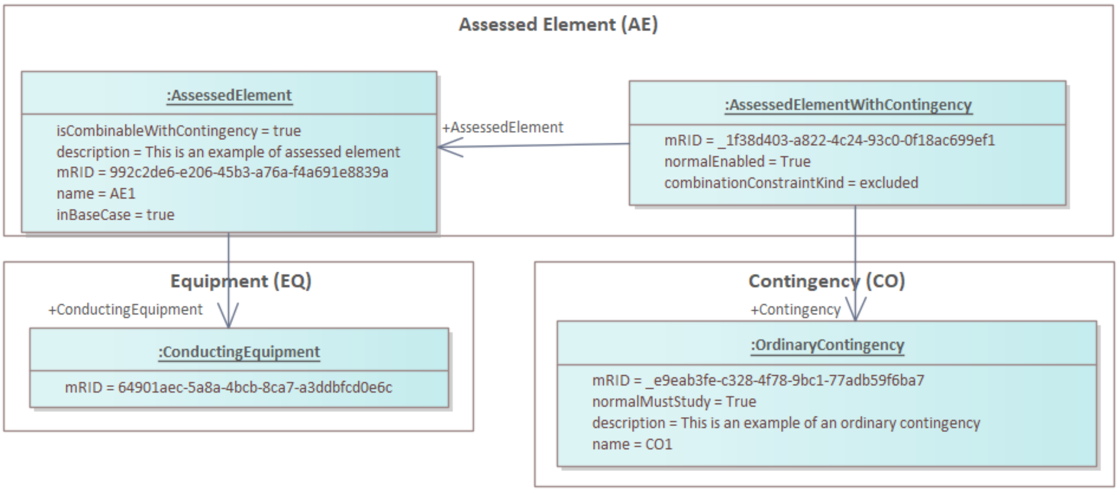


Figure 15 – Assessed Element with Contingency – scenario 2.

The corresponding dataset snippet for scenario 2 is as follows:

```
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
  <nc:AssessedElement.isCombinableWithContingency>true</nc:AssessedElement.isCombinableWithContingency>
</nc:AssessedElement>

<nc:AssessedElementWithContingency rdf:ID="_1f38d403-a822-4c24-93c0-0f18ac699ef1">
  <nc:AssessedElementWithContingency.mRID>1f38d403-a822-4c24-93c0-
0f18ac699ef1</nc:AssessedElementWithContingency.mRID>
  <nc:AssessedElementWithContingency.Contingency rdf:resource="#_e9eab3fe-c328-4f78-9bc1-77adb59f6ba7"/>
  <nc:AssessedElementWithContingency.AssessedElement rdf:resource="#_992c2de6-e206-45b3-a76a-f4a691e8839a"/>
  <nc:AssessedElementWithContingency.combinationConstraintKind
rdf:resource="https://cim4.eu/ns/nc#ElementCombinationConstraintKind.excluded"/>
  <nc:AssessedElementWithContingency.normalEnabled>true</nc:AssessedElementWithContingency.normalEnabled>
</nc:AssessedElementWithContingency>
```

The following remarks apply to this example:

- AssessedElementWithContingency object is defined to identify the pair (combination) that is excluded from the study, i.e. contingency analysis.

The Contingency dataset snippet is as follows:

```
<nc:OrdinaryContingency rdf:ID="_e9eab3fe-c328-4f78-9bc1-77adb59f6ba7">
  <cim:IdentifiedObject.name>CO1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an ordinary contingency;Tie Line
loss</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>e9eab3fe-c328-4f78-9bc1-77adb59f6ba7</cim:IdentifiedObject.mRID>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
</nc:OrdinaryContingency>
```

C. Scenario 3 – Limited inclusion: Modelling of AssessedElement with Contingency

Scenario 3 occurs in cases where an assessed element is defined as not combinable with all Contingency objects, defined and enabled for the timestamp that is studied, but a combination with particular Contingency is included in the study. The example is focused on OrdinaryContingency but can be applied for any other type of contingencies supported by the Contingency profile.

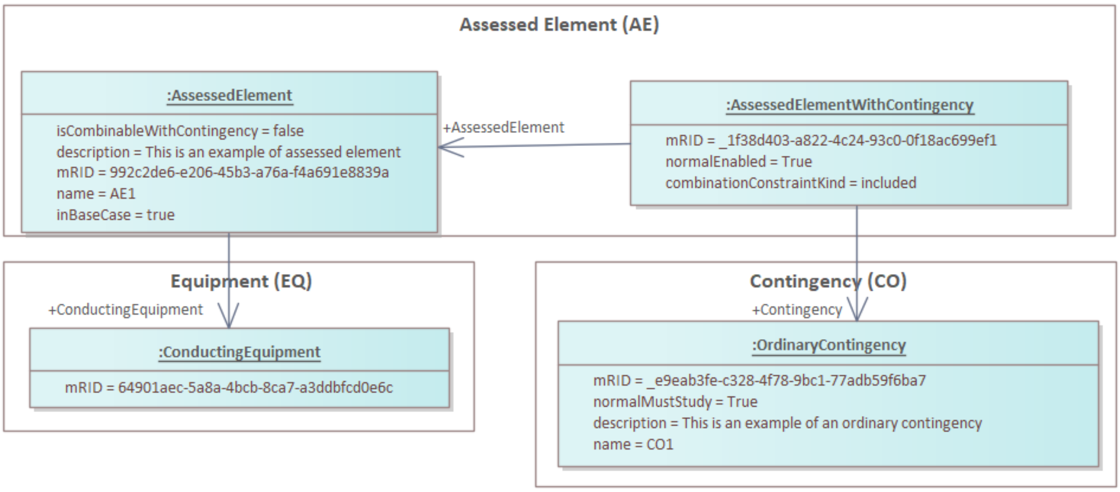


Figure 16 – Assessed Element with Contingency – scenario 3.

The corresponding Assessed Element dataset snippet is as follows:

```
<nc:AssessedElement rdf:ID="_992c2de6-e206-45b3-a76a-f4a691e8839a">
  <cim:IdentifiedObject.name>AE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>992c2de6-e206-45b3-a76a-f4a691e8839a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c"/>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
  <nc:AssessedElement.isCombinableWithContingency >false</nc:AssessedElement.isCombinableWithContingency>
</nc:AssessedElement>

<nc:AssessedElementWithContingency rdf:ID="_1f38d403-a822-4c24-93c0-0f18ac699ef1">
  <nc:AssessedElementWithContingency.mRID>1f38d403-a822-4c24-93c0-
0f18ac699ef1</nc:AssessedElementWithContingency.mRID>
  <nc:AssessedElementWithContingency.Contingency rdf:resource="#_e9eab3fe-c328-4f78-9bc1-77adb59f6ba7"/>
  <nc:AssessedElementWithContingency.AssessedElement rdf:resource="#_992c2de6-e206-45b3-a76a-f4a691e8839a"/>
  <nc:AssessedElementWithContingency.combinationConstraintKind
rdf:resource="https://cim4.eu/ns/nc#ElementCombinationConstraintKind.included"/>
  <nc:AssessedElementWithContingency.normalEnabled>true</nc:AssessedElementWithContingency.normalEnabled>
</nc:AssessedElementWithContingency>
```

The Contingency dataset snippet is as follows:

```
<nc:OrdinaryContingency rdf:ID="_e9eab3fe-c328-4f78-9bc1-77adb59f6ba7">
  <cim:IdentifiedObject.name>CO1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an ordinary contingency; Tie Line
loss</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>e9eab3fe-c328-4f78-9bc1-77adb59f6ba7</cim:IdentifiedObject.mRID>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
</nc:OrdinaryContingency>
```

The following remarks apply to this example:

- The AssessedElement and the Contingency that are linked are referenced in the AssessedElementWithContingency object by their mRIDs;
- The contingency type can also be ExceptionalContingency and OutOfRangeContingency;
- AssessedElement class has other mandatory attributes already presented in section 7.1.5.1 and 7.1.5.2.

7.1.5.6 Assessed Element with Remedial Action

This section presents examples to illustrate how to cover different use cases that require specification of an Assessed Element (AE) with a Remedial Action (RA). The following uses cases are covered:

1) **Full scope**: All defined and enabled remedial actions are considered when resolving a violation of an assessed element.

2) **Limited inclusion**: One or limited number of remedial actions are considered (the only RA that are applicable) when resolving a violation of an assessed element.

3) **Limited exclusion**: One or limited number of remedial actions are not considered when resolving a violation of an assessed element. For instance, "RA1" is excluded, i.e., not considered/not used as possible RA, when "AE1" or "AE2" are having violations.

4) **Consideration**: One or limited number of remedial actions can be considered when resolving a violation of an assessed element. The difference between limited inclusion and consideration is that in consideration multiple remedial action can be considered, while in the limited inclusion only defined remedial action are applicable.

The following general remarks apply to the design of the included, excluded, or considered remedial actions:

- By providing a mechanisms of inclusion and exclusion, the data exchange specification aims at enabling sending party to reflect on specific situations, to minimize the data exchanged for the business process, to give guidance to the RAO which as a side effect helps the performance of the business process. In general, all remedial actions can be considered for all assessed elements, but this would take significant amount of time.

- Constraining RAO by limiting the possibilities on which remedial actions can be used for resolving violations on assessed elements can be considered a breach of the requirements defined in Network Codes and methodologies. Therefore, it should only be used in cases where this helps the performance of the process but does not limit the effect of optimising remedial actions and finding the best possible solution.

- The AE has an attribute isCombinableWithRemedialAction. If this is set to True, RAO would consider this AE available for combinations will all defined remedial actions. if this is the desired behaviour there is no need to define all pairs by using AssessedElementWithRemedialAction. If this is set to False, RAO would expect to find instructions on which concrete pairs (combinations) are valid to be studied for this AE.

- The AssessedElementWithRemedialAction provides information on the combination between an AssessedElement and a RemedialAction. This combination can have the meaning of "inclusion", "exclusion" or "consideration". If a combination is included RAO will include it when performing the analysis. It does not make sense to define an included combination for an AsessedElement that has the attribute isCombinableWithRemedialAction set to True as this will result in duplicated combinations. The usage of "inclusion" has a meaning only when used for assessed elements that are constrained, i.e., isCombinableWithRemedialAction attribute is set to False. On the other hand, the usage of "exclusion" of a combination only makes sense when isCombinableWithRemedialAction attribute is set to True, as RAO would implicitly define all combinations between assessed elements and remedial actions and will exclude the combinations that are provided in the data exchange.

- When defining an AssessedElement the System Operator can create multiple AssessedElements objects that refer to same limit or equipment. This approach helps in cases where it is required to combine "inclusion", "exclusion", and "consideration" approaches which targets assessment of same equipment.

- The data model used for the exchange provides means to enable or disable a combination defined by AssessedElementWithRemedialAction. This can be done at structural data level, the schedules or in the data exchange that is per time unit. Therefore, RAO shall take into account all inputs when setting up the combinations that would apply for a study of a timestamp. For example, an "AE1" is defined in the structural data as combinable (isCombinableWithRemedialAction set to True). There are 2 AssessedElementWithRemedialAction defined – "AE1-RA1" and "AE1-RA2" that are both enabled in the structural data as “exclusion”. The SIS dataset disables “AE1-RA1” and “AE1-RA2” for hour 1 and hour 2, but SSI dataset enables “AE1-RA1” for hour 1. Therefore, when RAO prepares the study of hour 1, a violation of “AE1” will be resolved by one of all enabled remedial actions for hour 1 except “RA1" as the “exclusion” “AE1-RA1” is enabled in SSI dataset and the “exclusion” “AE1-RA2” remains disabled by SIS dataset.

- Depending on the design of the remedial actions and assessed elements some combinations between assessed element and remedial action can be defined as “included” and some as “considered”. This will provide information to RAO that first the remedial actions that are “included” need to be optimised and if they are not able to resolve the violation some of the “considered” remedial actions can be studied/optimised. This approach can potentially be used with the design to include multiple remedial actions in a group and describe the dependency between the remedials actions in this group. The level of complexity increases and the guidance is to use this only when it is necessary and represents the real behaviour of these remedial actions.

This example shows how to specify an Assessed Element with a “Tap Position” Remedial Action.

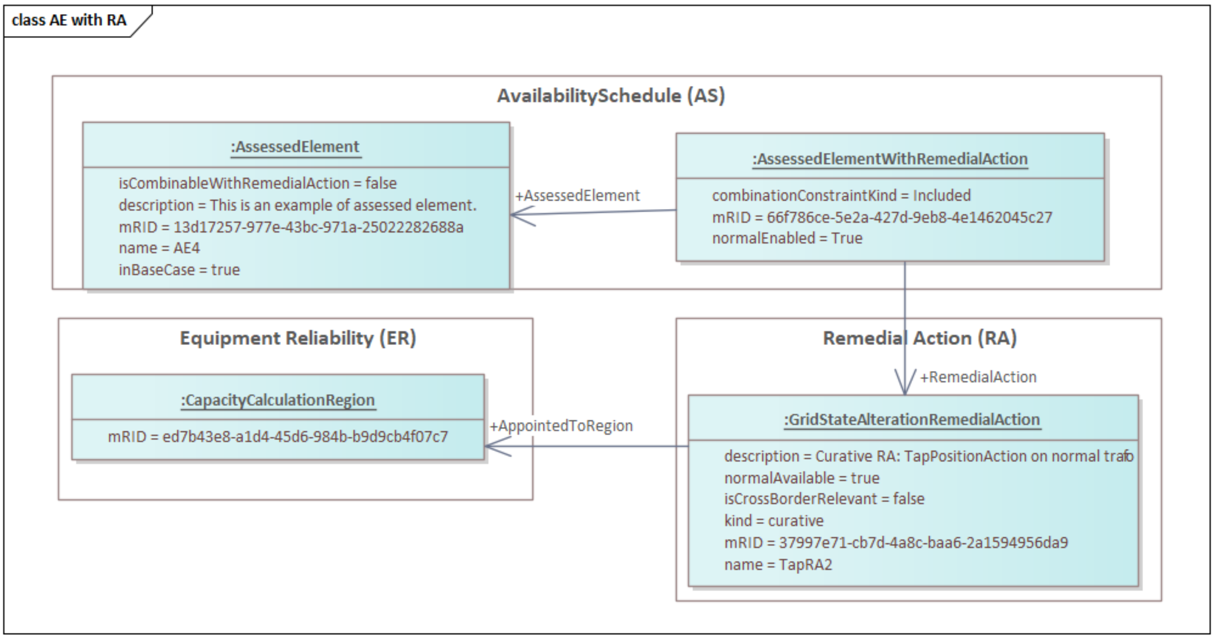


Figure 17 – Assessed Element with Remedial Action.

The corresponding Assessed Element dataset snippet is as follows:


```
<nc:AssessedElement rdf:ID="_13d17257-977e-43bc-971a-25022282688a">
  <cim:IdentifiedObject.name>AE4</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of assessed element.</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>13d17257-977e-43bc-971a-25022282688a</cim:IdentifiedObject.mRID>
  <nc:AssessedElement.ConductingEquipment rdf:resource="#_550ebe0d-f2b2-48c1-991f-cebea43a21aa"/>
  <nc:AssessedElement.ScannedForRegion rdf:resource="#_5179eb50-d943-451c-af81-194bdf9505e5"/>
  <nc:AssessedElement.AssessedSystemOperator rdf:resource="#_517cc7b9-df0c-4065-a5f2-2b8d7d9c1457"/>
  <nc:AssessedElement.isCombinableWithRemedialAction>false</nc:AssessedElement.isCombinableWithRemedialAction>
  <nc:AssessedElement.inBaseCase>true</nc:AssessedElement.inBaseCase>
</nc:AssessedElement>
<nc:AssessedElementWithRemedialAction rdf:ID="_66f786ce-5e2a-427d-9eb8-4e1462045c27">
  <nc:AssessedElementWithRemedialAction.mRID>66f786ce-5e2a-427d-9eb8-
4e1462045c27</nc:AssessedElementWithRemedialAction.mRID>
  <nc:AssessedElementWithRemedialAction.RemedialAction rdf:resource="#_37997e71-cb7d-4a8c-baa6-2a1594956da9"/>
  <nc:AssessedElementWithRemedialAction.AssessedElement rdf:resource="#_13d17257-977e-43bc-971a-25022282688a"/>
  <nc:AssessedElementWithRemedialAction.combinationConstraintKind
rdf:resource="https://cim4.eu/ns/nc#ElementCombinationConstraintKind.included"/>
  <nc:AssessedElementWithRemedialAction.normalEnabled>true</nc:AssessedElementWithRemedialAction.normalEnabled>
</nc:AssessedElementWithRemedialAction>
```

The snippet in RemedialAction dataset for a tap position remedial action is as shown below. Note that other remedial action types are possible.

```xml
<nc:GridStateAlterationRemedialAction rdf:ID="_37997e71-cb7d-4a8c-baa6-2a1594956da9">
  <cim:IdentifiedObject.mRID>37997e71-cb7d-4a8c-baa6-2a1594956da9</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>TapRA2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>Curative RA: TapPositionAction on normal trafo (MV Tap to 33) TapChangerID :
_fe25f43a-7341-446e-a71a-8ab7119ba806</cim:IdentifiedObject.description>
  <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
  <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
  <nc:RemedialAction.isCrossBorderRelevant>false</nc:RemedialAction.isCrossBorderRelevant>
  <nc:RemedialAction.AppointedToRegion rdf:resource="#_ed7b43e8-a1d4-45d6-984b-b9d9cb4f07c7"/>
</nc:GridStateAlterationRemedialAction>
```

7.1.5.7 Overlapping Assessed Element

This will be specified in the next version of the document.

7.1.5.8 Expected Use Cases

The following expected use cases are not explained in full detail. The next versions of the document could include more details. This list is also not exhaustive.

Table 6 – Expected Use Cases Related to Assessed Element

Name	Description	Comment
Non-overlapping XNE in a CCR	A line is XNE / secured for a CCR. CNE status can be TRUE or FALSE	consider also how element should be modelled/represented in the other CCR
Overlapping XNE in a CCR	A line is XNE / secured for a CCR. CNE status can be TRUE or FALSE and the XNE is considered overlapping for another CCR.	consider also how element should be modelled/represented in the other CCR
Excluded XNE 1	A line is EXCLUDED for a CCR because it is a e.g. powerplant line (=Internal reason). Scanned status in that CCR = TRUE or FALSE.	consider also how element should be modelled/represented in the other CCR
Excluded XNE 2	A line is EXCLUDED for a CCR (e.g. Core) because Core TSO-s agreed so (=EXCLUDED CORE reason). Scanned status in Core = TRUE or FALSE	consider also how element should be modelled/represented in the other CCR
Excluded XNE 3	A line is EXCLUDED for a CCR (e.g. Core) because it is XNE/secured for other CCR (=OTHER CCR reason). Element is overlapping. Scanned status in Core = TRUE or FALSE (Is overlapping a MUST in this case?)	consider also how element should be modelled/represented in the other CCR
Additional Scanned Element	A line (line < 220 kV) is AdditionalElement in a CCR (e.g. Core) and is Scanned for Core	consider also how element should be modelled/represented in the other CCR
Future XNE	A line is scheduled to be put into operation in Q4 of the next year as XNE/Secured in a CCR (e.g. Core)	consider also how element should be modelled/represented in the other CCR

Update of XNE region	A line is to be XNE/secured for first 6 months in a CCR (e.g. Core) and EXCLUDED-SCANNED in Other CCR. For other 6 months line is to be EXCLUDED-SCANNED in Core and XNE/secured for Other CCR. Exclusion reason is always Other CCR	
Update of XNE Limits - PATL	Update of Security Limits of Assessed Elements (PATL), valid only for specific hours	
Update of XNE Limits - TATL	Update of Security Limits of Assessed Elements (TATL), valid only for specific hours	
Re-inclusion of XNE (excluded to XNE)	A line is EXCLUDED in a CCR (e.g. Core), but for specific CROSA needs to be reincluded as XNE for Core.	
Exclusion of specific XNECs in Offline process	A combination of XNE / Contingency in a CCR (e.g. Core) that do not need to be addressed in ROSC	
Ad hoc Exclusion of specific XNEC	A combination of XNE / Contingency in a CCR (e.g. Core) that do not need to be addressed in CROSA (complete or certain hours) exceptionally because more efficiently addressed outside CROSA	

7.1.6 Contingency List

The Contingency List provision is illustrated in Figure 18.

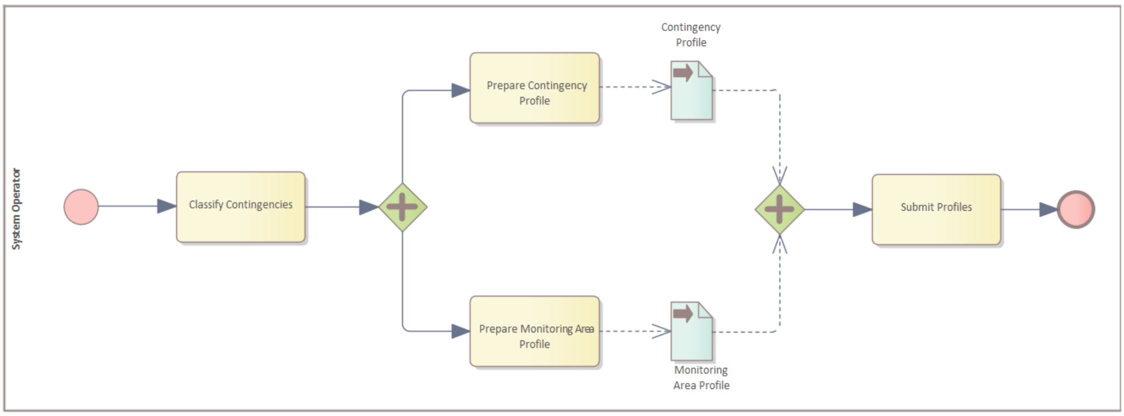


Figure 18 – Contingency list provision

The first step is to classify the contingencies as one of the three types illustrated in the category diagram shown in Figure 19.

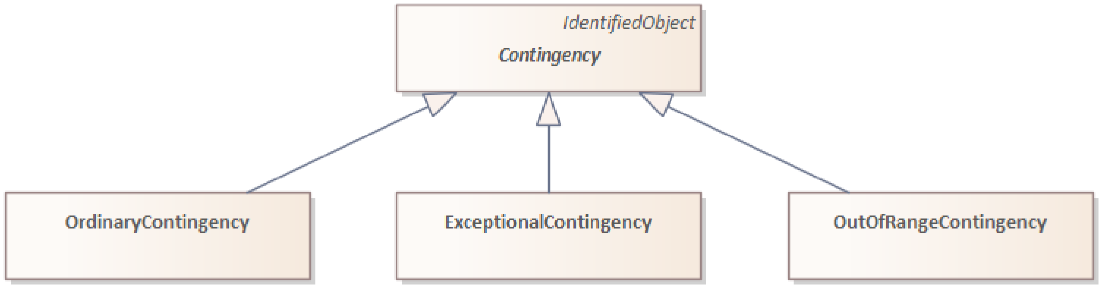


Figure 19 – Contingency category diagram

Contingencies classified as ordinary and as exceptional (fulfilling the criteria specified in CSAm art.10.1) shall be included in the Contingency List dataset. TSOs can also include external exceptional contingencies when they potentially endanger the operational security of its transmission system (CSAm art.10.3).
The Contingency profile is the main profile used for the delivery of the contingency list dataset. The Contingency class is instantiated to represent each contingency record in the list. Each instance can be linked to one or more equipment (e.g., a transmission line terminal) in the Equipment (EQ) profile through their unique mRID (Master Resource Identifier). It is possible to define if a contingency should be considered in the security analysis by properly setting the Contingency parameter normalMustStudy. The permanent and temporary occurrence increasing factor types (CSAm art.8.3) for each exceptional contingency can be defined in the ContingencyConditionKind enumeration.

The specification of the external exceptional contingencies from the list is done using the Monitoring Area profile. The external contingencies that are included in the contingency list of a System Operator are the contingencies which are in the Contingency Area also defined using the Monitoring Area profile. An example of monitoring area definition is provided in section 7.1.10.

7.1.6.1 Ordinary Contingency

This example illustrates how to specify an Ordinary Contingency.

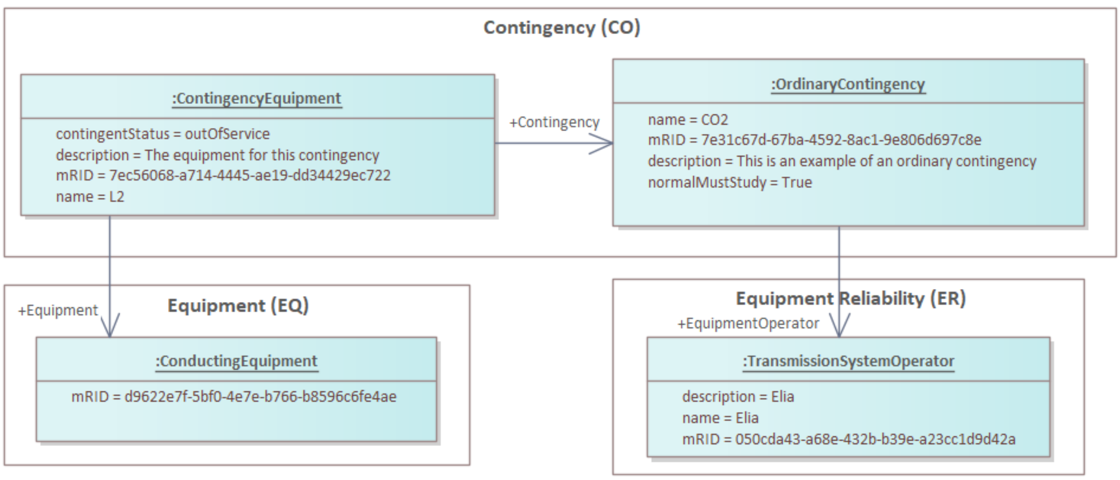


Figure 20 – Ordinary Contingency

The corresponding Contingency dataset snippet is as follows.

```
<nc:OrdinaryContingency rdf:ID="_7e31c67d-67ba-4592-8ac1-9e806d697c8e">
```

```xml
  <cim:IdentifiedObject.name>CO2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an ordinary contingency;Tie Line
loss</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7e31c67d-67ba-4592-8ac1-9e806d697c8e</cim:IdentifiedObject.mRID>
  <nc:Contingency.EquipmentOperator rdf:resource="#_050cda43-a68e-432b-b39e-a23cc1d9d42a"/>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
</nc:OrdinaryContingency>
<cim:ContingencyEquipment rdf:ID="_7ec56068-a714-4445-ae19-dd34429ec722">
  <cim:IdentifiedObject.name>L2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>The equipment for this contingency; Tie Line
loss</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7ec56068-a714-4445-ae19-dd34429ec722</cim:IdentifiedObject.mRID>
  <cim:ContingencyElement.Contingency rdf:resource="#_7e31c67d-67ba-4592-8ac1-9e806d697c8e"/>
  <cim:ContingencyEquipment.contingentStatus
rdf:resource="https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfService"/>
  <cim:ContingencyEquipment.Equipment rdf:resource="#_d9622e7f-5bf0-4e7e-b766-b8596c6fe4ae"/>
</cim:ContingencyEquipment>
```


The Equipment Reliability dataset snippet is as follows:


```xml
<nc:TransmissionSystemOperator rdf:ID="_050cda43-a68e-432b-b39e-a23cc1d9d42a ">
  <cim:IdentifiedObject.mRID>050cda43-a68e-432b-b39e-a23cc1d9d42a</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.description>Elia</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.name>Elia</cim:IdentifiedObject.name>
</nc:TransmissionSystemOperator>
```


The following remarks apply to this example:

- Similar to AssessedElement, the Contingency has a logic which allows a given Contingency to be active in the study (to be performed in a contingency analysis). The attribute normalMustStudy in the structural data is used for this purpose. ContingencyTimePoint.mustStudy is exchanged in the SIS dataset and Contingency.mustStudy is exchanged in the SSI dataset. The logic presented in 7.1.3 is followed. This is not specific for ordinary contingency and applies to all other types of contingencies.

7.1.6.2 Exceptional Contingency

This example illustrates how to specify an Exceptional Contingency.

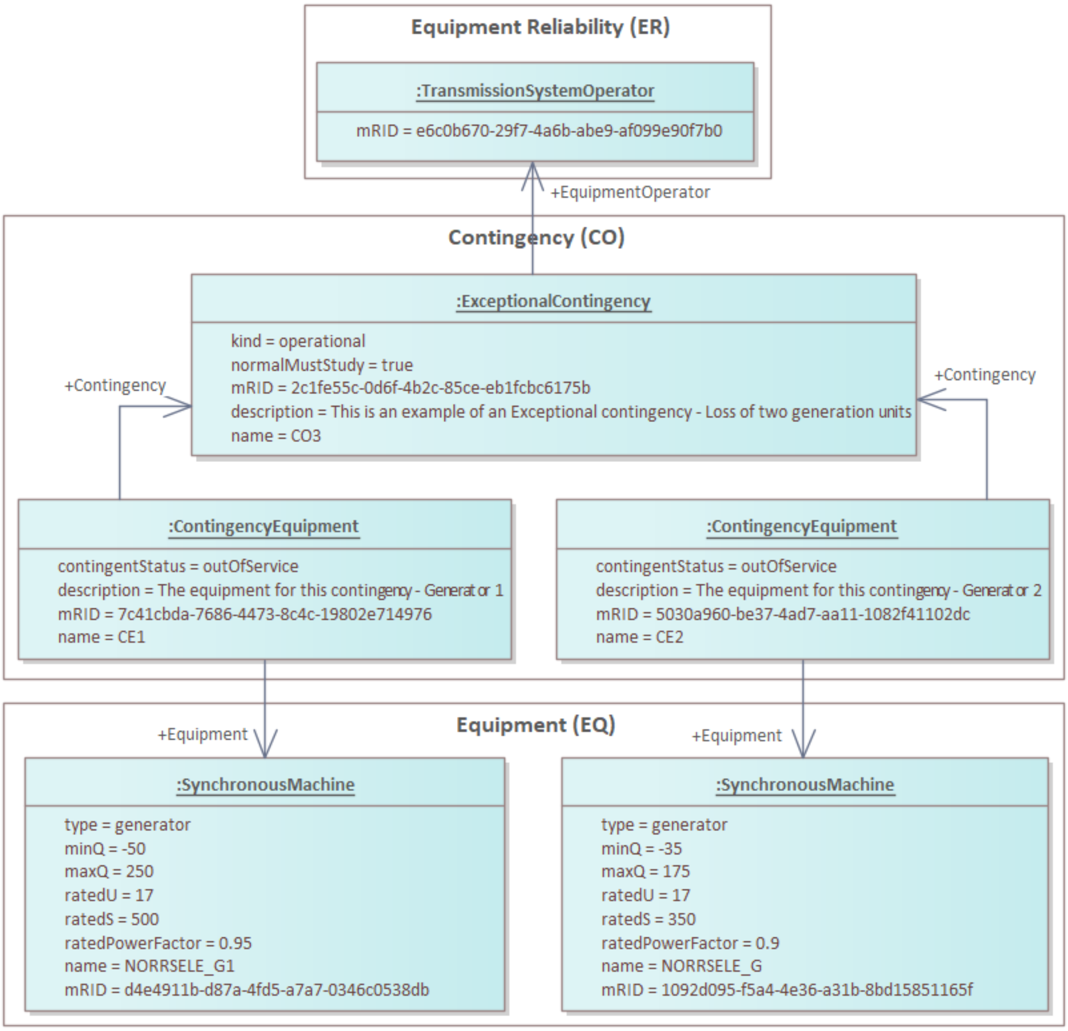


Figure 21 - Exceptional Contingency

The Contingency dataset snippet is as follows.


```
<cim:ContingencyEquipment rdf:ID=”_7c41cbda-7686-4473-8c4c-19802e714976”>
  <cim:IdentifiedObject.name>CE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>The equipment for this contingency – Generator
1</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7c41cbda-7686-4473-8c4c-19802e714976</cim:IdentifiedObject.mRID>
  <cim:ContingencyElement.Contingency rdf:resource=”#_2c1fe55c-0d6f-4b2c-85ce-eb1fcbc6175b”/>
  <cim:ContingencyEquipment.contingentStatus
rdf:resource=”https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfService”/>
  <cim:ContingencyEquipment.Equipment rdf:resource=”#_d4e4911b-d87a-4fd5-a7a7-0346c0538db3”/>
</cim:ContingencyEquipment>
<cim:ContingencyEquipment rdf:ID=”_5030a960-be37-4ad7-aa11-1082f41102dc”>
  <cim:IdentifiedObject.name>CE2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>The equipment for this contingency – Generator
2</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>5030a960-be37-4ad7-aa11-1082f41102dc</cim:IdentifiedObject.mRID>
  <cim:ContingencyElement.Contingency rdf:resource=”#_2c1fe55c-0d6f-4b2c-85ce-eb1fcbc6175b”/>
  <cim:ContingencyEquipment.contingentStatus
rdf:resource=”https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfService”/>
  <cim:ContingencyEquipment.Equipment rdf:resource=”#_1092d095-f5a4-4e36-a31b-8bd15851165f”/>
</cim:ContingencyEquipment>
<nc:ExceptionalContingency rdf:ID=”_2c1fe55c-0d6f-4b2c-85ce-eb1fcbc6175b”>
  <cim:IdentifiedObject.name>CO3</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an Exceptional contingency – Loss of two generation
units</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>2c1fe55c-0d6f-4b2c-85ce-eb1fcbc6175b</cim:IdentifiedObject.mRID>
  <nc:Contingency.EquipmentOperator rdf:resource=”#_e6c0b670-29f7-4a6b-abe9-af099e90f7b0”/>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
  <nc:ExceptionalContingency.kind rdf:resource=”https://cim4.eu/ns/nc#ContingencyConditionKind.operational”/>

</nc:ExceptionalContingency>
```

The Equipment dataset snippet is as follows.

```xml
<cim:SynchronousMachine rdf:ID="_d4e4911b-d87a-4fd5-a7a7-0346c0538db3">
  <cim:Equipment.EquipmentContainer rdf:resource="#_a7f5e1c1-d18a-473d-905f-cb13d4711d89" />
  <cim:IdentifiedObject.mRID>d4e4911b-d87a-4fd5-a7a7-0346c0538db3</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>NORRSELE_G1</cim:IdentifiedObject.name>
  <cim:RegulatingCondEq.RegulatingControl rdf:resource="#_51b004dd-fb43-5c9b-85a8-3b04bd4a7f6c" />
  <cim:RotatingMachine.GeneratingUnit rdf:resource="#_8f6d7917-dd59-b418-d4f2-58dc5fc259e3" />
  <cim:RotatingMachine.ratedPowerFactor>0.95</cim:RotatingMachine.ratedPowerFactor>
  <cim:RotatingMachine.ratedS>500</cim:RotatingMachine.ratedS>
  <cim:RotatingMachine.ratedU>17</cim:RotatingMachine.ratedU>
  <cim:SynchronousMachine.maxQ>250</cim:SynchronousMachine.maxQ>
  <cim:SynchronousMachine.minQ>-50</cim:SynchronousMachine.minQ>
  <cim:SynchronousMachine.type rdf:resource="https://cim.ucaiug.io/ns#SynchronousMachineKind.generator" />
</cim:SynchronousMachine>
<cim:SynchronousMachine rdf:ID="_1092d095-f5a4-4e36-a31b-8bd15851165f">
  <cim:Equipment.EquipmentContainer rdf:resource="#_a7f5e1c1-d18a-473d-905f-cb13d4711d89" />
  <cim:IdentifiedObject.mRID>1092d095-f5a4-4e36-a31b-8bd15851165f</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>NORRSELE_G2</cim:IdentifiedObject.name>
  <cim:RegulatingCondEq.RegulatingControl rdf:resource="#_ee9064e4-3f25-e88e-8c7b-66763e94050a" />
  <cim:RotatingMachine.GeneratingUnit rdf:resource="#_f899aef4-6912-8989-23e3-0fe63e1852f3" />
  <cim:RotatingMachine.ratedPowerFactor>0.9</cim:RotatingMachine.ratedPowerFactor>
  <cim:RotatingMachine.ratedS>350</cim:RotatingMachine.ratedS>
  <cim:RotatingMachine.ratedU>17</cim:RotatingMachine.ratedU>
  <cim:SynchronousMachine.maxQ>175</cim:SynchronousMachine.maxQ>
  <cim:SynchronousMachine.minQ>-35</cim:SynchronousMachine.minQ>
  <cim:SynchronousMachine.type rdf:resource="https://cim.ucaiug.io/ns#SynchronousMachineKind.generator" />
</cim:SynchronousMachine>
```

For simplicity, some parts of the Equipment dataset snippet are not represented in the diagram (e.g., association of the SynchrounousMachine objects with EquipmentContainer and RegulatingControl objects).

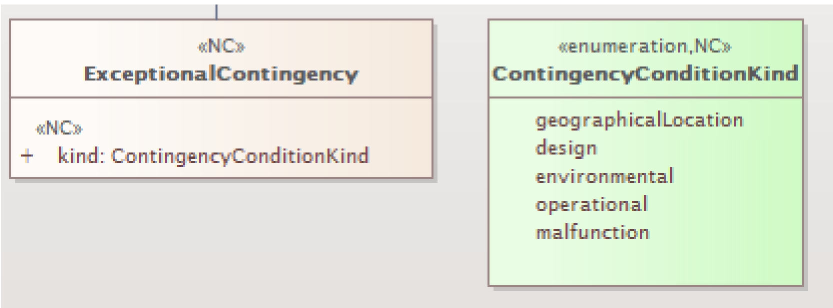
In line with CSAm Article 8, each TSO shall determine for each exceptional contingency the relevance and criteria of application of the following occurrence increasing factors:

(a) permanent occurrence increasing factors

(b) temporary occurrence increasing factors

From ROSC perspective, the exceptional contingencies are therefore split into permanent and temporary exceptional contingencies. Permanent exceptional contingencies are always included in the Daily ROSC process while temporary exceptional contingencies are included only in case a TSO requests the inclusion during daily process.

The distinction between permanent and temporary exceptional contingency is implemented by defining the ContingencyConditionKind for each ExceptionalContingency as given below:



- Permanent exceptional contingency is defined by ContingencyConditionKind: geographicalLocation or design

- Temporary exceptional contingency is defined by ContingencyConditionKind: environmental, operational or malfunction

By default, for all temporary exceptional contingencies mustStudy shall be set to false in the structural data. Afterwards, in case it is required by TSO to include it during the daily process via SSI / SIS profile the value of mustStudy is changed to true for specific time period.

7.1.6.3 Out-of-range Contingency

This example illustrates how to specify an out-of-range Contingency.

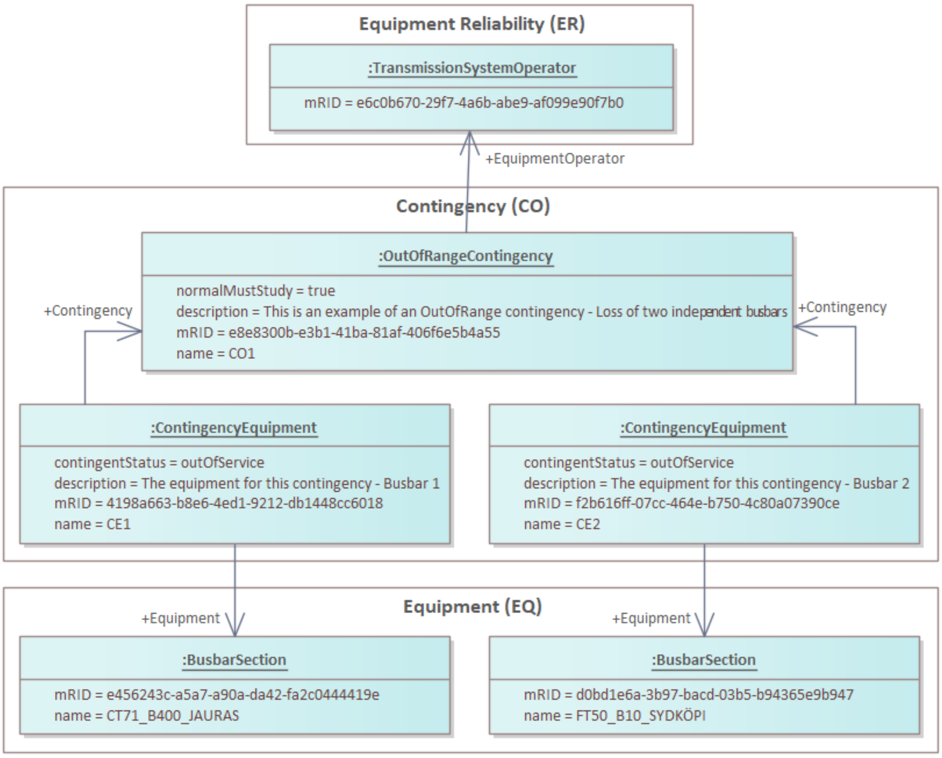


Figure 22 - Out of Range Contingency

The Contingency dataset snippet is as follows.


```
<cim:ContingencyEquipment rdf:ID="_4198a663-b8e6-4ed1-9212-db1448cc6018">
  <cim:IdentifiedObject.name>CE1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>The equipment for this contingency - Busbar 1</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>4198a663-b8e6-4ed1-9212-db1448cc6018</cim:IdentifiedObject.mRID>
  <cim:ContingencyElement.Contingency rdf:resource="#_e8e8300b-e3b1-41ba-81af-406f6e5b4a55"/>
  <cim:ContingencyEquipment.contingentStatus
rdf:resource="https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfService"/>
  <cim:ContingencyEquipment.Equipment rdf:resource="#_e456243c-a5a7-a90a-da42-fa2c0444419e"/>
</cim:ContingencyEquipment>
<cim:ContingencyEquipment rdf:ID="_f2b616ff-07cc-464e-b750-4c80a07390ce">
  <cim:IdentifiedObject.name>CE2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>The equipment for this contingency - Busbar 2</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>f2b616ff-07cc-464e-b750-4c80a07390ce</cim:IdentifiedObject.mRID>
  <cim:ContingencyElement.Contingency rdf:resource="#_e8e8300b-e3b1-41ba-81af-406f6e5b4a55"/>
  <cim:ContingencyEquipment.contingentStatus
rdf:resource="https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfService"/>
  <cim:ContingencyEquipment.Equipment rdf:resource="#_d0bd1e6a-3b97-bacd-03b5-b94365e9b947"/>
</cim:ContingencyEquipment>
<nc:OutOfRangeContingency rdf:ID="_e8e8300b-e3b1-41ba-81af-406f6e5b4a55">
  <cim:IdentifiedObject.name>CO1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an OutOfRange contingency - Loss of two independent
busbars</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>e8e8300b-e3b1-41ba-81af-406f6e5b4a55</cim:IdentifiedObject.mRID>
  <nc:Contingency.EquipmentOperator rdf:resource="#_e6c0b670-29f7-4a6b-abe9-af099e90f7b0"/>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
</nc:OutOfRangeContingency>
```


The Equipment dataset snippet is as follows.


```
<cim:BusbarSection rdf:ID="_e456243c-a5a7-a90a-da42-fa2c0444419e">
  <cim:Equipment.EquipmentContainer rdf:resource="#_007dedc8-ce4f-4f2c-b424-bc7b8fe1da30" />
  <cim:IdentifiedObject.mRID>e456243c-a5a7-a90a-da42-fa2c0444419e</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>CT71_B400_JAURAS</cim:IdentifiedObject.name>
</cim:BusbarSection>
<cim:BusbarSection rdf:ID="_d0bd1e6a-3b97-bacd-03b5-b94365e9b947">
  <cim:Equipment.EquipmentContainer rdf:resource="#_8eb93370-c564-4279-9b11-57b6a3f95e5c" />
  <cim:IdentifiedObject.mRID>d0bd1e6a-3b97-bacd-03b5-b94365e9b947</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>FT50_B10_SYDKÖPI</cim:IdentifiedObject.name>
</cim:BusbarSection>
```

```
<cim:VoltageLevel rdf:ID="_007dedc8-ce4f-4f2c-b424-bc7b8fe1da30">
  <cim:IdentifiedObject.mRID>007dedc8-ce4f-4f2c-b424-bc7b8fe1da30</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>JAURAS_4_CT71</cim:IdentifiedObject.name>
  <cim:VoltageLevel.BaseVoltage rdf:resource="#_597e44dc-2a6e-4c62-82f3-f82cc46e0e14" />
  <cim:VoltageLevel.Substation rdf:resource="#_eb3b03b0-d562-47d9-ad7a-90a433ddc0ac" />
</cim:VoltageLevel>
<cim:VoltageLevel rdf:ID="_8eb93370-c564-4279-9b11-57b6a3f95e5c">
  <cim:IdentifiedObject.mRID>8eb93370-c564-4279-9b11-57b6a3f95e5c</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>SYDKÖPIN_11_FT50</cim:IdentifiedObject.name>
  <cim:VoltageLevel.BaseVoltage rdf:resource="#_12b77529-a0cf-fed0-ae74-6912bb5fac8d" />
  <cim:VoltageLevel.Substation rdf:resource="#_97a2eca6-bf41-447c-8786-ca82736395d9" />
</cim:VoltageLevel>
```


For simplicity, some parts of the Equipment dataset snippet are not represented in the diagram (e.g., association of the SynchrounousMachine objects with EquipmentContainer and RegulatingControl objects).

7.1.7 List of Remedial Actions

The List of Remedial Actions provision process is illustrated in Figure 23.

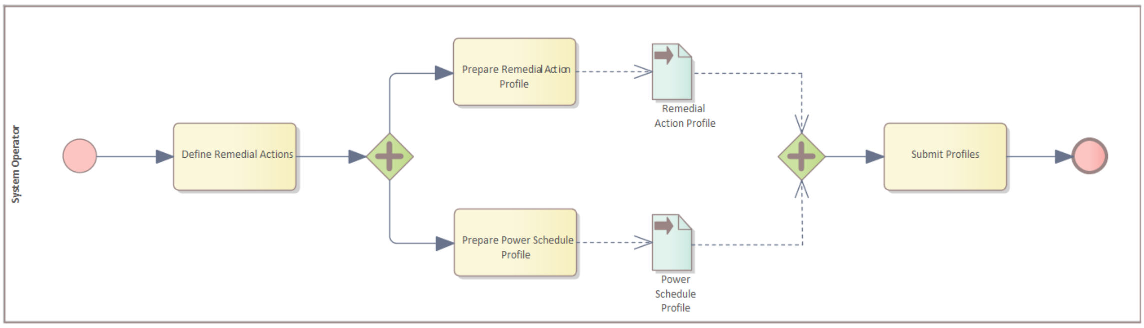
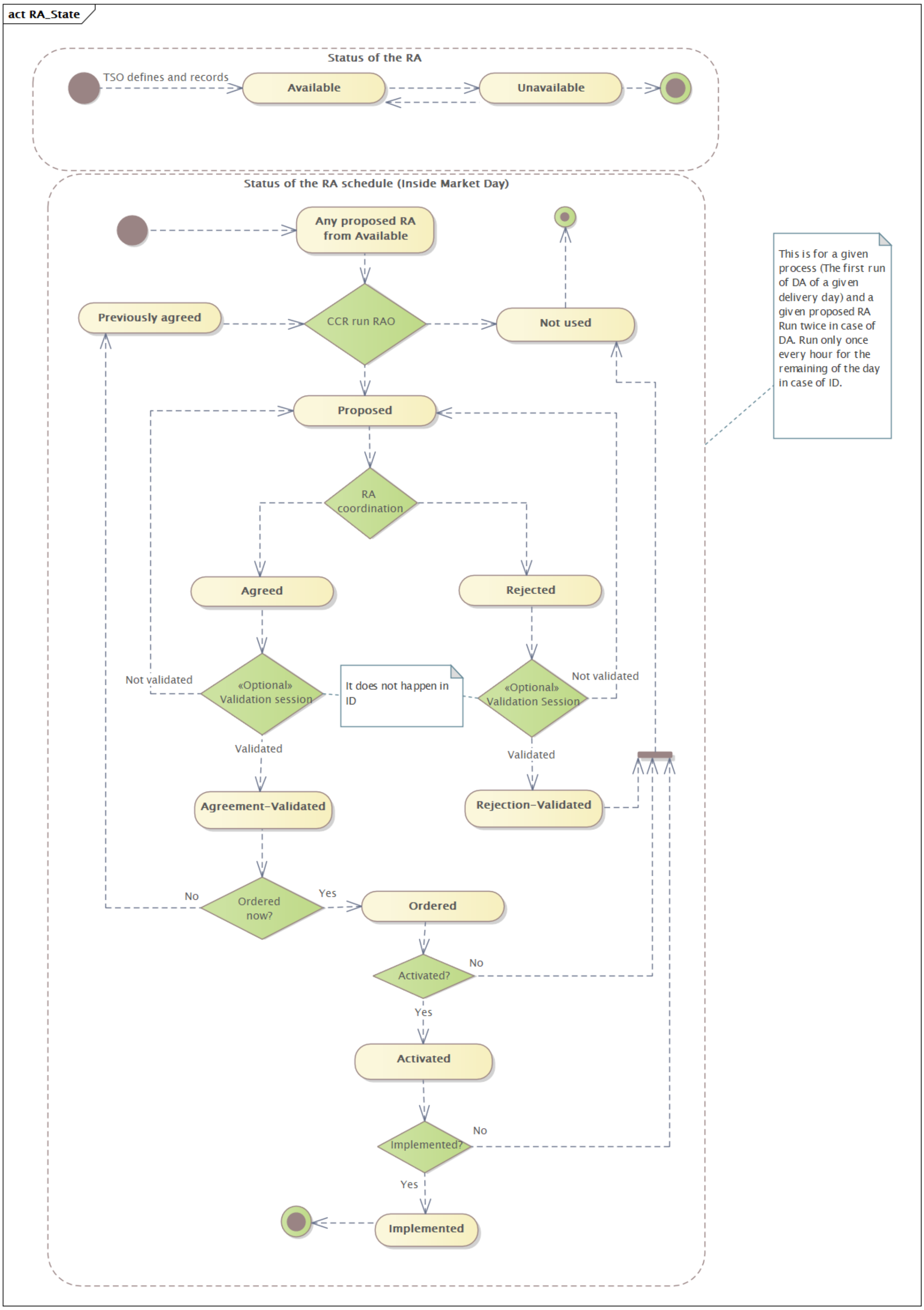


Figure 23 – List of Remedial Actions provision

System operator can define a set of remedial actions as part of the structural data. Once defined, a remedial action can be considered as available (depending on the value of normalAvailable and data provided in SIS or SSI datasets), in this case the remedial action can be considered when running the business process or unavailable in case that a remedial action cannot be used (upper part of Figure 24). In case that a remedial action is not needed anymore, once it is disabled, it can be archived for tracking and historic purposes.
The Remedial Action profile is used for the provision of the list of Remedial Actions. Additionally, the Power Schedule profile can be used depending on the use case.

1556 

1557 **Figure 24 – Remedial action state diagram**

1558

All available remedial actions can be used for the remedial action optimization process which will choose the most appropriate remedial actions to solve the different issues in the scenario. These remedial actions are denominated as proposed remedial actions.

Just after the remedial action optimisation process is finished, remedial action coordination starts. If it passes the coordination, the remedial action can be agreed or rejected. These two states must be validated during the validation session. If they are not finally validated, they become proposed again.

In case that a rejected remedial action is validated, then it becomes Rejection-Validated. On the other hand, if the agreed remedial action is validated, then it becomes Agreement-Validated. Agreement-Validated remedial actions can be ordered now or in a later stage. In case that a remedial action is not ordered now, then it becomes a previously agreed remedial action. If it is ordered now, then the remedial action changes its status to Ordered. Ordered means that the SO sends the order to the corresponding party to proceed with the RA, and in most cases ordered means it is a binding order (could be that still, in an exceptional case, the RA could be cancelled after being ordered) In case that an ordered RA is not finally activated, then it becomes Not used. After ordered, the RA can become activated in which the forecast case is updated with regards to the acceptance criteria. In case that an activated RA is not finally implemented, then it becomes Not used. However, if the activated RA is implemented, then it becomes Implemented and the process finishes.

The following types of remedial actions can be defined:

- Grid state alteration remedial action – describes one or many grid state alterations applied to a grid model state or a particular scenario in order to resolve one or more identified constraints.
- Scheme remedial action – involves a scheme that can include conditional logic and stages of grid alteration. The primary remedial action is the arming of these schemes, which will then perform curative remedial action when the condition is met. System Integrity Protection Scheme (SIPS) and Special Protection Scheme (SPS) are example of this. Scheme remedial actions can be coordinable or non-coordinable.
- Redispatch remedial action - Redispatch means a measure, including curtailment, that is activated by one or more transmission system operators or distribution system operators by altering the generation, load pattern, or both, in order to change physical flows in the electricity system and relieve a physical congestion or otherwise ensure system security (Regulation (EU) 2019/943). In its essence from CSA perspective, redispatch remedial action is always defined by potential increase or decrease of power infeed in a known location, i.e. exact node of the grid model.
- Countertrade remedial action - Countertrade means a trade between bidding zone to solve a congestion. Therefore, a countertrade remedial action means a measure performed by one or several TSOs in one or several bidding zones in order to relieve physical congestions where the location of activated resources within the bidding zone is not known. A countertrade offer by a TSO is in general based on some existing third party bids since a TSO shall not offer countertrade randomly and risk whether it can really provide it. Therefore, countertrade can be associated to:
    - bid from the market
    - bid from tertiary energy providers (which is a control area bid, not associated to a specific unit by its definition).

  A countertrade offer, which a TSO offers to RAO, consists of a merit order of MW-price blocks which are actually individual discrete bids and shall contain additional parameters which are currently defined in PowerBidSchedule (i.e., lead time, step increment, max activation).

  In order to allow correct modelling of countertrade offer within the grid model, the countertrade remedial action is linked to a GLSK (provided in ER dataset) which defines how a change in the balance / net position (single value) of a zone is transformed into a set of values of delta injections in specified nodes (multiple values) of a certain grid model. By default, a countertrade is associated to the so-called "country GSK" meaning an increase of infeed proportional to the remaining available capacity on all generating units within a bidding zone, excluding nuclear and renewable types.
- Availability remedial action - cancels or reschedules an availability schedule.

A remedial action can include multiple grid state alteration and this is necessary in order to model multiple actions within one remedial action. The design depends on the business need and the complexity of the remedial action that needs to be modelled. For instance, a topology action would in most of the cases act on multiple switches to achieve a change in a substation topology. In addition, remedial actions can be grouped into groups, and the dependency between them specified.

The following sections illustrate several remedial actions that are often used by system operator.

7.1.7.1 Grid State Alteration Remedial Action – Tap position

This example illustrates how to specify a Grid State Alteration Remedial Action.

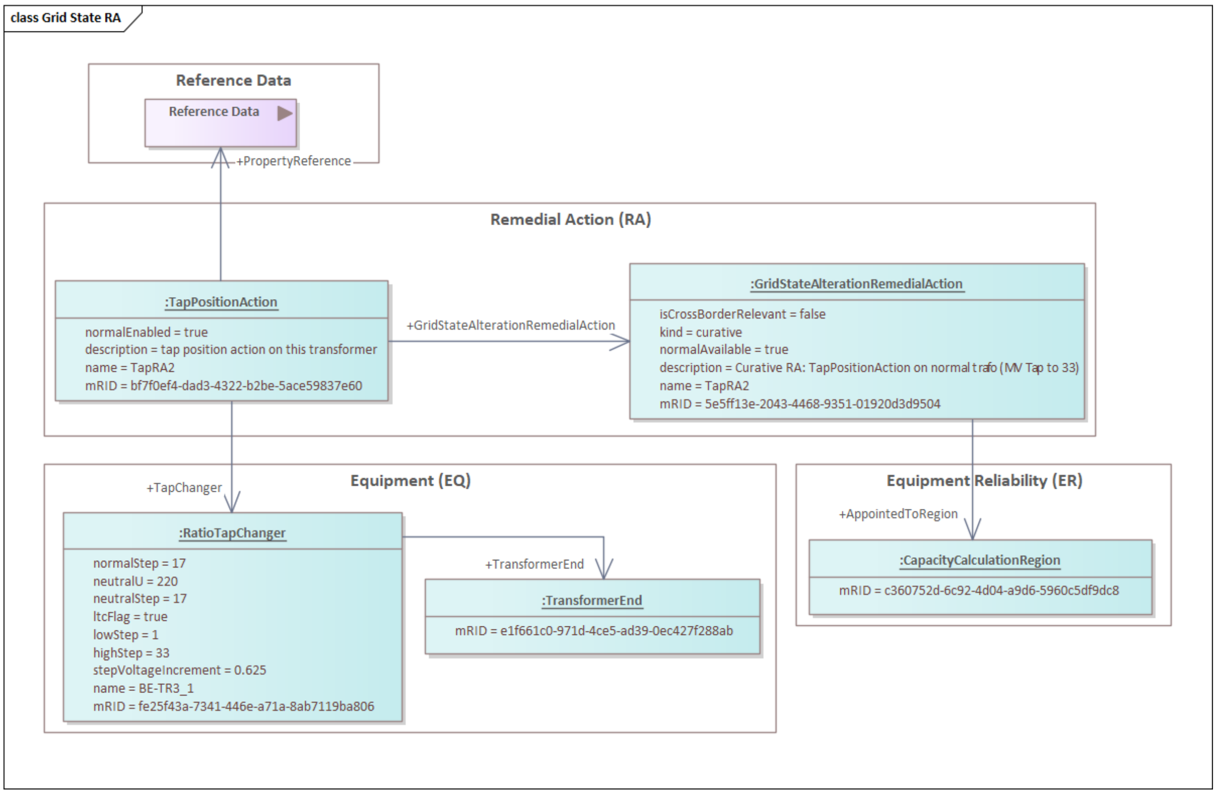


Figure 25 - Grid State Alteration (Tap Position) Example

The corresponding Remedial Action dataset snippet is as follows:

```
<nc:GridStateAlterationRemedialAction rdf:ID="_5e5ff13e-2043-4468-9351-01920d3d9504">
   <cim:IdentifiedObject.mRID>5e5ff13e-2043-4468-9351-01920d3d9504</cim:IdentifiedObject.mRID>
   <cim:IdentifiedObject.name>TapRA2</cim:IdentifiedObject.name>
   <cim:IdentifiedObject.description>Curative RA: TapPositionAction on normal trafo (MV Tap to 33) TapChangerID :
_fe25f43a-7341-446e-a71a-8ab7119ba806</cim:IdentifiedObject.description>
   <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
   <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
   <nc:RemedialAction.isCrossBorderRelevant>false</nc:RemedialAction.isCrossBorderRelevant>
   <nc:RemedialAction.AppointedToRegion rdf:resource="#_c360752d-6c92-4d04-a9d6-5960c5df9dc8"/>
</nc:GridStateAlterationRemedialAction>
<nc:TapPositionAction rdf:ID="_bf7f0ef4-dad3-4322-b2be-5ace59837e60">
   <cim:IdentifiedObject.mRID>bf7f0ef4-dad3-4322-b2be-5ace59837e60</cim:IdentifiedObject.mRID>
   <cim:IdentifiedObject.name>TapRA2</cim:IdentifiedObject.name>
   <cim:IdentifiedObject.description>tap position action </cim:IdentifiedObject.description>
   <nc:GridStateAlteration.PropertyReference
rdf:resource="https://energy.referencedata.eu/PropertyReference/TapChanger.step"/>
   <nc:GridStateAlteration.GridStateAlterationRemedialAction rdf:resource="#_5e5ff13e-2043-4468-9351-01920d3d9504"/>
   <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
   <nc:TapPositionAction.TapChanger rdf:resource="#_fe25f43a-7341-446e-a71a-8ab7119ba806"/>
</nc:TapPositionAction>
```

The corresponding Equipment dataset snippet is as follows:

```
<cim:RatioTapChanger rdf:ID="_fe25f43a-7341-446e-a71a-8ab7119ba806">
  <cim:IdentifiedObject.mRID>fe25f43a-7341-446e-a71a-8ab7119ba806</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>BE-TR3_1</cim:IdentifiedObject.name>
  <cim:RatioTapChanger.TransformerEnd rdf:resource="#_e1f661c0-971d-4ce5-ad39-0ec427f288ab" />
<cim:RatioTapChanger.stepVoltageIncrement>0.625</cim:RatioTapChanger.stepVoltageIncrement>
  <cim:TapChanger.highStep>33</cim:TapChanger.highStep>
  <cim:TapChanger.lowStep>1</cim:TapChanger.lowStep>
  <cim:TapChanger.ltcFlag>true</cim:TapChanger.ltcFlag>
  <cim:TapChanger.neutralStep>17</cim:TapChanger.neutralStep>
  <cim:TapChanger.neutralU>220</cim:TapChanger.neutralU>
  <cim:TapChanger.normalStep>17</cim:TapChanger.normalStep>
</cim:RatioTapChanger>
```

The following remarks apply to this example :

- The diagram does not include explicit reference to the PropertyReference, but the dataset snippet indicates this.
- Depending on the setup a tap position action can be constrained to only allow tap change within a predefined range that is different than the tap changer regulation capabilities provided in the power flow part of the IGM. Constraints of this character are implemented by using StaticPropertyRange and IntertemporalPropertyRange.

7.1.7.2 Grid State Alteration Remedial Action – Topology

The example below illustrates how to specify a Grid State Alteration Topology Remedial Action.

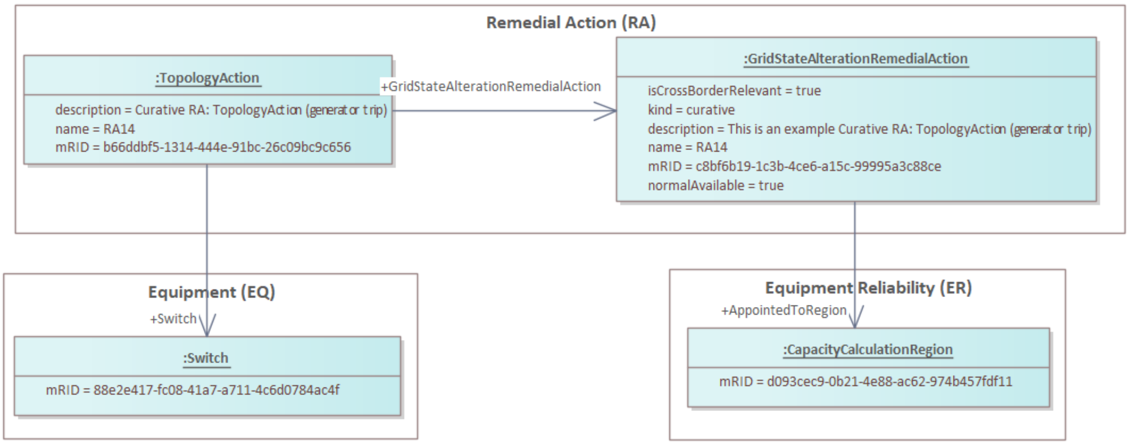


Figure 26 - Grid State Alteration (Topology) Example

The corresponding Remedial Action dataset snippet is as follows:

```
  <nc:TopologyAction rdf:ID="_b66ddbf5-1314-444e-91bc-26c09bc9c656">
    <cim:IdentifiedObject.mRID>b66ddbf5-1314-444e-91bc-26c09bc9c656</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RA14</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>Curative RA: TopologyAction (generator
trip)</cim:IdentifiedObject.description>
    <nc:GridStateAlteration.PropertyReference
rdf:resource="https://energy.referencedata.eu/PropertyReference/Switch.open"/>
    <nc:GridStateAlteration.GridStateAlterationRemedialAction rdf:resource="#_c8bf6b19-1c3b-4ce6-a15c-
99995a3c88ce"/>
    <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
    <nc:TopologyAction.Switch rdf:resource="#_88e2e417-fc08-41a7-a711-4c6d0784ac4f"/>
  </nc:TopologyAction>

  <nc:GridStateAlterationRemedialAction rdf:ID="_c8bf6b19-1c3b-4ce6-a15c-99995a3c88ce">
    <cim:IdentifiedObject.mRID>c8bf6b19-1c3b-4ce6-a15c-99995a3c88ce</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RA14</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example Curative RA: TopologyAction (generator
trip)</cim:IdentifiedObject.description>
    <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
    <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
    <nc:RemedialAction.AppointedToRegion rdf:resource="#_d093cec9-0b21-4e88-ac62-974b457fdf11"/>
  </nc:GridStateAlterationRemedialAction>
```

The following remarks apply to this example:

- It is required that topological remedial actions are modelled to act on the switches in the elements and not by indicating which element is switched. Therefore, this requires that the underlying power system model contains switching devices for at least the elements that are going to be used in topology remedial actions or any other remedial actions that require change of switching device status. This does not mean that the underlying model shall be full SCADA/EMS node-breaker model. The level of detail is driven by the need of remedial actions and the requirements in the SOGL on reporting statuses of the switching devices.
- The TSO can design the remedial action to either provide RAO with full flexibility or constrain the action that can be performed on the switching device. For instance, a remedial action can allow for a change of the status of a switch regardless of the initial status of the switch or it can instruct to only open or only close a switch. If the remedial action is designed to only open a switch and if in the grid model the switch is already open in the SSH, RAO will not be selecting this remedial action as its implementation will be pointless. This constraints on the switching devices in case of Topology grid state alteration are defined by using StaticPropertyRange. For switching devices the attribute RangeConstraint.direction can only have values RelativeDirectionKind.upAndDown (which will allow RAO to either open or close the switch) or RelativeDirectionKind.none (which instructs RAO that only the RangeConstraint.normalValue shall be applied, i.e. is normalValue is 1, which mean Switch.open should be set to true, RAO can only open the switch if the switch is closed in the base case).

The following example illustrates the usage of StaticPropertyRange to constrain a topology grid state alteration.

```
<!-- Equipment Profile -->
  <cim:RatioTapChanger rdf:ID="_ed8613d9-d80c-0e29-0b7f-cb7b1577631e">
    <cim:IdentifiedObject.mRID>ed8613d9-d80c-0e29-0b7f-cb7b1577631e</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>63-59</cim:IdentifiedObject.name>
    <cim:RatioTapChanger.TransformerEnd rdf:resource="#_cadc3373-888a-1d8b-1bb5-78c353042cf8" />
    <cim:RatioTapChanger.stepVoltageIncrement>4</cim:RatioTapChanger.stepVoltageIncrement>
    <cim:TapChanger.highStep>31</cim:TapChanger.highStep>
    <cim:TapChanger.lowStep>1</cim:TapChanger.lowStep>
    <cim:TapChanger.ltcFlag>false</cim:TapChanger.ltcFlag>
    <cim:TapChanger.neutralStep>16</cim:TapChanger.neutralStep>
    <cim:TapChanger.neutralU>220</cim:TapChanger.neutralU>
    <cim:TapChanger.normalStep>17</cim:TapChanger.normalStep>
  </cim:RatioTapChanger>

<!-- SV Profile initial -->
  <cim:SvTapStep rdf:ID="_094ff670-f9df-4a71-9880-44ac071c833d">
    <cim:SvTapStep.TapChanger rdf:resource="#_ed8613d9-d80c-0e29-0b7f-cb7b1577631e"/>
    <cim:SvTapStep.position>10</cim:SvTapStep.position>
  </cim:SvTapStep>

<!-- Remedial Action Profile -->
  <nc:TapPositionAction rdf:ID="_dbad8bad-94a9-428a-a8d6-ef6f48490e6d">
    <cim:IdentifiedObject.mRID>dbad8bad-94a9-428a-a8d6-ef6f48490e6d</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RA16</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>Curative RA: TapPositionAction</cim:IdentifiedObject.description>
    <nc:GridStateAlteration.PropertyReference
rdf:resource="https://energy.referencedata.eu/PropertyReference/TapChanger.step"/>
    <nc:GridStateAlteration.GridStateAlterationRemedialAction rdf:resource="#_2e4f4212-7b30-4316-9fce-
ca618f2a8a05"/>
    <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
    <nc:TapPositionAction.TapChanger rdf:resource="#_ed8613d9-d80c-0e29-0b7f-cb7b1577631e"/>
  </nc:TapPositionAction>

  <nc:GridStateAlterationRemedialAction rdf:ID="_2e4f4212-7b30-4316-9fce-ca618f2a8a05">
    <cim:IdentifiedObject.mRID>2e4f4212-7b30-4316-9fce-ca618f2a8a05</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RA16</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>Curative RA: TapPositionAction</cim:IdentifiedObject.description>
    <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
    <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
    <nc:RemedialAction.AppointedToRegion rdf:resource="https://energy.referencedata.eu/energy/EIC/10Y1001C--
00059P"/>
  </nc:GridStateAlterationRemedialAction>

  <nc:StaticPropertyRange rdf:ID="_451f4fdd-21ec-42c9-9386-2c42d729f01a">
    <cim:IdentifiedObject.mRID>451f4fdd-21ec-42c9-9386-2c42d729f01a</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>SPR1</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>StaticPropertyRange sample: restraining tap step change to a specific
range</cim:IdentifiedObject.description>
    <nc:RangeConstraint.direction rdf:resource="https://cim4.eu/ns/nc#RelativeDirectionKind.up"/>
    <nc:RangeConstraint.normalValue>16</nc:RangeConstraint.normalValue>
    <nc:RangeConstraint.GridStateAlteration rdf:resource="#_2e4f4212-7b30-4316-9fce-ca618f2a8a05"/>
    <nc:GridStateAlteration.PropertyReference
rdf:resource="https://energy.referencedata.eu/PropertyReference/TapChanger.step"/>
    <nc:RangeConstraint.valueKind rdf:resource="https://cim4.eu/ns/nc#ValueOffsetKind.absolute"/>
  </nc:StaticPropertyRange>
```

As it can be seen in the above example, the allowed range for tap step change (PropertyReference) is “up” (RangeConstraint.direction), which means that RAO can only apply tap steps of “absolute” value (RangeConstraint.valueKind) of “higher than 16” (RangeConstraint.normalValue), even though the tap changer step can physically have values from 1 to 31 (as seen in the EQ snippet). Therefore, the new solution will not have SvTapStep.position of 10 as given in the “initial” SV of the IGM.

7.1.7.3 Power Remedial Actions: Countertrade and Redispatch

7.1.7.3.1 Design options

There are four option that use different mechanisms to realise the countertrade and redispatch remedial actions.

- Option 1: Using grid state alteration

This option relies on grid state alterations remedial actions which requires that a GridStateAlteration is defined for each of the generating units part of the redispatch or countertrade.

- Option 2: Using power schedule

The following classes are used:

  - In RemedialAction profile dataset
    - PowerRemedialAction refers to BiddingZone and/or BiddingZoneBorder
  - In PowerSchedule profile dataset
    - PowerSchedule objects point to PowerRemedialAction
    - One PowerSchedule object refers to one GeneratingUnit. The PowerTimePoint is used to provide information on time and power (the allocated power for the given point in time).
- Option 3: Using bid schedule

This is the only option where process can be assigned. The following classes are used:

  - In RemedialAction profile dataset
    - PowerRemedialAction refers to BiddingZone and/or BiddingZoneBorder
  - In StateInstructionSchedule profile dataset
    - PowerBidSchedule object that refers to PowerRemedialAction
    - PowerShiftKeyDistribution object refers to PowerBidSchedule
    - PowerBidSchedule has PowerBidScheduleTimePoint that provides the active power for points in time
    - PowerShiftKeyDistribution object refers to PowerShiftKeySchedule which refers to the GeneratingUnit
    - ParticipationFactorTimePoint which refers to the PowerShiftKeySchedule is used to exchange the participation factors for different points in time.
- Option 4: Using power shift key strategy

The following classes are used:

  - In RemedialAction profile dataset
    - PowerRemedialAction refers to BiddingZone and/or BiddingZoneBorder
    - PowerShiftKeyStrategy object refers to the PowerRemedialAction
  - In EquipmentReliability profile dataset
    - PowerShiftKeyStrategy is defined with all the setup using SchedullingArea
  - In StateInstructionSchedule profile dataset
    - PowerShiftKeyDistribution object refers to PowerShiftKeySchedule object.
    - PowerShiftKeyDistribution object also refers to the PowerShiftKeyStrategy object in the ER dataset. It is possible to have different PowerShiftKeyStrategy per PowerShiftkeyDistribution

In this option there is no need that PowerShiftKeySchedule object refers to GeneratingUnit as this is done via the PowerShiftKeyStrategy. There is no need to use ParticipationFactorTimePoint.

- Option 5: Using bid schedule and power shift key strategy

The following classes are used:

- In RemedialAction profile dataset
  - PowerRemedialAction refers to BiddingZone and/or BiddingZoneBorder
  - PowerShiftKeyStrategy object refers to the PowerRemedialAction
- In EquipmentReliability profile dataset
  - PowerShiftKeyStrategy class using enumeration PowerShiftKeyKind
  - SchedulingArea with corresponding references to generating unit(s) in case of RedispatchRemedialAction (for CountertradeRemedialAction not mandatory)
- In StateInstructionSchedule profile dataset
  - PowerBidSchedule object that refers to PowerRemedialAction
  - PowerBidSchedule has PowerBidScheduleTimePoint that provides the active power and price for points in time
  - PowerShiftKeyDistribution with reference to PowerShiftKeySchedule
  - In case of ExplicitInstruction PowerShiftKeySchedule is required with ParticipationFactorTimePoints and potential reference to GeneratingUnit (exactly the same as stated in ER)

With this approach clear distinction between structured data (offline data) and schedule data (e.g. daily process) is achieved since only SIS is used in daily process with reference to ER and RA profiles.

7.1.7.3.2 Countertrade Remedial Action

This example illustrates how to define a Countertrade Remedial Action.

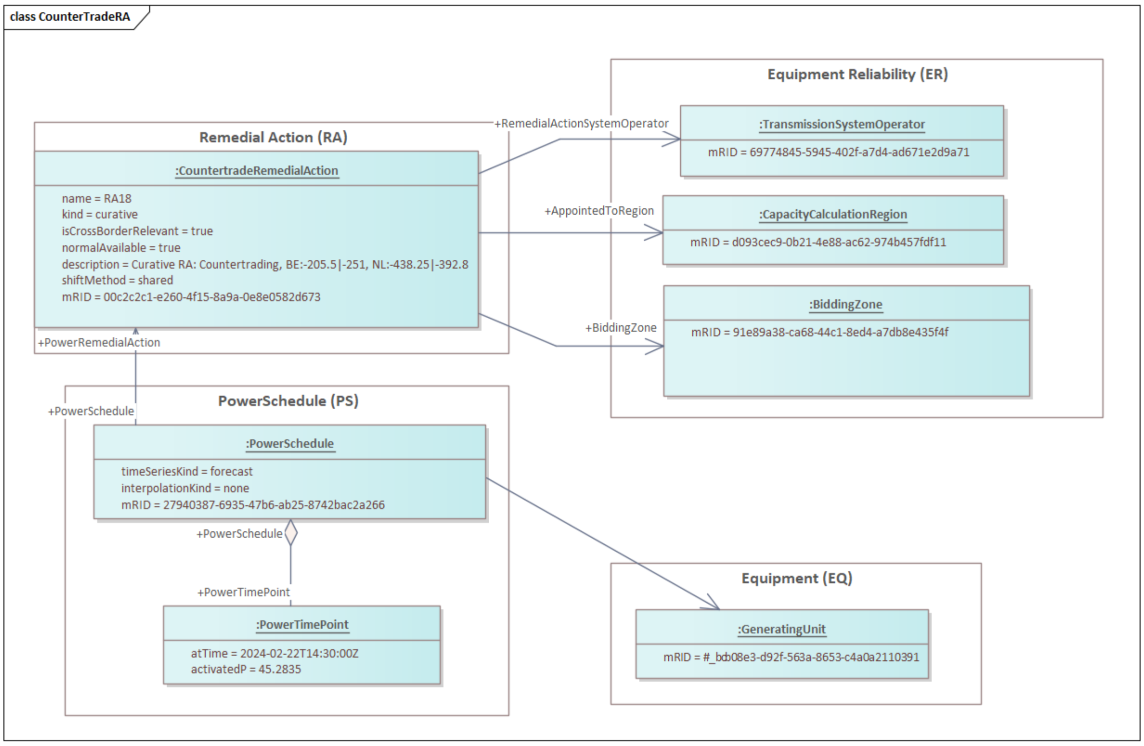


Figure 27 - Power Remedial Action Example with PowerSchedule

The corresponding Remedial Action dataset snippet is as follows:

```
<nc:CountertradeRemedialAction rdf:ID=”_00c2c2c1-e260-4f15-8a9a-0e8e0582d673”>
  <cim:IdentifiedObject.description>Curative RA: Countertrading, BE:-205.5|-251, NL:-438.25|-
392.8</cim:IdentifiedObject.description>
  <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
  <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
  <nc:RemedialAction.AppointedToRegion rdf:resource=”#_d093cec9-0b21-4e88-ac62-974b457fdf11”/>
  <nc:RemedialAction.kind rdf:resource=”https://cim4.eu/ns/nc#RemedialActionKind.curative”/>
  <cim:IdentifiedObject.mRID>00c2c2c1-e260-4f15-8a9a-0e8e0582d673</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>RA18</cim:IdentifiedObject.name>
  <nc:PowerRemedialAction.BiddingZone rdf:resource=”#_91e89a38-ca68-44c1-8ed4-a7db8e435f4f”/>
  <nc:RemedialAction.RemedialActionSystemOperator                    rdf:resource=”#_69774845-5945-402f-a7d4-
ad671e2d9a71”/></nc:CountertradeRemedialAction>
```

The corresponding PowerSchedule snippet is as follows:

```
  <nc:PowerSchedule rdf:ID="#_27940387-6935-47b6-ab25-8742bac2a266">
    <cim:IdentifiedObject.mRID>27940387-6935-47b6-ab25-8742bac2a266</cim:IdentifiedObject.mRID>
    <nc:PowerSchedule.PowerRemedialAction rdf:resource="#_00c2c2c1-e260-4f15-8a9a-0e8e0582d673"/>
    <nc:PowerSchedule.GeneratingUnit rdf:resource="#_bcb08e3-d92f-563a-8653-c4a0a2110391"/>
    <nc:BaseTimeSeries.timeSeriesKind rdf:resource="https://cim4.eu/ns/nc#BaseTimeSeriesKind.forecast"/>
    <nc:BaseTimeSeries.interpolationKind rdf:resource="https://cim4.eu/ns/nc#TimeSeriesInterpolationKind.none"/>
  </nc:PowerSchedule>
  <nc:PowerTimePoint rdf:ID="_014615b6-134c-40c3-9d1b-b4d3aa6704fc">
    <nc:PowerTimePoint.activatedP>45.2835</nc:PowerTimePoint.activatedP>
    <nc:PowerTimePoint.atTime>2024-02-22T14:30:00Z</nc:PowerTimePoint.atTime>
    <nc:PowerTimePoint.PowerSchedule rdf:resource="#_27940387-6935-47b6-ab25-8742bac2a266"/>
  </nc:PowerTimePoint>
```

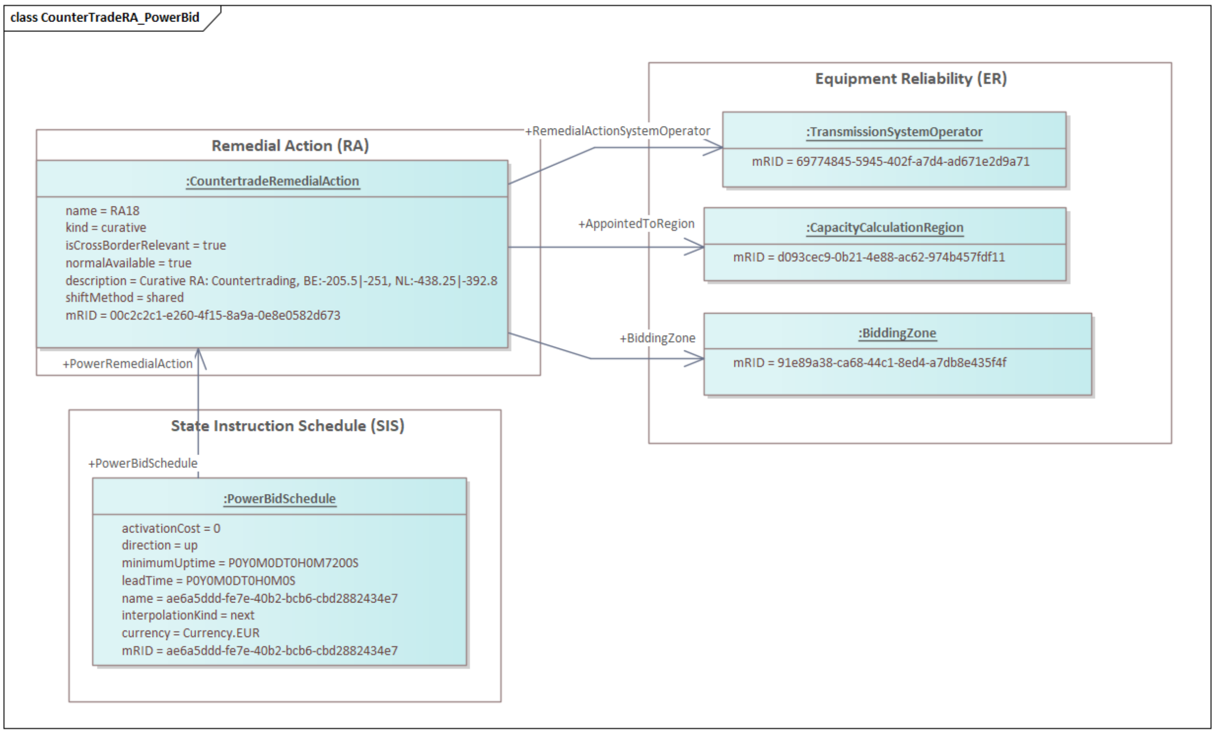


Figure 28 - Power Remedial Action Example with PowerBidSchedule

The following snippet illustrates how to specify a Countertrade remedial action by using PowerBidSchedule concept in the SIS profile:

```
  <nc:PowerBidSchedule rdf:ID="_ae6a5ddd-fe7e-40b2-bcb6-cbd2882434e7">
    <cim:IdentifiedObject.mRID>ae6a5ddd-fe7e-40b2-bcb6-cbd2882434e7</cim:IdentifiedObject.mRID>
    <nc:PowerBidSchedule.currency rdf:resource="https://cim.ucaiug.io/ns#Currency.EUR"/>
    <nc:BaseTimeSeries.interpolationKind rdf:resource="https://cim4.eu/ns/nc#TimeSeriesInterpolationKind.next"/>
    <cim:IdentifiedObject.name>ae6a5ddd-fe7e-40b2-bcb6-cbd2882434e7</cim:IdentifiedObject.name>
    <nc:PowerBidSchedule.PowerRemedialAction rdf:resource="#_00c2c2c1-e260-4f15-8a9a-0e8e0582d673"/>
    <nc:PowerBidSchedule.leadTime>P0Y0M0DT0H0M0S</nc:PowerBidSchedule.leadTime>
    <nc:PowerBidSchedule.minimumUptime>P0Y0M0DT0H0M7200S</nc:PowerBidSchedule.minimumUptime>
    <nc:PowerBidSchedule.direction rdf:resource="https://cim4.eu/ns/nc#BidDirectionKind.up"/>
    <nc:PowerBidSchedule.activationCost>999.9startupCostactivationCost>0</nc:PowerBidSchedule.activationCost
activationCoststartupCost>
  </nc:PowerBidSchedule>
```

7.1.7.3.3 Redispatch Remedial Action

The following example illustrates two ways how to specify a Redispatch Remedial Action. Both examples refer to the following Equipment profile snippet:

```
<!-- Equipment Profile -->
  <cim:SynchronousMachine rdf:ID="_3a3b27be-b18b-4385-b557-6735d733baf0">
    <cim:Equipment.EquipmentContainer rdf:resource="#_4ba71b59-ee2f-450b-9f7d-cc2f1cc5e386" />
    <cim:Equipment.aggregate>false</cim:Equipment.aggregate>
    <cim:IdentifiedObject.description>Machine</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>3a3b27be-b18b-4385-b557-6735d733baf0</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>BE-G1</cim:IdentifiedObject.name>
    <eu:IdentifiedObject.shortName>BE-G1</eu:IdentifiedObject.shortName>
    <cim:RegulatingCondEq.RegulatingControl rdf:resource="#_6ba406ce-78cf-4485-9b01-a34e584f1a8d" />
    <cim:RotatingMachine.GeneratingUnit rdf:resource="#_18993b11-2966-4bce-bab9-d86103f83b53" />
    <cim:RotatingMachine.ratedPowerFactor>0.85</cim:RotatingMachine.ratedPowerFactor>
    <cim:RotatingMachine.ratedS>300</cim:RotatingMachine.ratedS>
    <cim:RotatingMachine.ratedU>10.5</cim:RotatingMachine.ratedU>
    <cim:SynchronousMachine.InitialReactiveCapabilityCurve rdf:resource="#_59ff1e53-0e1a-44c0-ada5-7a0b3a660170" />
    <cim:SynchronousMachine.earthing>true</cim:SynchronousMachine.earthing>
    <cim:SynchronousMachine.earthingStarPointR>0</cim:SynchronousMachine.earthingStarPointR>
    <cim:SynchronousMachine.earthingStarPointX>0</cim:SynchronousMachine.earthingStarPointX>
    <cim:SynchronousMachine.ikk>0</cim:SynchronousMachine.ikk>
    <cim:SynchronousMachine.maxQ>300</cim:SynchronousMachine.maxQ>
    <cim:SynchronousMachine.minQ>-300</cim:SynchronousMachine.minQ>
    <cim:SynchronousMachine.mu>0</cim:SynchronousMachine.mu>
    <cim:SynchronousMachine.qPercent>50</cim:SynchronousMachine.qPercent>
    <cim:SynchronousMachine.r>0</cim:SynchronousMachine.r>
    <cim:SynchronousMachine.r0>0</cim:SynchronousMachine.r0>
    <cim:SynchronousMachine.r2>0</cim:SynchronousMachine.r2>
    <cim:SynchronousMachine.satDirectSubtransX>0.2</cim:SynchronousMachine.satDirectSubtransX>
    <cim:SynchronousMachine.satDirectSyncX>2</cim:SynchronousMachine.satDirectSyncX>
    <cim:SynchronousMachine.satDirectTransX>0</cim:SynchronousMachine.satDirectTransX>
    <cim:SynchronousMachine.shortCircuitRotorType
rdf:resource="https://cim.ucaiug.io/ns#ShortCircuitRotorKind.turboSeries1" />
    <cim:SynchronousMachine.type rdf:resource="https://cim.ucaiug.io/ns#SynchronousMachineKind.generatorOrMotor" />
    <cim:SynchronousMachine.voltageRegulationRange>0</cim:SynchronousMachine.voltageRegulationRange>
    <cim:SynchronousMachine.x0>0.13</cim:SynchronousMachine.x0>
    <cim:SynchronousMachine.x2>0.171</cim:SynchronousMachine.x2>
  </cim:SynchronousMachine>
  <cim:SynchronousMachine rdf:ID="_d4e4911b-d87a-4fd5-a7a7-0346c0538db3">
    <cim:Equipment.EquipmentContainer rdf:resource="#_a7f5e1c1-d18a-473d-905f-cb13d4711d89" />
    <cim:IdentifiedObject.mRID>d4e4911b-d87a-4fd5-a7a7-0346c0538db3</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>FR-G1</cim:IdentifiedObject.name>
    <cim:RegulatingCondEq.RegulatingControl rdf:resource="#_51b004dd-fb43-5c9b-85a8-3b04bd4a7f6c" />
    <cim:RotatingMachine.GeneratingUnit rdf:resource="#_8f6d7917-dd59-b418-d4f2-58dc5fc259e3" />
    <cim:RotatingMachine.ratedPowerFactor>0.95</cim:RotatingMachine.ratedPowerFactor>
    <cim:RotatingMachine.ratedS>500</cim:RotatingMachine.ratedS>
    <cim:RotatingMachine.ratedU>17</cim:RotatingMachine.ratedU>
    <cim:SynchronousMachine.earthing>false</cim:SynchronousMachine.earthing>
    <cim:SynchronousMachine.maxQ>250</cim:SynchronousMachine.maxQ>
    <cim:SynchronousMachine.minQ>-50</cim:SynchronousMachine.minQ>
    <cim:SynchronousMachine.qPercent>100</cim:SynchronousMachine.qPercent>
    <cim:SynchronousMachine.r>0</cim:SynchronousMachine.r>
    <cim:SynchronousMachine.r0>0</cim:SynchronousMachine.r0>
    <cim:SynchronousMachine.r2>0</cim:SynchronousMachine.r2>
    <cim:SynchronousMachine.satDirectSubtransX>0.2</cim:SynchronousMachine.satDirectSubtransX>
    <cim:SynchronousMachine.satDirectSyncX>1.1</cim:SynchronousMachine.satDirectSyncX>
    <cim:SynchronousMachine.shortCircuitRotorType
rdf:resource="https://cim.ucaiug.io/ns#ShortCircuitRotorKind.turboSeries2" />
    <cim:SynchronousMachine.type rdf:resource="https://cim.ucaiug.io/ns#SynchronousMachineKind.generator" />
    <cim:SynchronousMachine.x0>0</cim:SynchronousMachine.x0>
    <cim:SynchronousMachine.x2>0.1156</cim:SynchronousMachine.x2>
  </cim:SynchronousMachine>
```

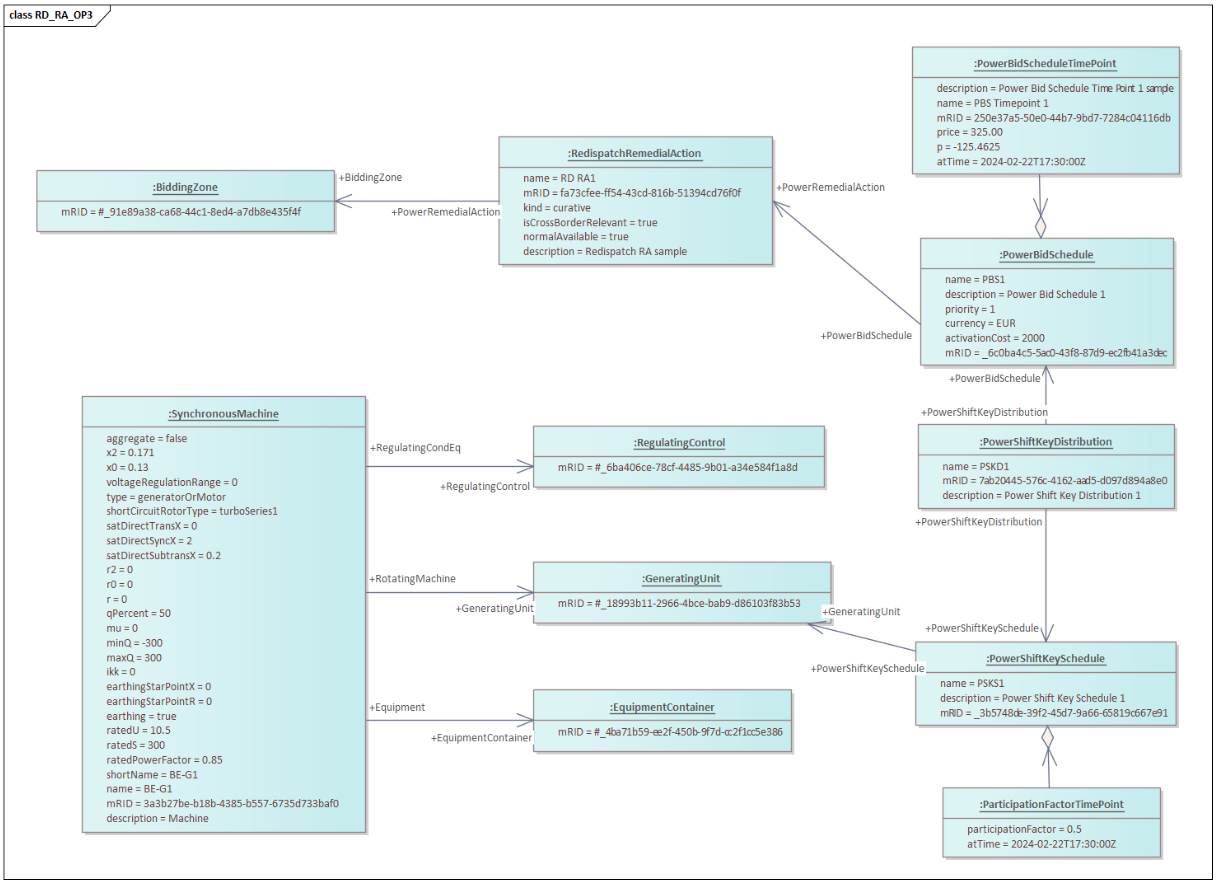


Figure 29 - Redispatch Remedial Action Example Option 3

The first way illustrates the usage of the abovementioned Option 3, i.e., using bid schedules. The RemedialAction profile snippet is given below:

```
<nc:RedispatchRemedialAction rdf:ID="_fa73cfee-ff54-43cd-816b-51394cd76f0f">
  <nc:PowerRemedialAction.BiddingZone rdf:resource="#_91e89a38-ca68-44c1-8ed4-a7db8e435f4f"/>
  <cim:IdentifiedObject.description>Redispatch RA sample</cim:IdentifiedObject.description>
  <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
  <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
  <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
  <cim:IdentifiedObject.mRID>fa73cfee-ff54-43cd-816b-51394cd76f0f</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>RD RA1</cim:IdentifiedObject.name>
</nc:RedispatchRemedialAction>
```

The corresponding State Instruction Schedule Profile snippet is given below:

```
<nc:PowerBidSchedule rdf:ID="_6c0ba4c5-5ac0-43f8-87d9-ec2fb41a3dec">
  <nc:PowerBidSchedule.activationCost>2000</nc:PowerBidSchedule.activationCost>
  <nc:PowerBidSchedule.currency rdf:resource="https://cim.ucaiug.io/ns#Currency.EUR"/>
  <nc:PowerBidSchedule.PowerRemedialAction rdf:resource="#_fa73cfee-ff54-43cd-816b-51394cd76f0f"/>
  <nc:PowerBidSchedule.priority>1</nc:PowerBidSchedule.priority>
  <cim:IdentifiedObject.description>Power Bid Schedule 1</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>6c0ba4c5-5ac0-43f8-87d9-ec2fb41a3dec</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>PBS1</cim:IdentifiedObject.name>
</nc:PowerBidSchedule>
<nc:PowerShiftKeyDistribution rdf:ID="_7ab20445-576c-4162-aad5-d097d894a8e0">
  <nc:PowerShiftKeyDistribution.PowerBidSchedule rdf:resource="#_6c0ba4c5-5ac0-43f8-87d9-ec2fb41a3dec"/>
  <nc:PowerShiftKeyDistribution.PowerShiftKeySchedule rdf:resource="#_3b5748de-39f2-45d7-9a66-65819c667e91"/>
  <cim:IdentifiedObject.description>Power Shift Key Distribution 1</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7ab20445-576c-4162-aad5-d097d894a8e0</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>PSKD1</cim:IdentifiedObject.name>
</nc:PowerShiftKeyDistribution>
<nc:PowerShiftKeySchedule rdf:ID="_3b5748de-39f2-45d7-9a66-65819c667e91">
  <nc:PowerShiftKeySchedule.GeneratingUnit rdf:resource="#_18993b11-2966-4bce-bab9-d86103f83b53"/>
  <cim:IdentifiedObject.description>Power Shift Key Schedule 1</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>3b5748de-39f2-45d7-9a66-65819c667e91</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>PSKS1</cim:IdentifiedObject.name>
</nc:PowerShiftKeySchedule>
<nc:PowerBidScheduleTimePoint rdf:ID="_250e37a5-50e0-44b7-9bd7-7284c04116db">
  <nc:PowerBidScheduleTimePoint.atTime>2024-02-22T17:30:00Z</nc:PowerBidScheduleTimePoint.atTime>
  <nc:PowerBidScheduleTimePoint.PowerBidSchedule rdf:resource="#_6c0ba4c5-5ac0-43f8-87d9-ec2fb41a3dec"/>
```

```
    <nc:PowerBidScheduleTimePoint.p>-125.4625</nc:PowerBidScheduleTimePoint.p>
    <nc:PowerBidScheduleTimePoint.price>325.00</nc:PowerBidScheduleTimePoint.price>
    <cim:IdentifiedObject.description>Power Bid Schedule Time Point 1 sample</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>250e37a5-50e0-44b7-9bd7-7284c04116db</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>PBS Timepoint 1</cim:IdentifiedObject.name>
  </nc:PowerBidScheduleTimePoint>
  <nc:ParticipationFactorTimePoint rdf:ID="_06dea5a7-512e-48da-a2fc-5e0ec83a5b8e">
    <nc:ParticipationFactorTimePoint.atTime>2024-02-22T17:30:00Z</nc:ParticipationFactorTimePoint.atTime>
    <nc:ParticipationFactorTimePoint.participationFactor>0.5</nc:ParticipationFactorTimePoint.participationFactor>
    <nc:PowerBidScheduleTimePoint.PowerShiftKeySchedule rdf:resource="#_3b5748de-39f2-45d7-9a66-65819c667e91"/>
    <cim:IdentifiedObject.description>Participation Factor Time Point 1 sample</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>06dea5a7-512e-48da-a2fc-5e0ec83a5b8e</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>PF Timepoint 1</cim:IdentifiedObject.name>
  </nc:ParticipationFactorTimePoint>
```

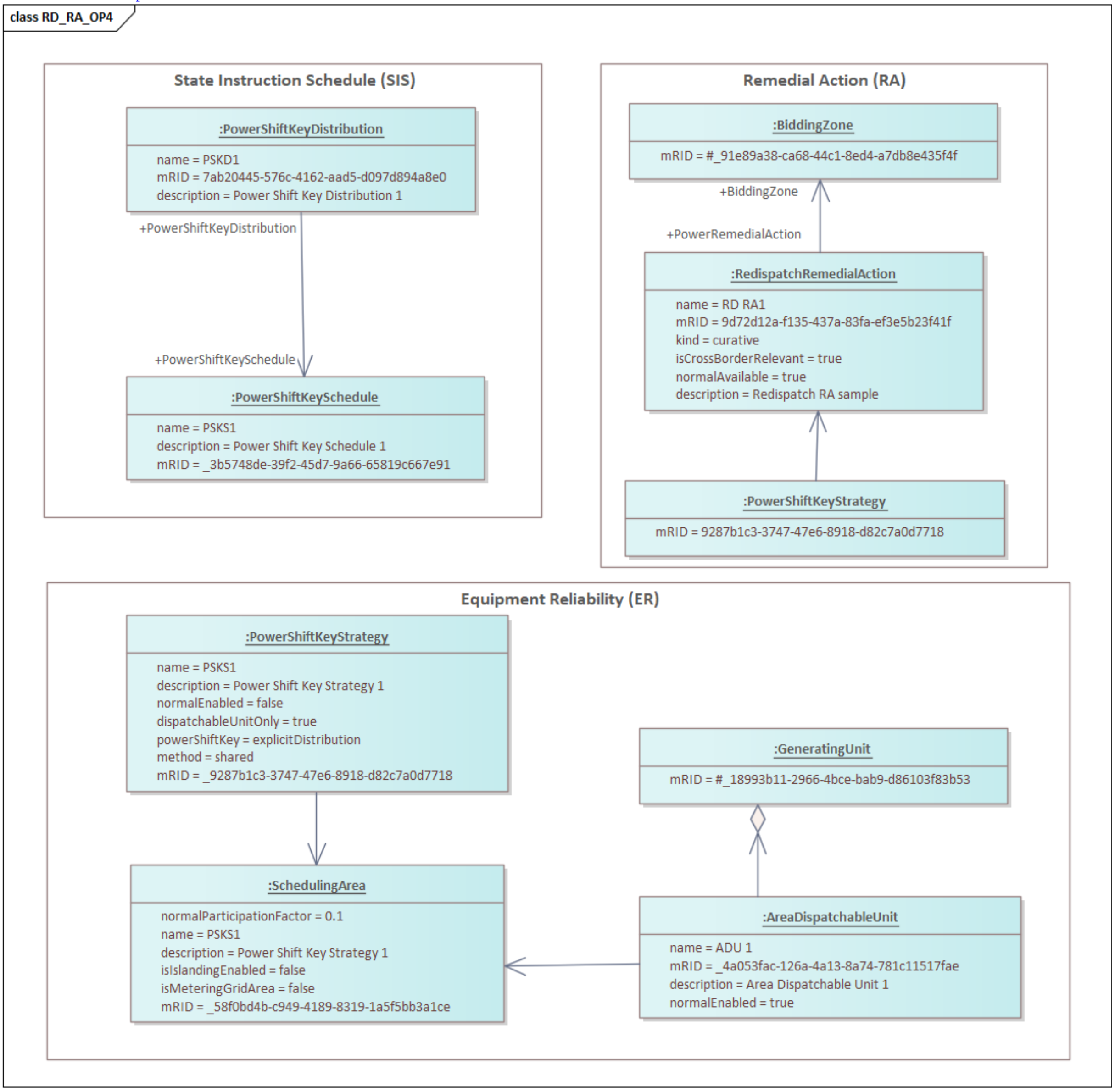


Figure 30 - Redispatch Remedial Action Example Option 4

The following example illustrates the way to define a RedispatchRemedialAction using power shift key strategy, as explained above in Option 4. The RemedialAction profile snippet is given below:

```
  <nc:RedispatchRemedialAction rdf:ID="_9d72d12a-f135-437a-83fa-ef3e5b23f41f">
    <nc:PowerRemedialAction.BiddingZone rdf:resource="#_91e89a38-ca68-44c1-8ed4-a7db8e435f4f"/>
    <cim:IdentifiedObject.description>Redispatch RA sample</cim:IdentifiedObject.description>
    <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
    <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
    <cim:IdentifiedObject.mRID>9d72d12a-f135-437a-83fa-ef3e5b23f41f</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RD RA1</cim:IdentifiedObject.name>
```

```
  </nc:RedispatchRemedialAction>
  <nc:PowerShiftKeyStrategy rdf:about="_9287b1c3-3747-47e6-8918-d82c7a0d7718">
    <nc:PowerShiftKeyStrategy.PowerRemedialAction rdf:resource="#_9d72d12a-f135-437a-83fa-ef3e5b23f41f"/>
    <cim:IdentifiedObject.mRID>9287b1c3-3747-47e6-8918-d82c7a0d7718</cim:IdentifiedObject.mRID>
  </nc:PowerShiftKeyStrategy>
```

The corresponding Equipment Reliability profile snippet is given below:

```
  <nc:PowerShiftKeyStrategy rdf:ID="_9287b1c3-3747-47e6-8918-d82c7a0d7718">
    <nc:PowerShiftKeyStrategy.SchedulingArea rdf:resource="#_58f0bd4b-c949-4189-8319-1a5f5bb3a1ce"/>
    <nc:PowerShiftKeyStrategy.method rdf:resource="https://cim4.eu/ns/nc#ShiftMethodKind.shared"/>
    <nc:PowerShiftKeyStrategy.powerShiftKey
rdf:resource="https://cim4.eu/ns/nc#PowerShiftKeyKind.explicitDistribution"/>
    <nc:PowerShiftKeyStrategy.dispatchableUnitOnly>true</nc:PowerShiftKeyStrategy.dispatchableUnitOnly>
    <nc:PowerShiftKeyStrategy.normalEnabled>false</nc:PowerShiftKeyStrategy.normalEnabled>
    <cim:IdentifiedObject.description>Power Shift Key Strategy 1</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>9287b1c3-3747-47e6-8918-d82c7a0d7718</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>PSKS1</cim:IdentifiedObject.name>
  </nc:PowerShiftKeyStrategy>
  <nc:SchedulingArea rdf:ID="_58f0bd4b-c949-4189-8319-1a5f5bb3a1ce">
    <nc:SchedulingArea.isMeteringGridArea>true</nc:SchedulingArea.isMeteringGridArea>
    <nc:SchedulingArea.isIslandingEnabled>false</nc:SchedulingArea.isIslandingEnabled>
    <nc:SchedulingArea.normalParticipationFactor>0.1</nc:SchedulingArea.normalParticipationFactor>
    <cim:IdentifiedObject.description>Scheduling Area 1</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>58f0bd4b-c949-4189-8319-1a5f5bb3a1ce</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>SA 1</cim:IdentifiedObject.name>
  </nc:SchedulingArea>
  <nc:AreaDispatchableUnit rdf:ID="_4a053fac-126a-4a13-8a74-781c11517fae">
    <nc:AreaDispatchableUnit.GeneratingUnit rdf:resource="#_18993b11-2966-4bce-bab9-d86103f83b53"/>
    <nc:AreaDispatchableUnit.normalEnabled>true</nc:AreaDispatchableUnit.normalEnabled>
    <nc:AreaDispatchableUnit.SchedulingArea rdf:resource="#_58f0bd4b-c949-4189-8319-1a5f5bb3a1ce"/>
    <cim:IdentifiedObject.description>Area Dispatchable Unit 1</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>4a053fac-126a-4a13-8a74-781c11517fae</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>ADU 1</cim:IdentifiedObject.name>
  </nc:AreaDispatchableUnit>
```

The corresponding State Instruction Schedule profile snippet is given below:

```
  <nc:PowerShiftKeyDistribution rdf:ID="_7ab20445-576c-4162-aad5-d097d894a8e0">
    <nc:PowerShiftKeyDistribution.PowerShiftKeyStrategy rdf:resource="#_9287b1c3-3747-47e6-8918-d82c7a0d7718"/>
    <nc:PowerShiftKeyDistribution.PowerShiftKeySchedule rdf:resource="#_3b5748de-39f2-45d7-9a66-65819c667e91"/>
    <cim:IdentifiedObject.description>Power Shift Key Distribution 1</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>7ab20445-576c-4162-aad5-d097d894a8e0</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>PSKD1</cim:IdentifiedObject.name>
  </nc:PowerShiftKeyDistribution>
  <nc:PowerShiftKeySchedule rdf:ID="_3b5748de-39f2-45d7-9a66-65819c667e91">
    <cim:IdentifiedObject.description>Power Shift Key Schedule 1</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>3b5748de-39f2-45d7-9a66-65819c667e91</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>PSKS1</cim:IdentifiedObject.name>
  </nc:PowerShiftKeySchedule>
```

7.1.7.4 Availability Remedial Action

Availability remedial action is a remedial action that cancels or reschedules an availability schedule. It is used when it is desired to cancel or shorten an outage.

The following example illustrates how to define an Availability Remedial Action. To define an availability remedial action, it is required to define AvailabilitySchedule which is defined in the AvailabilitySchedule dataset.

Availability remedial action can also use availability schedule for defining changes in the operational limits by using the class AvailabilityExceprionalLimit. This can be used, for instance, for enabling or disabling the current limit on ACLineSegment terminal in combination with other availability functions with the same availability schedule or de-rating due to fault. It is not recommended to use this approach to just provide new set of limits that can be provided by using Steady State Hypothesis profile.

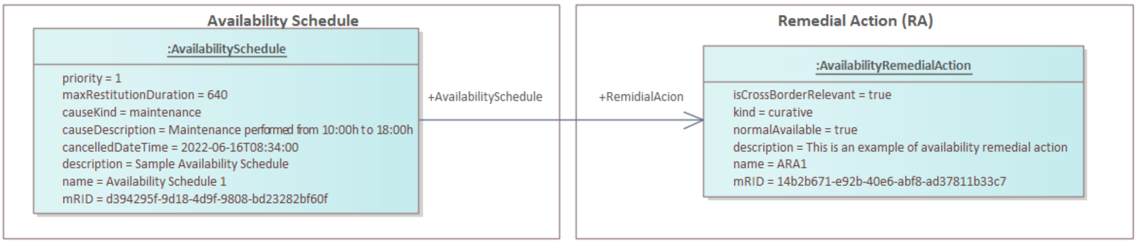


Figure 31 - Availability Schedule Remedial Action Example

The corresponding Availability Schedule dataset snippet is as follows:

```
  <nc:AvailabilitySchedule rdf:ID="_d394295f-9d18-4d9f-9808-bd23282bf60f">
    <cim:IdentifiedObject.mRID>d394295f-9d18-4d9f-9808-bd23282bf60f</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>Availability Schedule 1</cim:IdentifiedObject.name>
         <cim:IdentifiedObject.description>Sample Availability Schedule</cim:IdentifiedObject.description>
    <nc:AvailabilitySchedule.cancelledDateTime>2022-06-16T08:34:00Z</nc:AvailabilitySchedule.cancelledDateTime>
         <nc:AvailabilitySchedule.causeDescription>Maintenance performed from 10:00h to 
18:00h</nc:AvailabilitySchedule.causeDescription>
         <nc:AvailabilitySchedule.causeKind 
rdf:resource="https://cim4.eu/ns/nc#AvailabilityScheduleCauseKind.maintenance"/>
         <nc:AvailabilitySchedule.maxRestitutionDuration>640</nc:AvailabilitySchedule.maxRestitutionDuration>
         <nc:AvailabilitySchedule.priority>1</nc:AvailabilitySchedule.priority>
         <nc:AvailabilitySchedule.RemedialAction rdf:resource="#_14b2b671-e92b-40e6-abf8-ad37811b33c7"/>
  </nc:AvailabilitySchedule>
```

The corresponding Remedial Action dataset snippet is as follows:

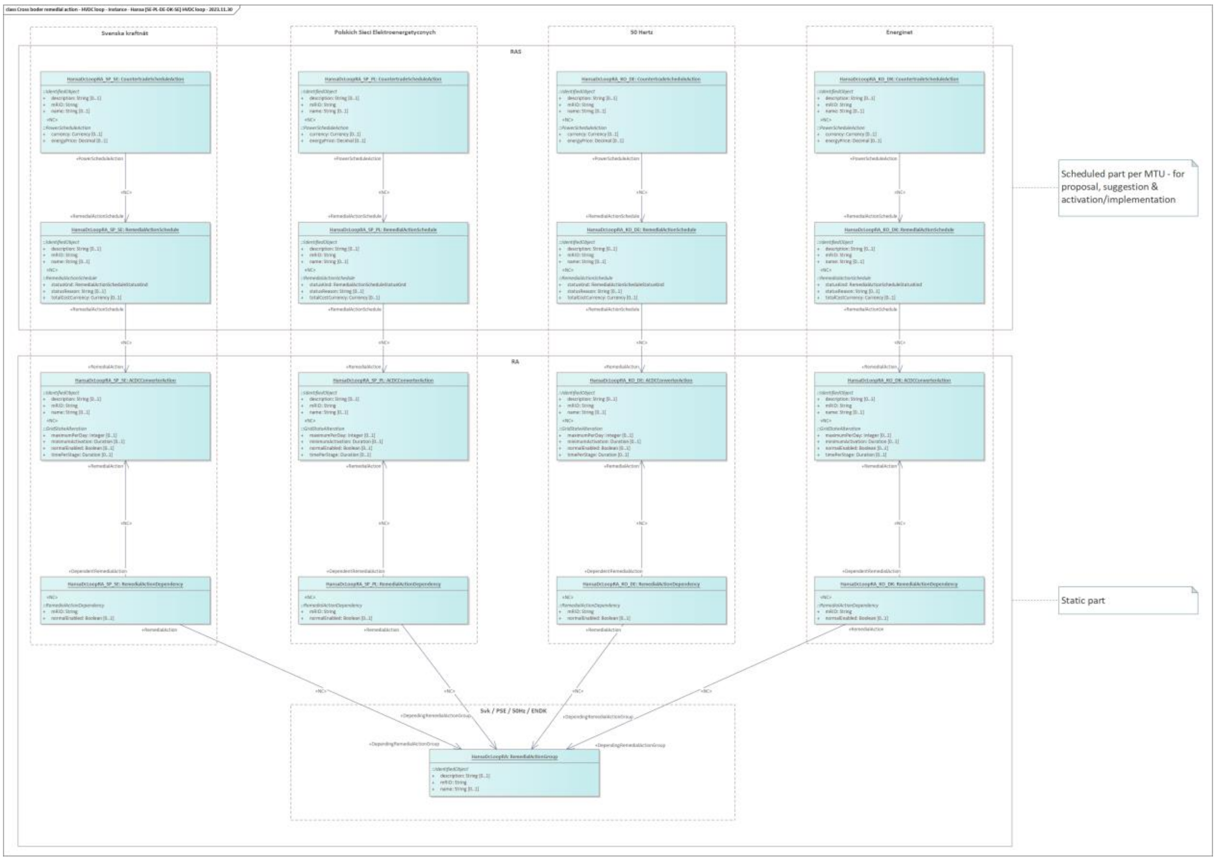
```
  <nc:AvailabilityRemedialAction rdf:ID="_14b2b671-e92b-40e6-abf8-ad37811b33c7">
    <cim:IdentifiedObject.mRID>14b2b671-e92b-40e6-abf8-ad37811b33c7</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>ARA1</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example of availability remedial 
action</cim:IdentifiedObject.description>
         <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
    <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
  </nc:AvailabilityRemedialAction>
```

7.1.7.5 Remedial Action with Dependencies

Remedial action profile enables definition of a remedial action dependency. This is realised by using the RemedialActionDependency. The dependency can be of different kind and applies to all remedial actions that have dependencies and are included in a RemedialActionGroup.

One use case of using this dependency mechanism is when remedial actions from multiple TSOs are to be treated as one Remedial Action, e.g., the so-called DC-loop in the HANSA region, where two HVDC must be regulated at the same time when the remedial action is activated.

This example will be elaborated more in detail in the next version of the document.



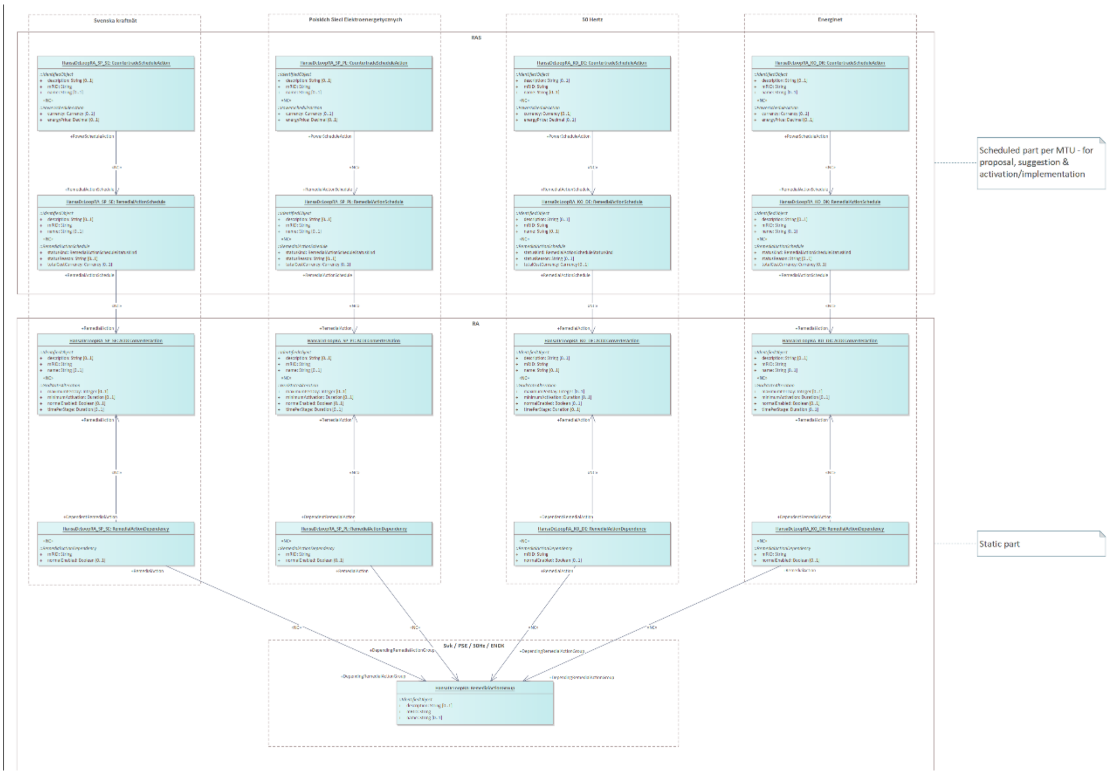


Figure 32 – Remedial Action with Dependencies – HVDC case

7.1.7.6 Contingency with Remedial Action

This section defines how to cover different use cases that require specification of a Contingency (CO) with a Remedial Action (RA). The following uses cases are covered:

1) **Full scope**: All defined and enabled remedial actions are considered when resolving a violation of an assessed element after a contingency.

2) **Limited inclusion**: One or limited number of remedial actions are considered (the only RA that are applicable) when resolving a violation of an assessed element after a contingency.

3) **Limited exclusion**: One or limited number of remedial actions are not considered when resolving a violation of an assessed element after a contingency. For instance, “RA1” is excluded, i.e., not considered/not used as possible RA, when “AE1” or “AE2” are having violations for “CO1”.

4) **Consideration**: One or limited number of remedial actions can be considered when resolving a violation of an assessed element after a contingency.

The following general remarks apply to the design of the included, excluded, or considered remedial actions with contingency:

- The objective is to minimize the data exchanged for the business process, but at the same time give guidance to the RAO in order to help the performance of the business process. In general, all remedial actions can be considered for all assessed elements, but this would take significant amount of time. Therefore, the data model provides a mechanism to help limiting cases to be studied.

- It should be noted that constraining RAO by limiting the possibilities on which remedial actions can be used for resolving violations on assessed elements can be considered a breach of the requirements defined in Network Codes and methodologies. Therefore, it should only be used in cases where this helps the performance of the process but does not limit the effect of optimising remedial actions and finding the best possible solution.

- Contingencies can be referenced by remedial actions and/or assessed elements which helps to minimize computational efforts when performing contingency analysis during remedial action optimization and the business processes in general. For additional details, refer to 7.1.5.6 on combinations between assessed element and remedial action.

The link between contingency and remedial action is provided in the exchange of remedial actions and the link with assessed element is defined in the exchange of assessed elements. This means that in case some specific combinations need to be defined, contingency objects should be defined prior to the definition of the combinations with assessed elements and remedial actions. In case a TSO applies the design in which contingencies are relevant for all assessed elements and remedial actions (i.e., no explicit combinations), there is no explicit dependency between the process of contingencies creation and the processes of defining assessed elements and remedial actions.

The example below illustrates how to specify a Remedial Action that is to be applied when a specific Contingency occurs.

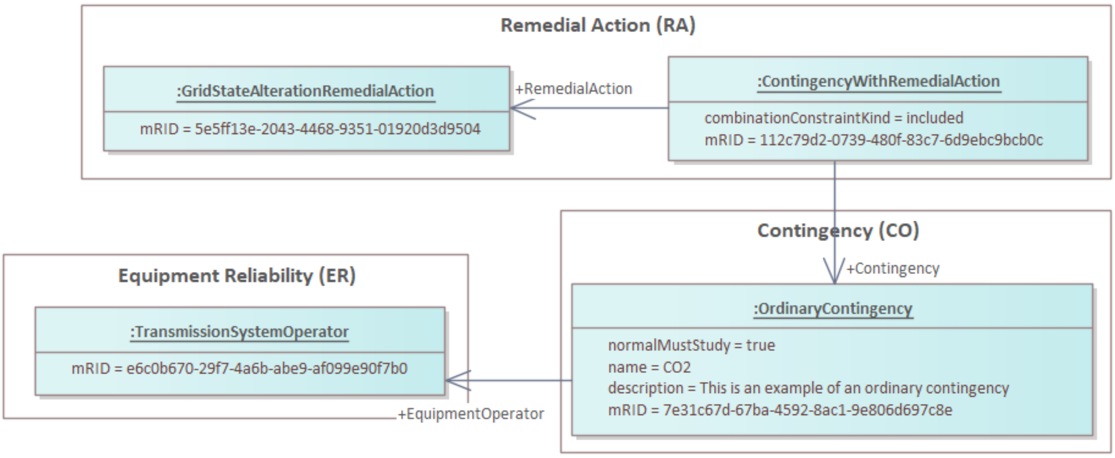


Figure 33 – Remedial Action with Contingency

The corresponding Remedial Action dataset snippet is as follows:

```xml
  <nc:GridStateAlterationRemedialAction rdf:ID="_5e5ff13e-2043-4468-9351-01920d3d9504">
    <cim:IdentifiedObject.mRID>5e5ff13e-2043-4468-9351-01920d3d9504</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>TapRA2</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>Curative RA: TapPositionAction on normal trafo (MV Tap to 33)
</cim:IdentifiedObject.description>
    <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
    <nc:RemedialAction.isCrossBorderRelevant>false</nc:RemedialAction.isCrossBorderRelevant>
    <nc:RemedialAction.AppointedToRegion rdf:resource="#_963d6f71-b3af-448e-864d-af326ed1a577"/>
  </nc:GridStateAlterationRemedialAction>

<nc:ContingencyWithRemedialAction rdf:ID="_112c79d2-0739-480f-83c7-6d9ebc9bcb0c">
  <nc:ContingencyWithRemedialAction.mRID>112c79d2-0739-480f-83c7-
6d9ebc9bcb0c</nc:ContingencyWithRemedialAction.mRID>
  <nc:ContingencyWithRemedialAction.combinationConstraintKind
rdf:resource="https://cim4.eu/ns/nc#ElementCombinationConstraintKind.included"/>
  <nc:ContingencyWithRemedialAction.RemedialAction rdf:resource="#_5e5ff13e-2043-4468-9351-01920d3d9504"/>
  <nc:ContingencyWithRemedialAction.Contingency rdf:resource="#_7e31c67d-67ba-4592-8ac1-9e806d697c8e"/>
</nc:ContingencyWithRemedialAction>
```

The Contingency dataset snippet is as follows:

```xml
<nc:OrdinaryContingency rdf:ID="_7e31c67d-67ba-4592-8ac1-9e806d697c8e">
  <cim:IdentifiedObject.name>CO2</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>This is an example of an ordinary contingency; Tie Line
loss</cim:IdentifiedObject.description>
  <cim:IdentifiedObject.mRID>7e31c67d-67ba-4592-8ac1-9e806d697c8e</cim:IdentifiedObject.mRID>
  <nc:Contingency.EquipmentOperator rdf:resource="#_e6c0b670-29f7-4a6b-abe9-af099e90f7b0"/>
  <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
</nc:OrdinaryContingency>
```

7.1.7.7 Expected Use Cases

The following expected use cases are not explained in full detail. The next versions of the document could include more details. The list of use cases is not exhaustive.

Table 7 – Expected Use Cases Related to Remedial Action.

Name	Description	Comment
Preventive and curative topological RAs	Defining a RA as both preventive and curative with the same resulting switching state.	Due to the structure of the NC profiles, two different RAs (preventive and curative) with the same resulting switching state need to be defined.
Open busbar coupler and move a line from one Busbar to another	Defining a RA with opening the Busbar coupler (in order to create 2 different nodes) and	

	performing reconfiguration of a line.	
Opening busbar coupler	Opening a busbar coupler (preventive), no dependency to another switch needed	
Open/close of a single grid element - preventive	Switching on/off a single line / transformer as a topological RA. (Preventive)	
Open/close of a single grid element - curative	Switching on/off a single line / transformer as a topological RA. (Curative)	
Combination of topological actions - exclusive relationship	Two different RAs in the same substation but cannot be applied at the same time due to some technical or operational constraint	
Tap change on a power transformer as RA	Changing the tap position on a power transformer as RA	
SSSC (static synchronous series compensator)	Using SSSC's capability of changing the current on a specific line as an RA to reduce the flows on a congested grid element	The way of modelling the RA use case is highly depending on how the SSSC is modelled in the power flow part of the IGM. The SSSC is covered in detain in the ER profile part of the NC profiles.
Switching on a grid element with restitution time	Switching on a grid element in maintenance with restitution time. (preventive)	
Bypassing a PST in base case	Open one or several switches to bypass a PST	
Bypassing a PST after contingency	Open one or several switches to bypass a PST after a specific contingency occurs	
Modelling of Topological RAs with bus-branch IGMs	Modelling all the abovementioned use cases in a bus-branch case	This requires either modification of the grid model creation process or a post processing where the switches are added model and kept persistent.
PST taps preventive RA	Changing PST taps in a predefined range in a preventive way in base case	
PST taps curative RA	Changing PST taps in a predefined range in a curative way after contingency	
Target flow	Aiming for a maximal target flow in base case/after contingency, automatic change of taps to keep the flow under a predefined threshold	
Parallel PST operation	Two or more PSTs are operated in parallel; the PSTs are grouped so the tap change on each unit is the same	
PST with simultaneous preventive RA and curative RA	Two RAs, one preventive and the other curative, pointing to the same PST.	

PST action for PST groups	Asymmetrical tap changes of 4 parallel PSTs during voltage control	PSTs should be grouped into different groups and subgroups with appropriate availability flags
Single generating plant providing preventive redispatch volumes	Preventive RA on a generating plant connected to a single node capable of providing positive and negative active power	
Parent Child (one generating unit, two modes)	Different operation modes of combined-cycle power plants	
Parent Child (two generating units)	Generators not allowed to start simultaneously	
Group combined minimum/maximum infeed	Restriction of the sum power for a group of generators connected to a same node (e.g. in case of power plant line outage).	
Preventive RA pump storage	Preventive RA on a Pump Storage Power Plant with 2 modes for PGM - generating and pump mode, where Pmin and Pmax and other offline parameters are defined separately for each mode.	
Already realized redispatch (before DA CROSA)	Already ordered RA, as offline data to be linked with the RA schedule afterwards, but the volumes / prices are adapted according to what was already ordered.	
Curative redispatch with predefined pairs of single generating plants	Predefined pair of curative RD is triggered for a single contingency case	
Curative redispatch compensated by countertrade in the same bidding zone	Curative redispatch compensated by countertrade located in the bidding zone where the RA is activated for a single contingency case (simulating aFRR)	The constraints related to balancing the system still apply to these curative RAs. This balance is achieved via compensation by a slack distribution located in the bidding zone where the curative RA is activated.
Countertrade with multiple steps and a single GLSK	Single countertrade offer by a TSO covering 24 hours, expressed in price-MWh/h steps/pairs, associating a GLSK defined as proportional to the remaining available capacity (pro-rata distribution based on headroom) at all generator nodes in the TSO grid model	
Single nodal offer with multiple steps for different hours	Single-node offer which consists of MWh max, min step size defined for each power bid schedule, Pmin, Pmax defined for the Generator itself	

	(structural data and underlying model) and a number of MWh-EUR steps covering different hours during the day	
Hydro pump with parent-child generation with time shift	Single step hydro pump with the parent-child bid defined in opposite directions for a specific time shift	
Simple countertrade preventive	Potential of countertrade upwards/downwards with a single price of activation in base case	
Simple countertrade curative	Potential of countertrade upwards/downwards with a single price of activation after contingency	
Redispatch without TSO balancing	Potential from Reduction of renewable infeed which does not need balancing from TSO side	
Preventive redispatch with predefined group of loads	Preventive redispatch action where the redispatch potential is in the predefined set of loads which is a part of distribution grid and may also cross TSO borders	
Cross border HVDC with preventive & curative volumes	Sharing the upwards and downwards potential for an HVDC between two control areas within a CCR, assuming that both TSOs may deliver their own view on the available volumes and the RAO should take the most constraining input as final.	
Cross border HVDC with preventive and curative volumes using bandwidth attribute	Sharing the upwards and downwards potential for an HVDC between two control areas within a CCR, assuming that both TSOs may deliver their own view on the available volumes and the RAO should take the most constraining input as final.	
Preventive RA: HVDC setpoint change	Change the setpoint in base case, only one connecting TSO, for HVDC cables connecting a TSO that belongs to one CCR with a TSO which belongs to another CCR	For some HVDCs between two different synchronous zone this must be done via redispatch because this type of HVDC has associated prices while this attribute is not foreseen for HVDC category so far.
Curative RA: HVDC setpoint change	Change the setpoint after contingency, only one connecting TSO	

Preventive RA: HVDC mode switch	Switch from one mode to another one in base case: DC setpoint/AC mode/hybrid mode.	Relevant for HVDC on AC border only.
Curative RA: HVDC mode switch	Switch from one mode to another one after contingency	Relevant for HVDC on AC border only
Preventive RA: HVDC Hybrid mode	Changing the hybrid mode in base case (parameter k)	Relevant for HVDC on AC border only
Curative RA: HVDC Hybrid mode	Changing the hybrid mode after contingency (parameter k)	Relevant for HVDC on AC border only
Manually proposed Remedial Actions (via RA Schedule)		
Remedial Actions agreed in FAP (via RA Schedule)		
Cancelled earlier agreed Remedial Actions		
Suggestion of Alternative RAs for RAC (might be in RAC part)		
Decision about agreed/rejected RAs for RAC		

7.1.8 List of SPS

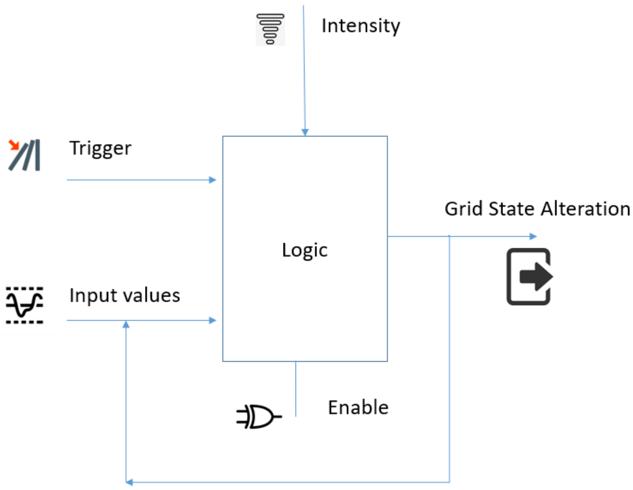


Figure 34 – SIPS overview

System Integrity Protection Schemes (SIPS), Special Protection Schemes (SPS) and Remedial Action Schemes (RAS) are often applied by TSOs to utilize the transmission capacity beyond conventional N-1 considerations. In many cases SIPS and SPS are used interchangeably, but in general SPS are considered part of SIPS.
This is done while still maintaining reliability of supply, for example by relieving overloaded lines through immediate disconnection of generator units when lines are disconnected by their protective relay equipment. Other schemes are also in use, such as emergency power on HVDC links, load shedding and network splitting. Without modelling SIPS or RAS unrealistic congestion/overload will be reported by the power flow simulation tools.

As shown in Figure 34, a SIPS is based on a logic which has inputs signals and related triggers to start the logic. Depending on the logic conditions and the intensity of the event, if the logic is enabled, the output of the SIPS will result in a grid state alteration.

In the NC profiles the structural data for SPS remedial action is defined using Remedial Action profile dataset. The Gate is defining the input logic and then Stage the output that is linked to a GridStateAlterationCollection allowing multiple grid state alterations to be part of a Stage, i.e. change to that will be applied after the gate trigger conditions are met.

The following are some examples of the objectives of system-wide protection/control schemes:

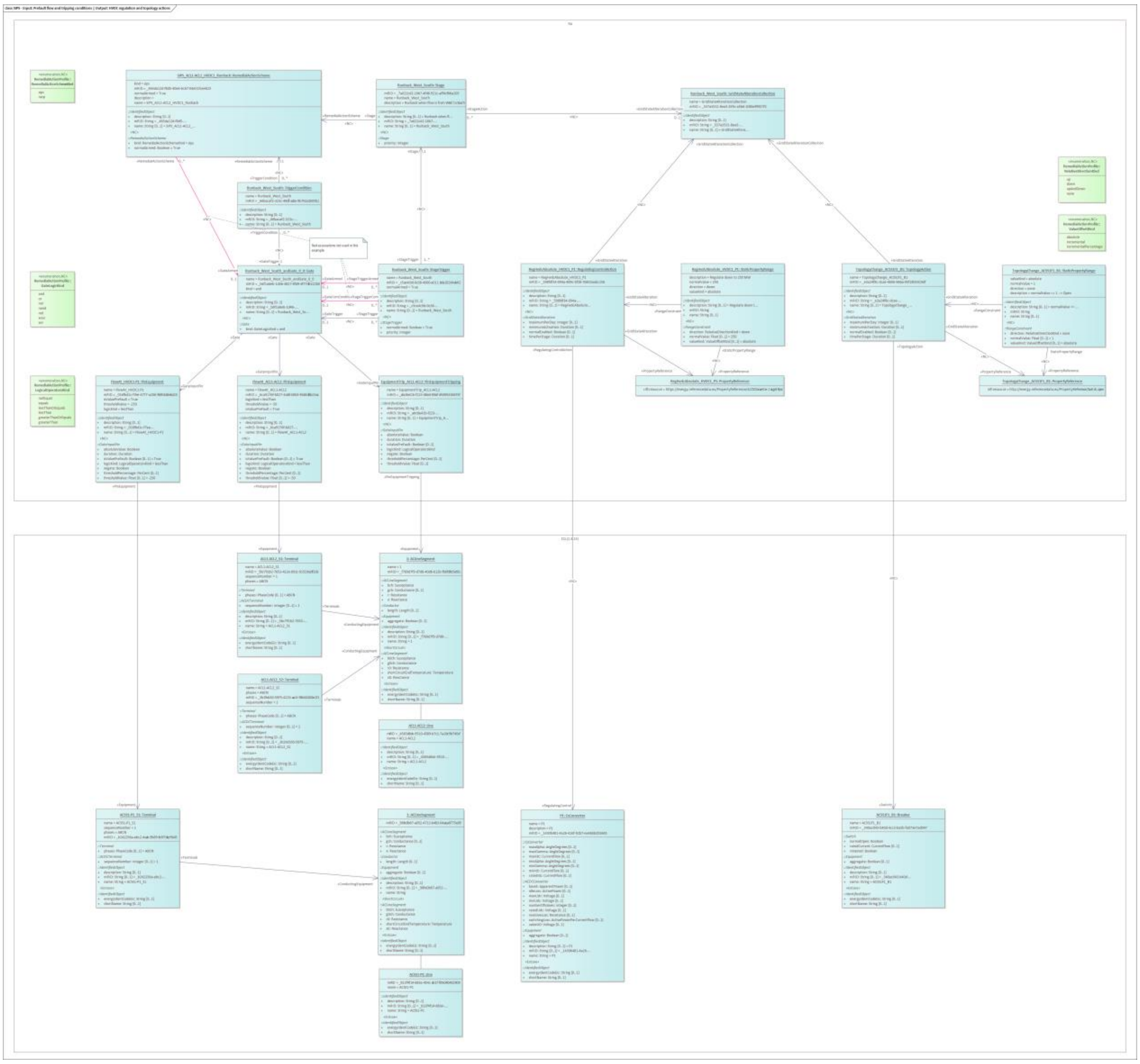
- Overload mitigation
- System separation for transient stability
- Load and generation shedding/rejection
- Under and over voltage load shedding
- Under and over frequency generation/load shedding
- Detection/shutdown of islanded network
- Over frequency tripping of unloaded generators
- Improvement of power transmission to increase total transfer capability
- Improvement of system stability under the large deployment of renewable energy resources
- Maximize the capability of apparatus (the thermal limit of apparatus**).**

Any values described in SSH, SIS and SSI datasets can be input values for Grid State Alteration value.

7.1.8.1 SIPS Monitoring of a line and actions on topology and HVDC

In the SIPS example shown in Figure 35, a pre-fault flow values on a line and a trip of the same line are used as input trigger conditions. On the grid state alteration output side, flow changes on a HVDC as well as topology changes on filters are shown.

The next versions of the document will elaborate more on this example.

2247 

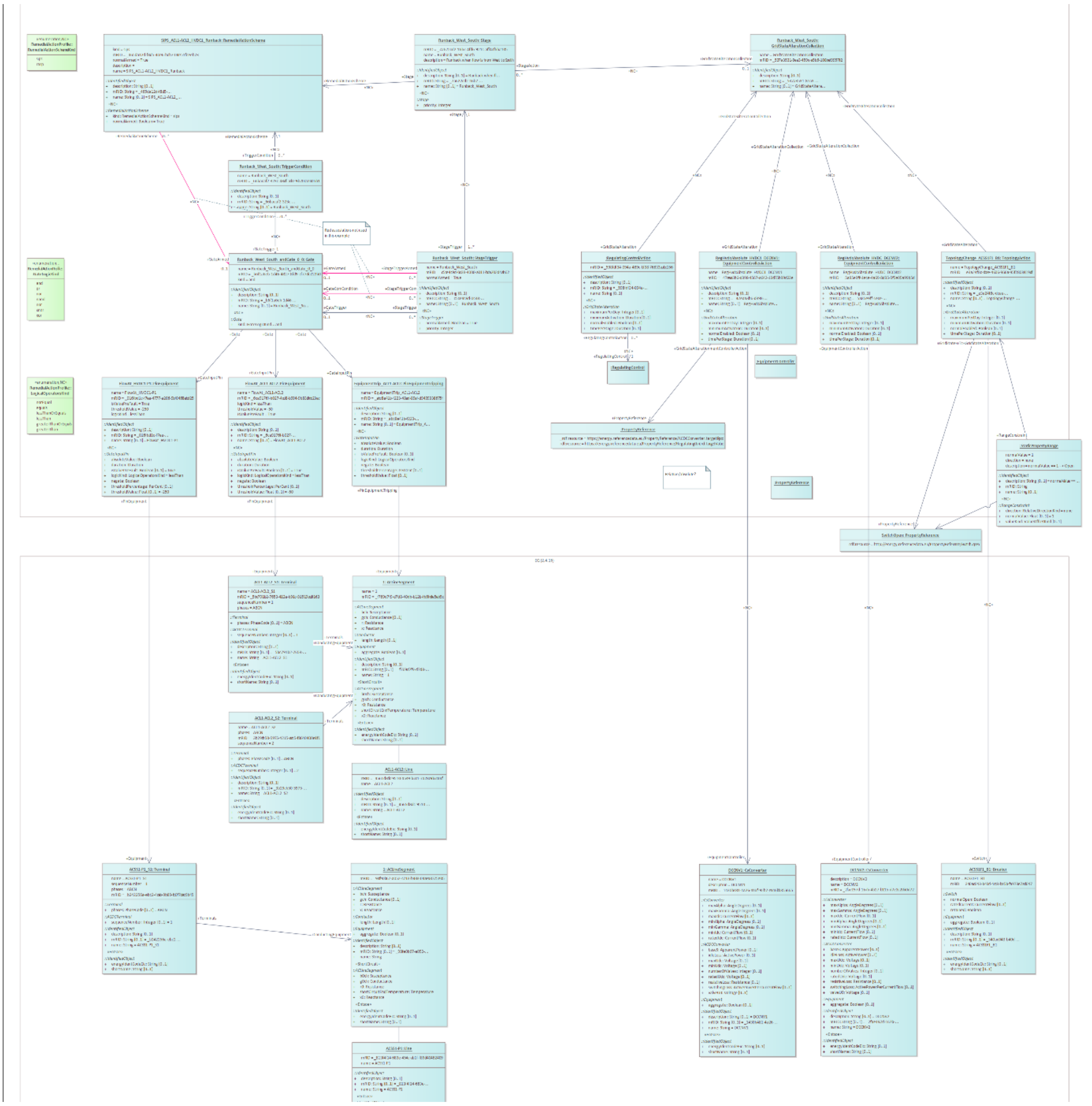


Figure 35 – SIPS Monitoring of a Line and Actions on Topology and HVDC

7.1.8.2 Expected Use Cases

The following expects use cases are not explained in full detail. The next versions of the document could include more details.

Table 8 – Expected Use Cases Related to SPS Remedial Action.

Name	Description	Comment
Decrease/ increase of production curative without prices	Decrease of production on one/several units after a specific contingency in case of overload/from a predefined flow on one or several XNEs (with a	

	specified activation time and activation gradient)	
Automatic tap change position if the PATL is reached (PST)		
Automatic opening of a breaker, depending on criteria (example : PATL reached)		

7.1.9 List of System Constraints

There are different types of system constraints. Defining stability limits, voltage angle limits as well as infeed limits defined on a power transfer corridor. These limits can be linked with the assessed elements so that they can be scanned or secured.

7.1.9.1 Voltage Angle Limit

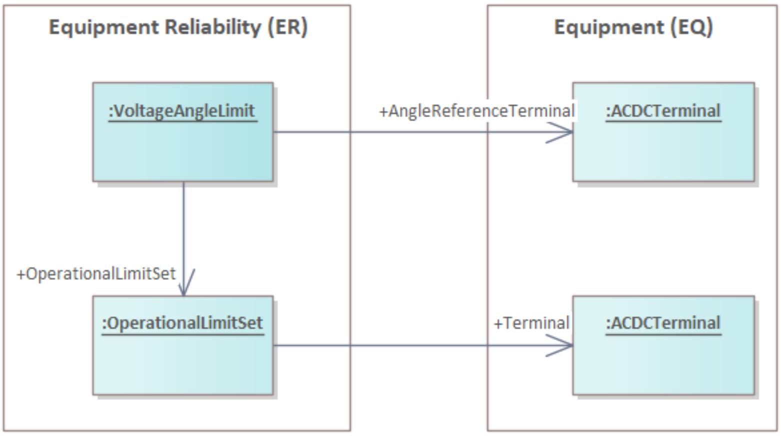


Figure 36 – Voltage Angle Limit

The corresponding Equipment Reliability dataset snippet is as follows:

```
  <nc:VoltageAngleLimit rdf:ID="_c06b2f38-c6c6-4fec-8ddb-234eebaea8ec">
    <cim:IdentifiedObject.mRID>c06b2f38-c6c6-4fec-8ddb-234eebaea8ec</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>VoltageAngleLimit1</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>Limit for voltage angle at a specific
terminal</cim:IdentifiedObject.description>
    <nc:VoltageAngleLimit.normalValue>10.0</nc:VoltageAngleLimit.normalValue>
    <nc:VoltageAngleLimit.AngleReferenceTerminal rdf:resource="#_5c206db8-ef8c-4e53-b2b9-38b52b194c5a"/>
    <cim:OperationalLimit.OperationalLimitSet rdf:resource="#_6fe5c43b-621c-88ac-1d90-22f075cdb50e"/>
  </nc:VoltageAngleLimit>
```

The corresponding Equipment dataset snippet is as follows:

```
  <cim:VoltageLimit rdf:ID="_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3">
    <cim:IdentifiedObject.mRID>c50c3855-28e9-b2c8-5d9d-199a5dbff8f3</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>high limit for BE-Busbar_1</cim:IdentifiedObject.name>
    <cim:OperationalLimit.OperationalLimitSet rdf:resource="#_6fe5c43b-621c-88ac-1d90-22f075cdb50e" />
    <cim:OperationalLimit.OperationalLimitType rdf:resource="#_82639e97-ec8d-59c3-3af6-0fcc05fa3eb4" />
    <cim:VoltageLimit.normalValue>421.8</cim:VoltageLimit.normalValue>
  </cim:VoltageLimit>
  <cim:OperationalLimitSet rdf:ID="_6fe5c43b-621c-88ac-1d90-22f075cdb50e">
    <cim:IdentifiedObject.mRID>6fe5c43b-621c-88ac-1d90-22f075cdb50e</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>Voltage limits for BE-Busbar_1</cim:IdentifiedObject.name>
    <cim:OperationalLimitSet.Terminal rdf:resource="#_fa9e0f4d-8a2f-45e1-9e36-3611600d1c94" />
  </cim:OperationalLimitSet>
  <cim:Terminal rdf:ID="_fa9e0f4d-8a2f-45e1-9e36-3611600d1c94">
    <cim:ACDCTerminal.sequenceNumber>1</cim:ACDCTerminal.sequenceNumber>
    <cim:IdentifiedObject.mRID>fa9e0f4d-8a2f-45e1-9e36-3611600d1c94</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>BE-Busbar_1_Busbar_Section</cim:IdentifiedObject.name>
    <cim:Terminal.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c" />
    <cim:Terminal.ConnectivityNode rdf:resource="#_4836f99b-c6e9-4ee8-a956-b1e3da882d46" />
  </cim:Terminal>
```

7.1.9.2 Power Transfer Corridor

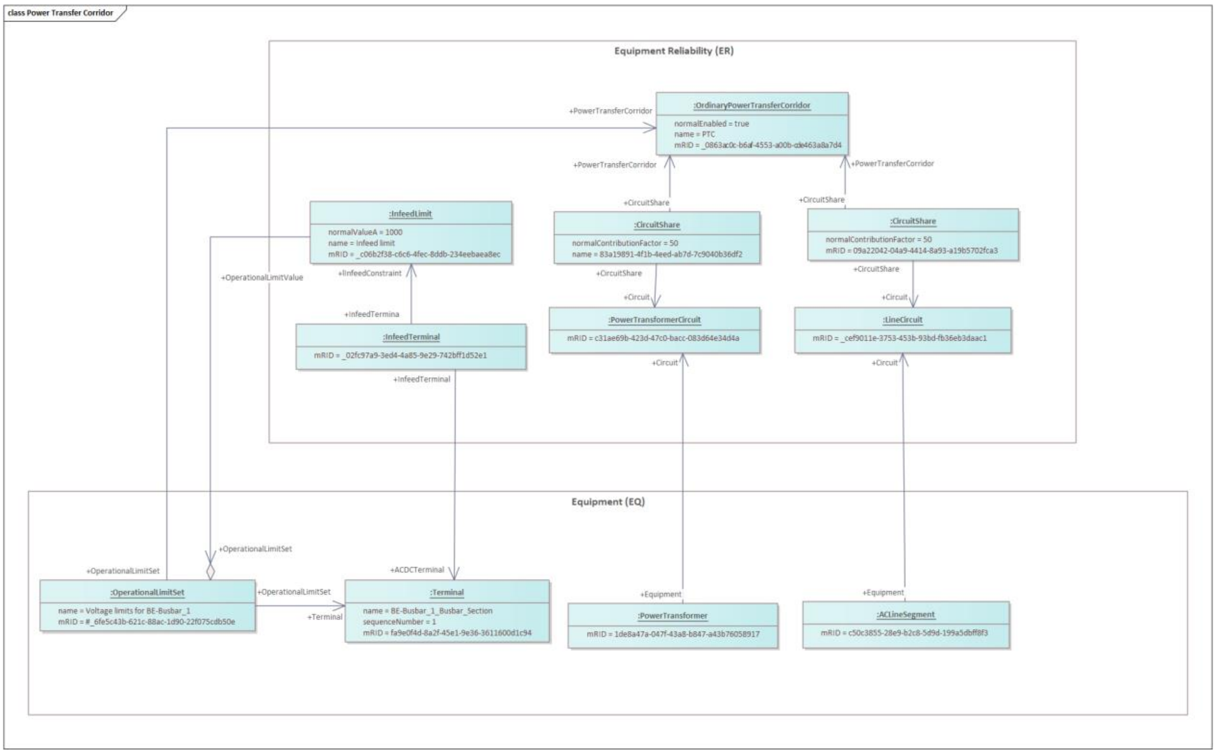


Figure 37 – Power Transfer Corridor

Power transfer corridor is defined by PowerTransferCorridor class in the Equipment Reliability dataset. It can be exceptional or ordinary type. In the example the ordinary power transfer corridor is illustrated.

A power transfer corridor can be composed by different circuits that have their share in the corridor. Circuits can be lines, transformers or DC circuits. However, each circuit can have different equipment object included in it.

The example illustrates a power transfer corridor that have a LineCircuit, a PowerTransformerCircuit, InfeedLimit

The corresponding Equipment Reliability dataset snippet is as follows:

```
<nc:InfeedLimit rdf:ID="_c06b2f38-c6c6-4fec-8ddb-234eebaea8ec">
  <cim:IdentifiedObject.mRID>c06b2f38-c6c6-4fec-8ddb-234eebaea8ec</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>Infeed limit</cim:IdentifiedObject.name>
  <nc:InfeedLimit.normalValueA>1000.0</nc:InfeedLimit.normalValueA>
  <cim:OperationalLimit.OperationalLimitSet rdf:resource="#_6fe5c43b-621c-88ac-1d90-22f075cdb50e"/>
</nc:InfeedLimit>

<nc:InfeedTerminal rdf:ID="_02fc97a9-3ed4-4a85-9e29-742bff1d52e1">
  <nc:InfeedTerminal.mRID>02fc97a9-3ed4-4a85-9e29-742bff1d52e1</nc:InfeedTerminal.mRID>
  <nc:InfeedTerminal.InfeedConstraint rdf:resource="#_c06b2f38-c6c6-4fec-8ddb-234eebaea8ec"/>
  <nc:InfeedTerminal.ACDCTerminal rdf:resource="#_fa9e0f4d-8a2f-45e1-9e36-3611600d1c94"/>
</nc:InfeedTerminal>

<nc:LineCircuit rdf:ID="_cef9011e-3753-453b-93bd-fb36eb3daac1">
  <nc:InfeedTerminal.mRID>cef9011e-3753-453b-93bd-fb36eb3daac1</nc:InfeedTerminal.mRID>
</nc:LineCircuit>

<nc:PowerTransformerCircuit rdf:ID="_c31ae69b-423d-47c0-bacc-083d64e34d4a">
  <nc:InfeedTerminal.mRID>c31ae69b-423d-47c0-bacc-083d64e34d4a</nc:InfeedTerminal.mRID>
</nc:PowerTransformerCircuit>

<cim:Equipment rdf:about="_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3">
  <nc:Equipment.Circuit rdf:resource="#_cef9011e-3753-453b-93bd-fb36eb3daac1"/>
</cim:Equipment>

<cim:Equipment rdf:about="_1de8a47a-047f-43a8-b847-a43b76058917">
  <nc:Equipment.Circuit rdf:resource="#_c31ae69b-423d-47c0-bacc-083d64e34d4a"/>
</cim:Equipment>
```

```
<nc:OrdinaryPowerTransferCorridor rdf:ID="_0863ac0c-b6af-4553-a00b-cde463a8a7d4">
  <cim:IdentifiedObject.mRID>0863ac0c-b6af-4553-a00b-cde463a8a7d4</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>PTC</cim:IdentifiedObject.name>
  <nc:PowerTransferCorridor.normalEnabled>true</nc:PowerTransferCorridor.normalEnabled>
</nc:OrdinaryPowerTransferCorridor>

<cim:OperationalLimitSet rdf:about="_6fe5c43b-621c-88ac-1d90-22f075cdb50e">
  <nc:OperationalLimitSet.PowerTransferCorridor rdf:resource="#_0863ac0c-b6af-4553-a00b-cde463a8a7d4"/>
</cim:OperationalLimitSet>

<nc:CircuitShare rdf:about="_09a22042-04a9-4414-8a93-a19b5702fca3">
  <cim:IdentifiedObject.mRID>09a22042-04a9-4414-8a93-a19b5702fca3</cim:IdentifiedObject.mRID>
  <nc:CircuitShare.Circuit rdf:resource="#_cef9011e-3753-453b-93bd-fb36eb3daac1"/>
  <nc:CircuitShare.PowerTransferCorridor rdf:resource="#_0863ac0c-b6af-4553-a00b-cde463a8a7d4"/>
  <nc:CircuitShare.normalContributionFactor>50</nc:CircuitShare.normalContributionFactor
</nc:CircuitShare>
<nc:CircuitShare rdf:about="_83a19891-4f1b-4eed-ab7d-7c9040b36df2">
  <cim:IdentifiedObject.mRID>83a19891-4f1b-4eed-ab7d-7c9040b36df2</cim:IdentifiedObject.mRID>
  <nc:CircuitShare.Circuit rdf:resource="#_c31ae69b-423d-47c0-bacc-083d64e34d4a "/>
  <nc:CircuitShare.PowerTransferCorridor rdf:resource="#_0863ac0c-b6af-4553-a00b-cde463a8a7d4"/>
  <nc:CircuitShare.normalContributionFactor>50</nc:CircuitShare.normalContributionFactor
</nc:CircuitShare>
```

The corresponding Equipment dataset snippet is as follows:

```
<cim:ACLineSegment rdf:ID="_c50c3855-28e9-b2c8-5d9d-199a5dbff8f3">
  <cim:IdentifiedObject.mRID>c50c3855-28e9-b2c8-5d9d-199a5dbff8f3</cim:IdentifiedObject.mRID>
  ...
</cim:ACLineSegment>
<cim:PowerTransformer rdf:ID="_1de8a47a-047f-43a8-b847-a43b76058917">
  <cim:IdentifiedObject.mRID>1de8a47a-047f-43a8-b847-a43b76058917</cim:IdentifiedObject.mRID>
  ...
</cim:PowerTransformer>

<cim:OperationalLimitSet rdf:ID="_6fe5c43b-621c-88ac-1d90-22f075cdb50e">
  <cim:IdentifiedObject.mRID>6fe5c43b-621c-88ac-1d90-22f075cdb50e</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>Voltage limits for BE-Busbar_1</cim:IdentifiedObject.name>
  <cim:OperationalLimitSet.Terminal rdf:resource="#_fa9e0f4d-8a2f-45e1-9e36-3611600d1c94" />
</cim:OperationalLimitSet>
<cim:Terminal rdf:ID="_fa9e0f4d-8a2f-45e1-9e36-3611600d1c94">
  <cim:ACDCTerminal.sequenceNumber>1</cim:ACDCTerminal.sequenceNumber>
  <cim:IdentifiedObject.mRID>fa9e0f4d-8a2f-45e1-9e36-3611600d1c94</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>BE-Busbar_1_Busbar_Section</cim:IdentifiedObject.name>
  <cim:Terminal.ConductingEquipment rdf:resource="#_64901aec-5a8a-4bcb-8ca7-a3ddbfcd0e6c" />
  <cim:Terminal.ConnectivityNode rdf:resource="#_4836f99b-c6e9-4ee8-a956-b1e3da882d46" />
</cim:Terminal>
```

7.1.10 Define scope of the analysis

Monitoring area profile defines possibility to exchange the definition of the following types of areas: monitoring area, observability area, sensitivity area, contingency area. Some of the use cases when usage of area definition is necessary are:

- In cases where it is required to identify the are based on influence factors
- In cases where the receiving system does not select all data submitted but needs to analyse part of the area. For instance, region A analysis needs to include part of region B.

Are definition uses the class AreaBorderTerminal to define the borders of the area. The following snipper illustrates definition of a monitoring area with two terminals. Eventually it is expected that there will be many terminals defined as the border needs to circle the area.

```
<nc:MonitoringArea rdf:ID="_adf0cf12-8f61-45af-b073-d73dd30e078d">
  <cim:IdentifiedObject.mRID>adf0cf12-8f61-45af-b073-d73dd30e078d</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>My observability area</cim:IdentifiedObject.name>
  <nc:MonitoringArea.SystemOperator rdf:resource="#_b1a6650b-bf47-469b-81f5-0319c265354b"/>
<nc:MonitoringArea.SynchronousArea rdf:resource="#_104f34a9-4b02-41a1-b3fb-2e3802e166b8"/>
</nc:MonitoringArea >

<nc:AreaBorderTerminal rdf:ID="_d7777b3f-4acb-452a-acca-5b100b299ba8">
  <nc:AreaBorderTerminal.mRID>d7777b3f-4acb-452a-acca-5b100b299ba8</ nc:AreaBorderTerminal.mRID >
  <nc:AreaBorderTerminal.MonitoringArea rdf:resource="#_adf0cf12-8f61-45af-b073-d73dd30e078d"/>
<nc:AreaBorderTerminal.Terminal rdf:resource="#_e504d183-64fb-4e44-9598-d19760660919"/>
</nc:ObservabilityArea >

<nc:AreaBorderTerminal rdf:ID="_418469cd-5e95-4320-bb1f-28e5dc0ea15f">
  <nc:AreaBorderTerminal.mRID>418469cd-5e95-4320-bb1f-28e5dc0ea15f</ nc:AreaBorderTerminal.mRID >
  <nc:AreaBorderTerminal.MonitoringArea rdf:resource="#_adf0cf12-8f61-45af-b073-d73dd30e078d"/>
```

<nc:AreaBorderTerminal.Terminal rdf:resource="#_c677bd82-40f3-40ac-a11b-01832631ced9"/>
</nc:ObservabilityArea >

7.2 Regional Security Assessment

7.2.1 Description

The Regional Security Assessment (RSA) is performed by the Security Assessment Coordinator. For information, the RSA is part of CROSA and is performed in intraday. The RSA subprocess is illustrated in Figure 38.

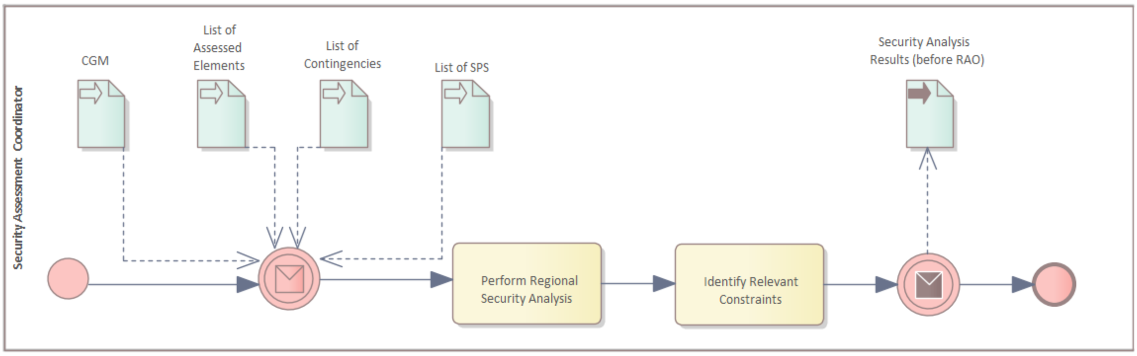


Figure 38 – Regional Security Assessment.

7.2.2 Inputs and Outputs

The list of Inputs and Outputs that are part of the subprocess is defined in Table 9.

Table 9 – Inputs and Outputs for Regional Security Assessment

Inputs	Outputs
Common Grid Model for the studied timeframe	Security Analysis Results (before RAO)
List of Assessed Elements	
List of Contingencies	
List of SPS (optional)	
The intensity (RAS) for agreed curative RA	

7.2.3 Conformity Requirements

To be able to support regional security assessment the Application shall conform to the following Application functions:

- Security analysis.

7.3 Remedial Action Optimization

7.3.1 Description

The Remedial Action Optimization (RAO) is performed by the Remedial Action Optimization Operator. The RAO subprocess is illustrated in Figure 39.

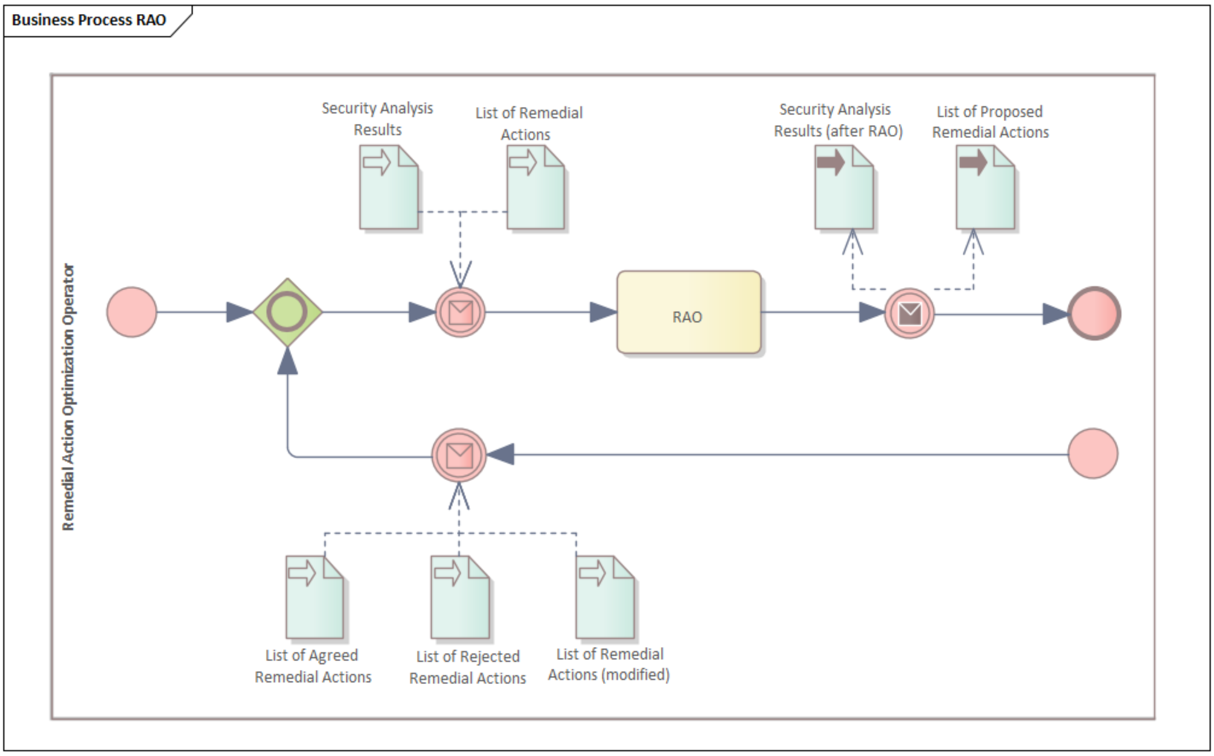


Figure 39 – Remedial Action Optimization.

7.3.2 Inputs and Outputs

Table 10 – Inputs and Outputs for Remedial Action Optimization

Inputs	Outputs
List of Available Remedial Actions	Security Analysis Results (after RAO, thus including proposed Remedial Actions)
Security Analysis Result (incl. Identified Constraints, before RAO, thus without proposed Remedial Actions)	List of Proposed Remedial Actions including sensitivity of Remedial Actions, at least on violations and cost of proposed Remedial Actions (per RA and in total)
Predefined rules for optimization – the exchange and the process for this is still to be defined	

7.3.3 Conformity Requirements

To be able to support remedial action optimization the Application shall conform to the following Application functions:

- Remedial action optimization.

7.3.4 Proposed Remedial Action Schedule

In general, the RAS profile can be used as an input if it is needed to inform that a remedial action is already used (before optimisation). SSI and SIS datasets include information if the remedial action is available to be used by the optimiser.

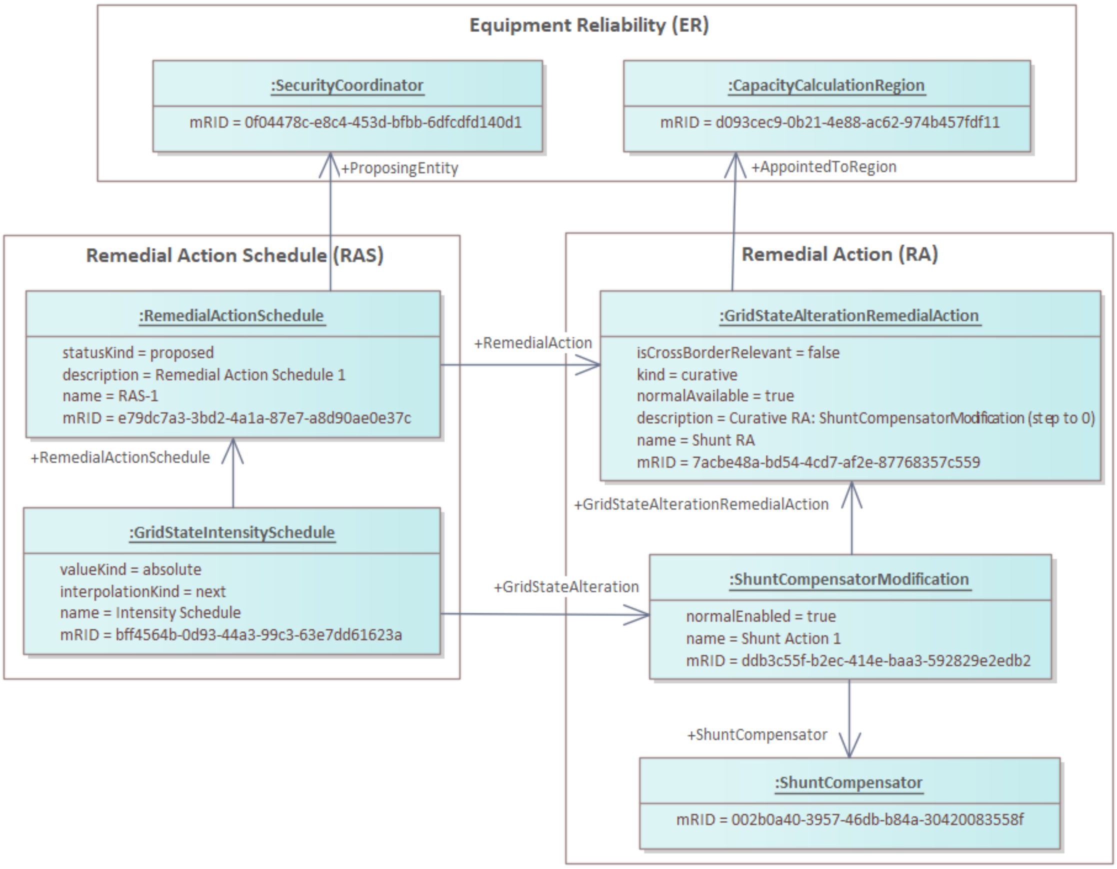


Figure 40 – Proposed Remedial Action Schedule – Grid Intensity

The corresponding Remedial Action Schedule dataset snippet is as follows:

```
<nc:GridStateIntensitySchedule rdf:ID="_bff4564b-0d93-44a3-99c3-63e7dd61623a">
  <cim:IdentifiedObject.name>intensity schedule</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.mRID>bff4564b-0d93-44a3-99c3-63e7dd61623a</cim:IdentifiedObject.mRID>
  <nc:BaseTimeSeries.interpolationKind rdf:resource="https://cim4.eu/ns/nc#TimeSeriesInterpolationKind.next"/>
  <nc:GenericValueSchedule.RemedialActionSchedule rdf:resource="#_e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e37c"/>
  <nc:GridStateIntensitySchedule.valueKind rdf:resource="https://cim4.eu/ns/nc#ValueOffsetKind.absolute"/>
  <nc:GridStateIntensitySchedule.GridStateAlteration rdf:resource="#_ddb3c55f-b2ec-414e-baa3-592829e2edb2"/>
</nc:GridStateIntensitySchedule>
<nc:RemedialActionSchedule rdf:ID="_e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e37c">
  <cim:IdentifiedObject.name>RAS-1</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.mRID>e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e37c</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.description>Remedial Action Schedule 1</cim:IdentifiedObject.description>
  <nc:RemedialActionSchedule.ProposingEntity rdf:resource="#_0f04478c-e8c4-453d-bfbb-6dfcdfd140d1"/>
  <nc:RemedialActionSchedule.RemedialAction rdf:resource="#_7acbe48a-bd54-4cd7-af2e-87768357c559"/>
  <nc:RemedialActionSchedule.statusKind
rdf:resource="https://cim4.eu/ns/nc#RemedialActionScheduleStatusKind.proposed"/>
</nc:RemedialActionSchedule>

  <nc:GenericValueTimePoint rdf:ID="_7dc3a232-66b2-4258-9f4a-1652bdddea8a">
    <nc:GenericValueTimePoint.GenericValueSchedule rdf:resource="#_bff4564b-0d93-44a3-99c3-63e7dd61623a"/>
    <nc:GenericValueTimePoint.value>0.0</nc:GenericValueTimePoint.value>
    <nc:GenericValueTimePoint.atTime>2022-06-16T04:30:00Z</nc:GenericValueTimePoint.atTime>
  </nc:GenericValueTimePoint>
```

The Remedial Action dataset is as follows:

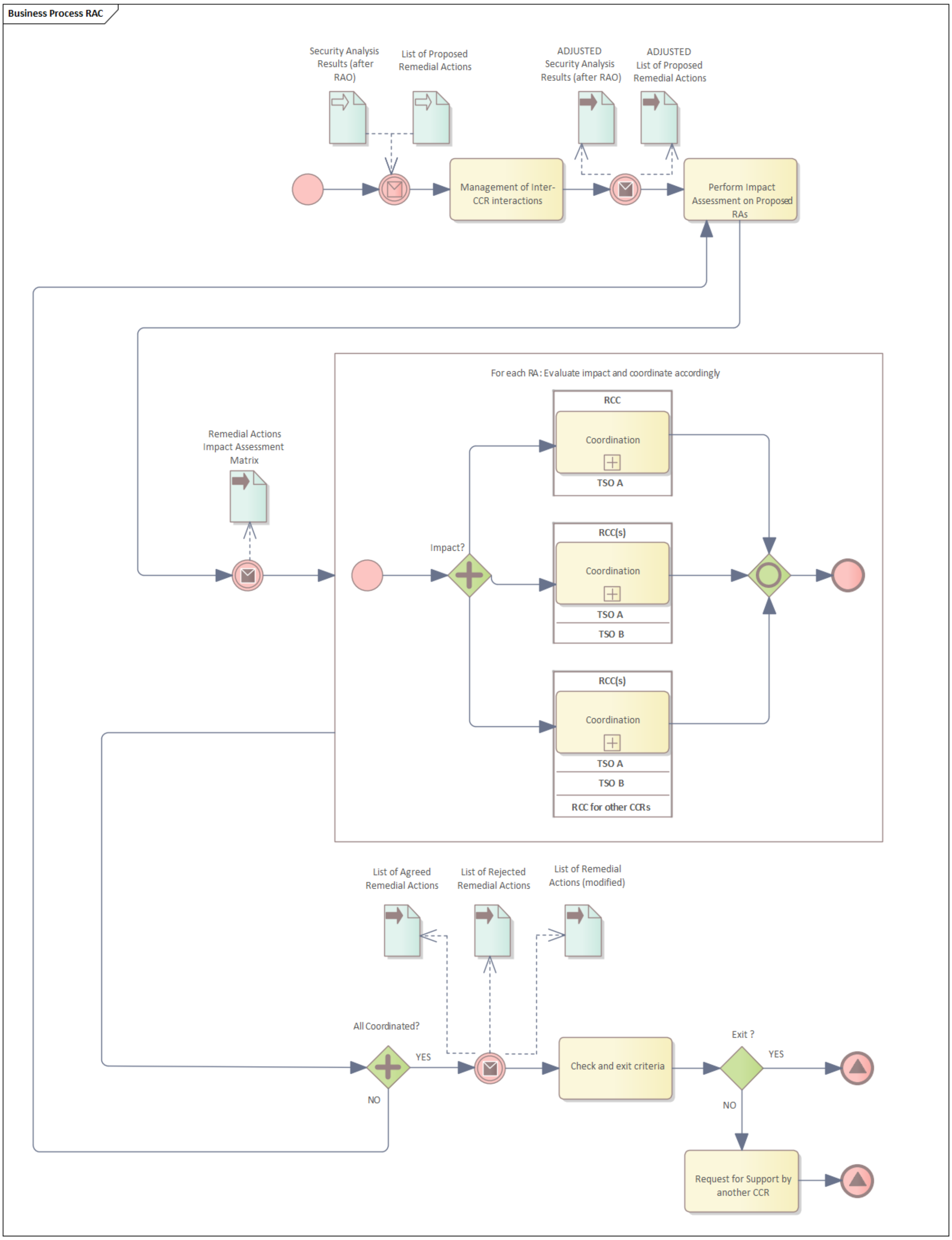
```
<nc:ShuntCompensatorModification rdf:ID="_ddb3c55f-b2ec-414e-baa3-592829e2edb2">
  <cim:IdentifiedObject.mRID>ddb3c55f-b2ec-414e-baa3-592829e2edb2</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>Shunt action 1</cim:IdentifiedObject.name>
  <nc:GridStateAlteration.PropertyReference
rdf:resource="https://energy.referencedata.eu/PropertyReference/ShuntCompensator.sections"/>
  <nc:GridStateAlteration.GridStateAlterationRemedialAction rdf:resource="#_7acbe48a-bd54-4cd7-af2e-87768357c559"/>
  <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
  <nc:ShuntCompensatorModification.ShuntCompensator rdf:resource="#_002b0a40-3957-46db-b84a-30420083558f"/>
</nc:ShuntCompensatorModification>
<nc:GridStateAlterationRemedialAction rdf:ID="_7acbe48a-bd54-4cd7-af2e-87768357c559">
  <cim:IdentifiedObject.mRID>7acbe48a-bd54-4cd7-af2e-87768357c559</cim:IdentifiedObject.mRID>
```

```xml
  <cim:IdentifiedObject.name>shunt RA</cim:IdentifiedObject.name>
  <cim:IdentifiedObject.description>Curative RA: ShuntCompensatorModification (step to 0). Shunt compensator ID:
_002b0a40-3957-46db-b84a-30420083558f</cim:IdentifiedObject.description>
  <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
  <nc:RemedialAction.kind rdf:resource="https://cim4.eu/ns/nc#RemedialActionKind.curative"/>
  <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
  <nc:RemedialAction.AppointedToRegion rdf:resource="#_d093cec9-0b21-4e88-ac62-974b457fdf11"/>
</nc:GridStateAlterationRemedialAction>
```


7.4 Remedial Action Coordination

7.4.1 Description

The Remedial Action Coordination (RAC) is performed by the Remedial Action Coordinator. The RAC subprocess is illustrated in Figure 41.



2498

2499 **Figure 41 – Remedial Action Coordination**

2500

7.4.2 Inputs and Outputs

Table 11 – Inputs and Outputs for Remedial Action Coordination

Inputs	Outputs
List of Proposed Remedial Actions including sensitivity of Remedial Actions on Identified Constraints and costs of proposed Remedial Actions (per Remedial Action and in total)	Remedial Action Impact Assessment Matrix (with indication of impacted TSOs per RA)
Security Analysis Results (after RAO)	List of Agreed Remedial Actions
	List of Rejected Remedial Actions

7.4.3 Conformity Requirements

To be able to support remedial action coordination the Application shall conform to the following Application functions:

- Coordination Confirmation.

7.4.4 Remedial Action Schedule – After Coordination

The following snippet from the Remedial Action Schedule dataset illustrates an acceptance of a Remedial Action Schedule (corresponding to the proposed schedule above) upon the completion of the coordination process:

```
  <nc:RemedialActionScheduleAcceptance rdf:ID="_ac45dd32-c3de-49d3-9664-689b5a762fd5">
    <cim:IdentifiedObject.mRID>ac45dd32-c3de-49d3-9664-689b5a762fd5</cim:IdentifiedObject.mRID>
    <nc:RemedialActionScheduleAcceptance.kind rdf:resource =
"https://cim4.eu/ns/nc#RemedialActionScheduleAcceptanceKind.accepted"/>
    <nc:RemedialActionScheduleAcceptance.RemedialActionSchedule rdf:resource="#_e79dc7a3-3bd2-4a1a-87e7-
a8d90ae0e37c"/>
    <nc:RemedialActionScheduleAcceptance.SystemOperator rdf:resource="#_31cf0436-1ede-452a-8b59-2a65bfdc9006"/>

  </nc:RemedialActionScheduleAcceptance>
```

The following snippet from the Remedial Action Schedule and Impact Assessment Matrix dataset illustrates the outcome of a rejection of a Remedial Action Schedule upon the completion of the coordination process:

```
<!-Remedial Action Schedule Profile →

  <nc:RemedialActionSchedule rdf:ID="_e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e7c">
    <cim:IdentifiedObject.name>RAS</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.mRID>e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e37c</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.description>RAS</cim:IdentifiedObject.description>
    <nc:RemedialActionSchedule.ProposingEntity rdf:resour"e="https://energy.referencedata.eu/energy/EIC/10Y1001C--
000"5L"/>
    <nc:RemedialActionSchedule.RemedialAction rdf:resourse="#_7acbe48a-bd54-4cd7-af2e-87768357c59"/>
    <nc:RemedialActionSchedule.statusKind
rdf:resourse="https://cim4.eu/ns/nc#RemedialActionScheduleStatusKind.proposed"/>
  </nc:RemedialActionSchedule>
--- Impact Assessment Matrix Profile -->

  <nc:RemedialActionScheduleOutcomeValue rdf:ID="_9f16db8d-3c1f-4fe8-b22f-51e223c8994">
    <cim:IdentifiedObject.mRID>9f16db8d-3c1f-4fe8-b22f-51e223c89694</cim:IdentifiedObject.mRID>
    <nc:OutcomeValue.ImpactAssessmentMatrix rdf:resourse="#_1555e1eb-ba6a-4171-bf0c-18d89fcf8b0"/>
    <nc:OutcomeValue.ImpactedSystemOperator rdf:resourse="#_1682bb5a-0eca-4923-a898-f7b6c4aa82b"/>
    <nc:OutcomeValue.outcome rdf:resourse="https://cim4.eu/ns/nc#OutcomeImpactAssessmentKind.false"/>
    <nc:RemedialActionOutcomeValue.RemedialActionSchedule rdf:resourse="#_e79dc7a3-3bd2-4a1a-87e7-a8d90ae0e7c"/>
  </nc:RemedialActionScheduleOutcomeValue>
```

7.5 Final Validation

7.5.1 Description

The Final Validation session is performed by the Remedial Action Validator. The subprocess is illustrated in Figure 42.

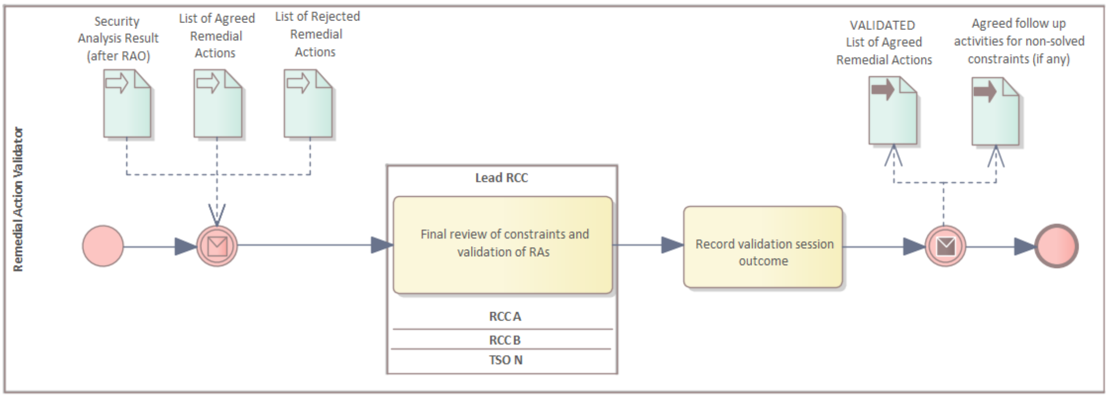


Figure 42 – Final Validation session

7.5.2 Inputs and Outputs

Table 12 – Inputs and Outputs for Final Remedial Action Validation

Inputs	Outputs
Outcome of RA agreement process (agreed remedial actions and their schedule)	Validated and potentially updated Remedial Action Impact Assessment Matrix (with indication of impacted TSOs)
Security Analysis Results (after RAO)	Agreed follow-up activities for non- solved Identified Constraints, if any

The following snippets illustrate the Impact Assessment Matrix and the corresponding Remedial Action and Remedial Action Schedule.

The Remedial Action dataset is as follows:

```
  <nc:TapPositionAction rdf:”D="_587cb391-ed1°-4a1d-876e-f90241add”e5">
    <cim:IdentifiedObject.mRID>587cb391-ed1°-4a1d-876e-f90241addce5</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>TapRA</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example of tap position action</cim:IdentifiedObject.description>
    <nc:GridStateAlteration.PropertyReference
rdf:resour”e="https://energy.referencedata.eu/PropertyReference/TapChanger.s”ep"/>
    <nc:GridStateAlteration.GridStateAlterationRemedialAction rdf:resour”e="#_5898c268-9b32-4ab5-9cfc-
64546135a”37"/>
    <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
    <nc:TapPositionAction.TapChanger rdf:resour”e="#_f6e8823f-d431-6fc7-37cf-b7a0d8003”dd"/>
  </nc:TapPositionAction>

  <nc:GridStateAlterationRemedialAction rdf:”D="_5898c268-9b32-4ab5-9cfc-64546135a”37">
    <cim:IdentifiedObject.mRID>5898c268-9b32-4ab5-9cfc-64546135a337</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>RA1</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example. Curative RA: TapPositionAction on PST (Tap position =
6)</cim:IdentifiedObject.description>
    <nc:RemedialAction.normalAvailable>true</nc:RemedialAction.normalAvailable>
    <nc:RemedialAction.kind rdf:resour”e="https://cim4.eu/ns/nc#RemedialActionKind.curat”ve"/>
    <nc:RemedialAction.isCrossBorderRelevant>true</nc:RemedialAction.isCrossBorderRelevant>
    <nc:RemedialAction.AppointedToRegion rdf:resour”e="#_7dabea20-7b2f-4f53-a4fd-8c075c9ed”8c"/>
  </nc:GridStateAlterationRemedialAction>
```

The Remedial Action Schedule dataset is as follows:

```
  <nc:RemedialActionSchedule rdf:”D="_264f9a19-ae29-4c95-b44c-6b7919ca0”6c">
    <cim:IdentifiedObject.name>RAS</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.mRID>264f9a19-ae29-4c95-b44c-6b7919ca0f6c</cim:IdentifiedObject.mRID>
    <nc:RemedialActionSchedule.ProposingEntity rdf:resour”e="https://energy.referencedata.eu/energy/EIC/10Y1001C--
000”5L"/>
    <nc:RemedialActionSchedule.RemedialAction rdf:resourse="#_587cb391-ed16-4a1d-876e-f90241adde5"/>
    <nc:RemedialActionSchedule.statusKind
rdf:resour”e="https://cim4.eu/ns/nc#RemedialActionScheduleStatusKind.proposed"/>
    <nc:RemedialActionSchedule.Contingency rdf:resourse="#_5d587c7e-9ced-416a-ad17-6ef9b241a98"/>
  </nc:RemedialActionSchedule>
```

The Impact Assessment Matrix dataset is as follows:


```
  <nc:QualitativeRemedialActionImpact rdf:”D="_70648bad-5435-49e8-82df-c0baa468e”d0">
    <cim:IdentifiedObject.mRID>70648bad-5435-49e8-82df-c0baa468e4d0</cim:IdentifiedObject.mRID>
    <nc:RemedialActionImpact.impactQuantity>5.8</nc:RemedialActionImpact.impactQuantity>
    <nc:RemedialActionImpact.kind rdf:resour”e="https://cim4.eu/ns/nc#ImpactAgreementKind.alw”ys"/>
    <nc:RemedialActionImpact.AssessingSystemOperator rdf:resour”e="#_1682bb5a-0eca-4923-a898-f7b6c4aa8”2b"/>
    <nc:RemedialActionImpact.RemedialAction rdf:resour”e="#_5898c268-9b32-4ab5-9cfc-64546135a”37"/>
  </nc:QualitativeRemedialActionImpact>

  <nc:OwnerRemedialActionAssessment rdf:”D="_1069a38a-f92d-4463-86ac-9ad315ffe”38">
    <cim:IdentifiedObject.mRID>1069a38a-f92d-4463-86ac-9ad315ffef38</cim:IdentifiedObject.mRID>
    <nc:OwnerRemedialActionAssessment.ImpactedSystemOperator rdf:resour”e="#_1682bb5a-0eca-4923-a898-f7b6c4aa8”2b"/>
    <nc:OwnerRemedialActionAssessment.RemedialActionImpact rdf:resour”e="#_70648bad-5435-49e8-82df-c0baa468e”d0"/>
  </nc:OwnerRemedialActionAssessment>

  <nc:CalculationBasedImpactAssessmentMatrix rdf:”D="_eaf1905f-327a-47c7-869a-2af02b88e”90">
    <cim:IdentifiedObject.mRID>eaf1905f-327a-47c7-869a-2af02b88e090</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>IAM1</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example of Impact Assessment
Matrix</cim:IdentifiedObject.description>
  </nc:CalculationBasedImpactAssessmentMatrix>

  <nc:ListBasedImpactAssessmentMatrix rdf:”D="_79d7c6dc-3bbc-4e5b-af0f-653790ff0”eb">
    <cim:IdentifiedObject.mRID>79d7c6dc-3bbc-4e5b-af0f-653790ff07eb</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>IAM2</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example of Impact Assessment
Matrix</cim:IdentifiedObject.description>
  </nc:ListBasedImpactAssessmentMatrix>

  <nc:RemedialActionOutcomeValue rdf:”D="_a0cf09dd-449e-4e80-ab31-92a92bbb9”0e">
    <cim:IdentifiedObject.mRID>a0cf09dd-449e-4e80-ab31°92a92bbb990e</cim:IdentifiedObject.mRID>
    <nc:OutcomeValue.ImpactAssessmentMatrix rdf:resour”e="#_eaf1905f-327a-47c7-869a-2af02b88e”90"/>
    <nc:OutcomeValue.ImpactedSystemOperator rdf:resour”e="#_1682bb5a-0eca-4923-a898-f7b6c4aa8”2b"/>
    <nc:OutcomeValue.outcome rdf:resour”e="https://cim4.eu/ns/nc#OutcomeImpactAssessmentKind.t”ue"/>
    <nc:RemedialActionOutcomeValue.RemedialAction rdf:resour”e="#_5898c268-9b32-4ab5-9cfc-64546135a”37"/>
  </nc:RemedialActionOutcomeValue>

  <nc:RemedialActionScheduleOutcomeValue rdf:”D="_8c504edb-1e45-407a-a190-496c144a2”f9">
    <cim:IdentifiedObject.mRID>8c504edb-1e45-407a-a190-496c144a2ef9</cim:IdentifiedObject.mRID>
    <nc:OutcomeValue.ImpactAssessmentMatrix rdf:resour”e="#_79d7c6dc-3bbc-4e5b-af0f-653790ff0”eb"/>
    <nc:OutcomeValue.ImpactedSystemOperator rdf:resour”e="#_1682bb5a-0eca-4923-a898-f7b6c4aa8”2b"/>
    <nc:OutcomeValue.outcome rdf:resour”e="https://cim4.eu/ns/nc#OutcomeImpactAssessmentKind.fa”se"/>
    <nc:RemedialActionOutcomeValue.RemedialActionSchedule rdf:resour”e="#_264f9a19-ae29-4c95-b44c-6b7919ca0”6c"/>
  </nc:RemedialActionScheduleOutcomeValue>
```


The following snippets illustrate the Security Analysis Result dataset and the corresponding Contingency, Equipment, and State Variables relationships.

The Security Analysis Result dataset snippet is as follows:


```
  <nc:ContingencyPowerFlowResult rdf:”D="_ea1eebe0-7e5e-46c1-8cf6-af110484a”f3">
    <cim:IdentifiedObject.mRID>ea1eebe0-7e5e-46c1-8cf6-af110484adf3</cim:IdentifiedObject.mRID>
    <nc:ContingencyPowerFlowResult.Contingency rdf:resour”e="#_7e31c67d-67ba-4592-8ac1-9e806d697”8e"/>
    <nc:PowerFlowResult.isViolation>true</nc:ContingencyPowerFlowResult.isViolation>
    <nc:PowerFlowResult.valueA>1673.4026</nc:ContingencyPowerFlowResult.valueA>
    <nc:PowerFlowResult.ACDCTerminal rdf:resour”e="#_3b3075b8-e0e5-66e9-447e-d7e11f767”8f"/>
    <nc:PowerFlowResult.atTime>2023-03-28T07:30:00Z</nc:ContingencyPowerFlowResult.atTime>
    <nc:PowerFlowResult.ReportedByRegion rdf:resour”e="#_09cf1e44-3328-4127-861a-14f187aca”ff"/>
    <nc:PowerFlowResult.OperationalLimit rdf:resour”e="#_b8fa5795-2fb2-3a9f-af51-44051d9fa”e7"/>
  </nc:ContingencyPowerFlowResult>

  <nc:BaseCasePowerFlowResult rdf:”D="_b1d6ec9a-76d3-4162-b19a-99b09fcd8”fa">
    <cim:IdentifiedObject.mRID>b1d6ec9a-76d3-4162-b19a-99b09fcd80fa</cim:IdentifiedObject.mRID>
    <nc:PowerFlowResult.isViolation>false</nc:BaseCasePowerFlowResult.isViolation>
    <nc:PowerFlowResult.ACDCTerminal rdf:resour”e="#_3b3075b8-e0e5-66e9-447e-d7e11f767”8f"/>
    <nc:PowerFlowResult.atTime>2023-03-28T06:30:00Z</nc:BaseCasePowerFlowResult.atTime>
    <nc:PowerFlowResult.valueW>-1.53093</nc:BaseCasePowerFlowResult.valueW>
    <nc:PowerFlowResult.valueVAR>0.961664</nc:BaseCasePowerFlowResult.valueVAR>
    <nc:PowerFlowResult.ReportedByRegion rdf:resour”e="#_09cf1e44-3328-4127-861a-14f187aca”ff"/>
  </nc:BaseCasePowerFlowResult>
```


The corresponding Contingency dataset snippet is as follows:


```
  <nc:OrdinaryContingency rdf:”D="_7e31c67d-67ba-4592-8ac1-9e806d697”8e">
    <cim:IdentifiedObject.name>CO2</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.description>This is an example of an ordinary contingency;Tie Line
loss</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>7e31c67d-67ba-4592-8ac1-9e806d697c8e</cim:IdentifiedObject.mRID>
    <nc:Contingency.EquipmentOperator rdf:resour”e="https://data.europa.eu/energy/EIC/10X1001A1001A”94"/>
    <nc:Contingency.normalMustStudy>true</nc:Contingency.normalMustStudy>
  </nc:OrdinaryContingency>

  <cim:ContingencyEquipment rdf:”D="_7ec56068-a714-4445-ae19-dd34429ec”22">
    <cim:IdentifiedObject.name>L2</cim:IdentifiedObject.name>
```

```
    <cim:IdentifiedObject.description>The equipment for this contingency; Tie Line
loss</cim:IdentifiedObject.description>
    <cim:IdentifiedObject.mRID>7ec56068-a714-4445-ae19-dd34429ec722</cim:IdentifiedObject.mRID>
    <cim:ContingencyElement.Contingency rdf:resour”e="#_7e31c67d-67ba-4592-8ac1-9e806d697”8e"/>
    <cim:ContingencyEquipment.contingentStatus
rdf:resour”e="https://cim.ucaiug.io/ns#ContingencyEquipmentStatusKind.outOfServ”ce"/>
    <cim:ContingencyEquipment.Equipment rdf:resour”e="#_d9622e7f-5bf0-4e7e-b766-b8596c6fe”ae"/>
  </cim:ContingencyEquipment>
```


The corresponding Equipment dataset snippet is as follows:


```
  <cim:ACLineSegment rdf:”D="_d9622e7f-5bf0-4e7e-b766-b8596c6fe”ae">
    <cim:ACLineSegment.b0ch>0.000147655</cim:ACLineSegment.b0ch>
    <cim:ACLineSegment.bch>9.42478e-5</cim:ACLineSegment.bch>
    <cim:ACLineSegment.g0ch>0.00015</cim:ACLineSegment.g0ch>
    <cim:ACLineSegment.gch>0.00015</cim:ACLineSegment.gch>
    <cim:ACLineSegment.r>4.3</cim:ACLineSegment.r>
    <cim:ACLineSegment.r0>7.1</cim:ACLineSegment.r0>
    <cim:ACLineSegment.shortCircuitEndTemperature>160</cim:ACLineSegment.shortCircuitEndTemperature>
    <cim:ACLineSegment.x>76</cim:ACLineSegment.x>
    <cim:ACLineSegment.x0>228</cim:ACLineSegment.x0>
    <cim:ConductingEquipment.BaseVoltage rdf:resour”e="#_63893f24-5b4e-407c-9a1e-4ff71121f”3c" />
    <cim:Conductor.length>100</cim:Conductor.length>
    <cim:Equipment.EquipmentContainer rdf:resour”e="#_77ca5612-67a1-4a52-a180-86560777a”4a" />
    <cim:IdentifiedObject.mRID>d9622e7f-5bf0-4e7e-b766-b8596c6fe4ae</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>TieLine_BE_FR3</cim:IdentifiedObject.name>
  </cim:ACLineSegment>
  <cim:Terminal rdf:”D="_3b3075b8-e0e5-66e9-447e-d7e11f767”8f">
    <cim:ACDCTerminal.sequenceNumber>2</cim:ACDCTerminal.sequenceNumber>
    <cim:IdentifiedObject.mRID>3b3075b8-e0e5-66e9-447e-d7e11f76788f</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>Cub_2</cim:IdentifiedObject.name>
    <cim:Terminal.ConductingEquipment rdf:resour”e="#_d9622e7f-5bf0-4e7e-b766-b8596c6fe”ae" />
    <cim:Terminal.ConnectivityNode rdf:resour”e="#_f738d362-c11c-4ca2-82da-a4fa115b3”92" />
    <cim:Terminal.phases rdf:resour”e="https://cim.ucaiug.io/ns#PhaseCode.”BC" />
  </cim:Terminal>
  <cim:OperationalLimitSet rdf:”D="_60f26e2f-c17e-e662-8205-e09a7a451”44">
    <cim:IdentifiedObject.mRID>60f26e2f-c17e-e662-8205-e09a7a451844</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>Current rating for TieLine_BE_FR3</cim:IdentifiedObject.name>
    <cim:OperationalLimitSet.Terminal rdf:resour”e="#_3b3075b8-e0e5-66e9-447e-d7e11f767”8f" />
  </cim:OperationalLimitSet>
  <cim:CurrentLimit rdf:”D="_b8fa5795-2fb2-3a9f-af51-44051d9fa”e7">
    <cim:CurrentLimit.normalValue>1574</cim:CurrentLimit.normalValue>
    <cim:IdentifiedObject.mRID>b8fa5795-2fbª-3a9f-af51-44051d9face7</cim:IdentifiedObject.mRID>
    <cim:IdentifiedObject.name>patl for TieLine_BE_FR3</cim:IdentifiedObject.name>
    <cim:OperationalLimit.OperationalLimitSet rdf:resour”e="#_60f26e2f-c17e-e662-8205-e09a7a451”44" />
    <cim:OperationalLimit.OperationalLimitType rdf:resour”e="#_811ce332-2072-7ec8-8f15-1860770be”87" />
  </cim:CurrentLimit>
```


The corresponding Steady State Hypothesis dataset snippet is as follows:


```
  <cim:CurrentLimit rdf:abo”t="#_b8fa5795-2fb2-3a9f-af51-44051d9fa”e7">
    <cim:CurrentLimit.value>1574</cim:CurrentLimit.value>
    <cim:IdentifiedObject.mRID>b8fa5795-2fb2-3a9f-af51-44051d9face7</cim:IdentifiedObject.mRID>
  </cim:CurrentLimit>
```


The corresponding base case State Variables dataset snippet is as follows:


```
  <cim:SvPowerFlow rdf:”D="_7807dd58-6c58-43d2-9998-83b6cc816”33">
    <cim:SvPowerFlow.Terminal rdf:resour”e="#_3b3075b8-e0e5-66e9-447e-d7e11f767”8f" />
    <cim:SvPowerFlow.p>-1.53093</cim:SvPowerFlow.p>
    <cim:SvPowerFlow.q>0.961664</cim:SvPowerFlow.q>
  </cim:SvPowerFlow>
```


7.5.3 Conformity Requirements

To be able to support final validation the Application shall conform to the following Application functions:

- Coordination Confirmation.

8 Application profile specification

8.1 General

Network codes related business process rely on data exchange standards to exchange the information on power system models as well as the relevant additional information specific for business processes. The set of information used by a business process is complex and has many interdependencies. In addition, the complexity is amplified by the requirement that this set of information needs to be used by multiple business processes as long as the timeframe (day ahead, two days ahead, etc.) and timestamp (e.g. particular hour in a day ahead timeframe) are the same. The requirements on this are set forth in the Network Codes related EU Regulations and Guidelines.

The following clarifications are important in order to have a common understanding on the types of data that is being exchanged and what data exchange standards or specifications are used to exchange it.

- IGM (Individual Grid Model) is a term defined in CACM[7]. Other network codes and methodologies refer to it. Additional requirements are specified by other network codes and business process methodologies.
- The IGM is the building block to create a common grid model (CGM) which is used to perform business processes for a particular timestamp of a timeframe. It is prepared by the modelling authority responsible for the power system.
- CGM (Common Grid Model) is a term defined in CACM. Other network codes and methodologies refer to it. A CGM includes all IGMs.
- IGMs and a CGM represent the power system, its connectivity and essential characteristics for the purpose of conducting power flow calculations (as a minimum requirement). This comes with all details related to the power system model, e.g. what portions of the grid are present, which data relates to the alternated current (AC) part of the power system or direct current (DC) part of the power system, etc. The IGMs and CGMs data exchange is covered by some of the profiles defined by the IEC CGMES which is a standard that defines various profiles used in the data exchange.
- The creation of IGMs, their collection and merging in CGMs is performed in the CGM Build process.
- The term “All relevant data” is used to describe all information that is exchanged in addition to the CGMs and serves needs of different business processes, i.e., CCC, CSA, OPC and Regional STA. This information includes structural, scheduled and per market time unit data related to modelling of remedial actions, contingencies, assessed network elements, availability plans (outage planning information), etc. The content of this data is a superset of the requirements by all business processes that rely on CGMs of a particular timestamp of a timeframe. This information exchange is covered by ENTSO-E Network Codes profiles. Additional data such as data to support short circuit calculations, geographical location information, diagram layout related information, dynamics data can also be added, if necessary. The IEC CGMES or other standards (e.g. IEC 61970-457 for dynamics and simulation settings) can be used to exchange this information.
- It is expected that all data delivered as IGM, CGM and All relevant data are consistent and conform to both the specifications defined in the data standards and business constraints that can be defined at pan-European or regional level. Data providers need to ensure this as CGM Build process cannot guarantee the consistency due to the fact that not all data is available in the CGM Build process.
- Consistency validation between ”All relevant data” and a CGM is performed as part of the business process that will use all data and can only result in invalidating “All relevant data” (i.e., it cannot invalidate a CGM) which may lead to limiting the scope of the business process. It is not expected that the CGM Build process is restarted to remedy such inconsistencies. IGM and CGM improvements can be performed during the CGM Build process.

The CSA needs information on remedial actions, assessed elements, contingencies, etc in order to complete the data needed to perform the coordinated security analysis. The all relevant data for CSA is supplied by the following profiles:

[7] Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

- Assessed element profile
- Availability schedule profile
- Contingency profile
- Equipment reliability profile which includes SIPS configuration, security limits, Power Transfer Corridor
- Grid disturbance profile
- Impact assessment matrix profile
- Monitoring area profile
- Object registry profile
- Power schedule profile
- Power system project profile
- Remedial action profile
- Remedial action schedule profile
- Security analysis result profile
- Sensitivity matrix profile
- State instruction schedule profile
- Steady state hypothesis schedule profile
- Steady state instruction profile

8.2 Dataset Dependency

The dataset dependency is illustrated in Figure 43. The diagram contains most used datasets conforming to different profiles but not necessarily all profiles. Therefore, for additional dependencies between datasets based on CGMES profiles not shown in the diagram, the dependencies provided in the CGMES are followed.

Note that the RAS profile dataset is exchanged as a schedule and not per time unit.

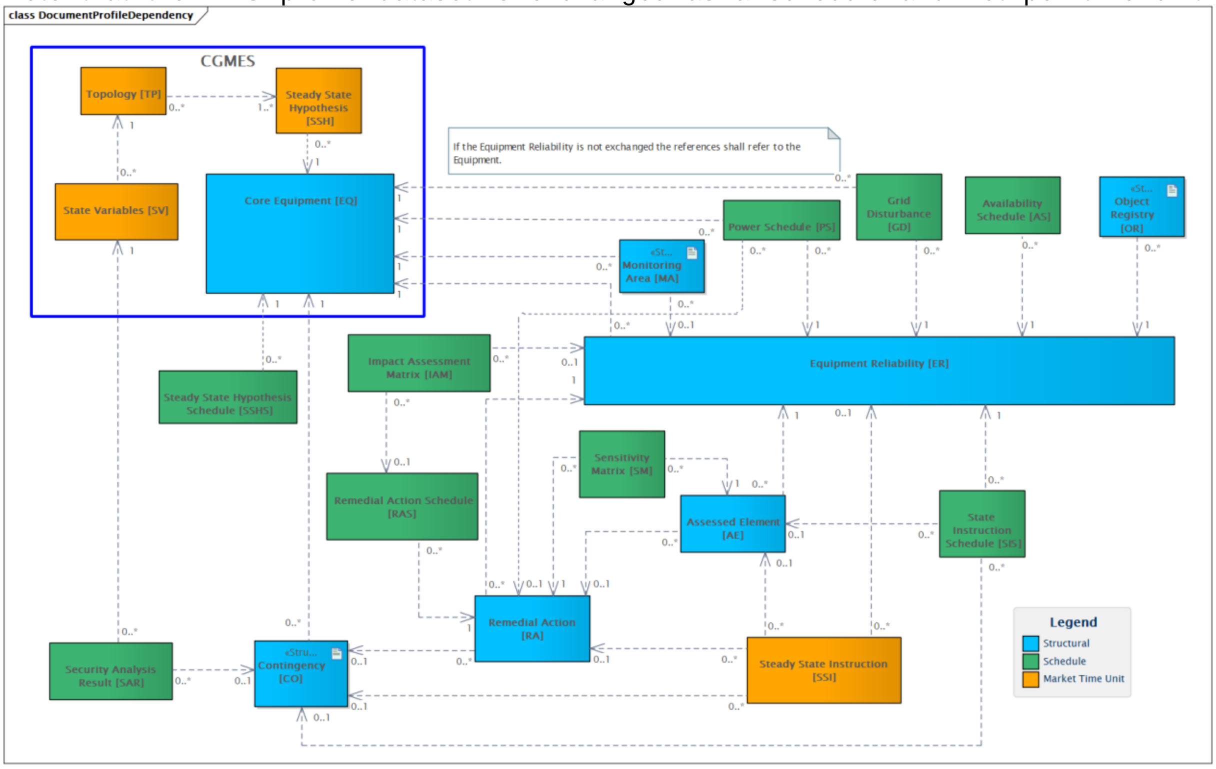


Figure 43 – Dataset dependencies

8.2.1 Dataset Header

Information on dependencies between datasets is provided by the attribute dcterms:references in the dataset header. This attribute is part of the extended by ENTSO-E header and metadata definitions. The header vocabulary contains all attributes defined in IEC 61970-552 and extended attributes to facilitate transition process for data exchanges that are using IEC 61970-552:2016 header. The updated header definitions rely on W3C recommendations which are used worldwide and are positively recognised by the European Commission.

RCP DES does not use IEC 61970-552:2016 header attributes and relies only on the extended attributes in the ENTSO-E document. SHACL based constraints provided by ENTSO-E as application profiles define required cardinalities for attributes part of the dataset header.

8.3 Compatibility with Other Data Exchange Standards

NC profiles have been designed and developed as extension to the version of CIM used by CGMES v3.0 (IEC 61970-600-1 and -2:2021). In general, they partially are compatible with CGMES v2.4 (IEC TS 61970-600-1 and -2:2017) to the extent present in both CGMES v3.0 and v2.4. This means, there are model incompatibilities (due to bug fixes in v3.0 and clear documentation of intent), namespace incompatibilities (due CIM17 vs. CIM16 change), as well as serious limitations in scope if underlying model remains on CGMES v2.4. Therefore, the following attention points shall be noted:

- If CGMES v2.4 is used to represent the IGM and CGM the remedial action cannot efficiently model power electronics and battery units as these objects are only available in CGMES v3.0. This also includes modelling limitation of representing control functions that have direct impact on the power flow calculation.
- The information about the operational limits is exchanged in the equipment instance data in the case of CGMES v2.4 based data exchange. Therefore, when there is a need

to frequently update the information on the limits, this will require that equipment data is exchanged more frequently or that difference equipment profile shall be used to optimize the data exchange. This limitation does not occur if the IGM and CGM are using CGMES v3.0 as the operational limits is exchanged in the steady state hypothesis dataset.

- In order to achieve an optimal information exchange, it is assumed that persistent identifiers are used for the IGM and CGM objects. Applying datasets based on NC profiles as add-on to an exchange which does not rely on persistent identifiers is neither feasible nor practical for any downstream process relying on CGM.

- Handling of topology remedial actions, power transfer corridors and their limits, SPS, require more detailed underling model. As CGMES v2.4 has clarity gaps in the modelling of hybrid node breaker and bus branch models work arounds are not straight forward. In addition, SOGL and CSAm detail the requirement of using node-breaker model and defining topology as the data concerning the connectivity of the different transmission system or distribution system elements in a substation and includes the electrical configuration and the position of circuit breakers and isolators.

The usage of UCTE DEF as a data exchange format for IGM and CGM for the purpose of CSA, CCC, OPC, STA processes is not recommended in conjunction with NC set of profiles, for the following non-exhaustive list of reasons (to name a few):

- NC profiles metadata require linkage with the IGM and CGM. UCTE DEF models are identified by file name. Therefore, an additional metadata layer must be added.

- NC profiles require references to identifiers of the elements from IGM in order to link the remedial actions, assessed elements, etc. UCTE DEF used node codes and circuit numbers (for interconnecting elements) in order to uniquely identify them. Therefore, if UCTE DEF is used there will be a need to maintain a list of persistent identifiers and their relationship with node names or elements names.

- CSA requires information on different operational limits that are related to the different time phases to be studied. UCTE DEF has very limited capabilities to exchange limits.

- Due to the scope of the UCTE DEF the business processes would be limited in terms of what kind of grid state alterations and remedial actions could be described and considered in the coordination process. Identification of type and modelling of the network elements that support voltage control, shunt-connected reactive devices, voltage regulation on transformers in case of regulator being modelled on the non-regulated power transformer end, will require special attention as they are not in scope of UCTE DEF and will be impossible to model without extending UCTE DEF.

- Generation capacity used as part of remedial actions should be modelled in detail due to limits handling in case of aggregated modelling.

- UCTE DEF does not separate the information related to the equipment, the information related to the operating point and it also does not cover the solution information. Data consistency changes between data exchanged with NC profiles and UCTE DEF data will be more extensive (full model exchange), have high dependencies over mapping tables that have to be integrated in the middleware, and will not benefit from using one equipment model for multiple time stamps.

- UCTE DEF does not allow exchange of power flow solution data, therefore this report will have to be standardized (out of scope of this document) to achieve full information exchange.

- Use of replaced IGM in created CGM is not possible to trace in case of UCTE DEF, that might complicate the process of data consistency against the grid models and remedial action applicability.

Therefore, it is highly recommended that business processes plan for a transition to always rely on latest data exchange standards and specifications in order to benefit from the consistency at profile level (data exchange definition level) and be able to achieve business objectives without being constraint by the data exchange.

8.4 Common and Reference Data

In the context of RCP DES metadata is the following categories of data:

- Common data: a set of data that is common for datasets from different publishers. It is stable data that is kept mainly among TSOs community.
- Reference data: a set of data that is part of taxonomy. It includes necessary minimum and it is stable data that is reachable via URL. It can be defined by ENTSO-E or other bodies and everybody, even outside TSO community can use it.
- Dataset header: metadata that is exchanged as part of the dataset distribution to provide necessary minimum of information.

Both common data and reference data have stable identifiers and are maintained following strict process. The key point with reference data and common data is that they are managed in processes that are outside the process that are in focus, i.e. they are shared across several business processes and among different parties, they are external to any one specific business process, and well defined coordination is required.

Applications implementing NC related data exchanges shall support the metadata and manage the linkage with datasets conforming to CGMES and NC profiles.

8.4.1 Common Data

Common data is normally maintained outside specific business process as it is valid for multiple business processes. In general, there could be a portion of common data that is common for all publishers within a business process, but this should be rather an exception. For instance, in data exchanges using NC profiles, the following common data is foreseen:

- Synchronous Area
- Organisation and ro–e - Transmission System Operator, Security Coordinator
- Capacity Calculation Region
- Bidding Zone Border
- Bidding Zone
- Overlapping Zone
- Base voltage (currently exchanged as boundary set, but this is being separated in the new setup)
- Any other data agreed to be treated as common data.

Therefore, the IGM creation process (delivering an IGM) and the process to prepare “All relevant data” are dependent on each other so that consistency between different datasets is ensured when datasets are prepared. Publishers (in this case TSOs) will refer to the identifiers defined in the datasets of the common data and IGM. Other parties in the process such as RCC

(RAO or other systems) will also use and refer to the common data when prepare the outputs of a business process.

In general, CGMES based data exchanges will also rely on common data such as information on base voltages and other common elements that are currently added to boundary datasets. It should be noted that boundary dataset can be seen as a kind of common data. However, this dataset has a special function essential for connecting (merging) data from different publishers (TSOs, modelling authorities – in general).

Common data is serialised according to either CGMES or NC profiles. For example, Equipment profile is used for the common data related to base voltages and Equipment Reliability profile is used for capacity calculation regions data and other specified classes in this profile. Therefore, datasets based on CGMES or NC profiles will refer to common data datasets via the attribute dcterms:references in the dataset header.

8.4.2 Reference Data

In order to have a better understanding of the header and metadata model, please review ENTSO-E Metadata and document header data exchange specification and ENTSO-E Boundary and reference data exchange application specification which are available in CGMES library under the ENTSO-E website.

In general, reference data can include code list, taxonomies or resources that are maintained in other processes.

- **Code list**: A Code list is a structured and predefined set of codes or identifiers that represent specific values, concepts, or categories within a defined domain. Some Code lists are linked to the information model and are then represented as enumerators. Other code list represent process and domain specific values. An example of a simple Code list is the Confidentiality provided in Energy Reference Data SKOS Concept Schemes.

- **Taxonomy**: Taxonomy is a systematic classification or arrangement of items, concepts, or terms into hierarchical categories based on shared characteristics, attributes, or relationships. It provides a structured framework for organizing information in a way that facilitates understanding, retrieval, and communication. Taxonomies are used in various fields, including biology, information science, knowledge management, and content organization, to create a logical and standardized structure for categorizing and organizing diverse elements. An example of a taxonomy is FaultCauseType provided in Energy Reference Data SKOS Concept Schemes.

- **Linked to resource**: An example of a linked to resource type of reference data is PowerFlowSettings provided in Energy Reference Data SKOS Concept Schemes.

The reference data is built using W3C recommendations, mainly, Provenance ontology (PROV-O), Time Ontology and Data Catalog Vocabulary (DCAT), Simple Knowledge Organization System (SKOS). The reference data can be referenced directly from the datasets. Examples of reference data are:

- Property Reference
- Country ISO codes
- Profiles URIs/identifiers
- Spatial information
- Any other data agreed to be treated as reference data.

As of this writing, reference data is manually created and maintained, and is provided to project participants as-is, to allow for implementations to progress. In the meantime, the process, and the governance for target publication of reference data is under development and will be leveraging linked data technologies and be managed centrally.

It should be noted that there is no intention that applications should implement string decoding of the URI address. The requirement is that applications shall access the URL (either in Internet or locally if a service is provided) and interpret the properties defined in the RDF based dataset that are related to a reference data item. There is some logic applied for the URIs, but this is more for the purpose of human orientation. The following examples illustrate the logic that is going to be applied when preparing the reference data:

- Property Reference
    - https://energy.referencedata.eu/PropertyReference/TapChanger.step

  EIC codes, which is used in the dcterms:publisher in the dataset header
    - https://energy.referencedata.eu/EIC/10T1001C--000170
- Spatial information (Frame, MAS) – in case of multiple modelling authority sets there is a number, if only one MAS the number is not provided.
    - For DK west: https://energy.referencedata.eu/DK-1-Power-Transmission-System
    - For NO: https://energy.referencedata.eu/NO-Power-Transmission-System
    - For HVDC: https://energy.referencedata.eu/NL-NO-Direct-Current-System
    - For HVDC: https://energy.referencedata.eu/FR-UK-1-Direct-Current-System
- Action (multiple business processes can reuse this action, it is used in prov:wasGeneratedBy in the dataset header.)
    - https://energy.referencedata.eu/{PROCESS}-{TIMEFRAME}-{RUN}-{PROFILE_KEYWORD}
    - https://energy.referencedata.eu/CGM-1D-1

  In general, this is just a link using UUID based URI, however, to support offline operation and not forcing applications to look up the name in the linked data given by the URI, the URI has a naming convention. For instance, if the data is only used by a single process e.g. CSA then CGM is replaced by CSA: https://energy.referencedata.eu/CSA-1D-1. If it is used by more than one process it is CGM or TYNDP (for long term planning).
- Abstract reference to the dataset that can have different versions is provided by dcat:isVersionOf
    - https:/energy.referencedata.eu/Tenet-EQ – for the equipment of TenneT
    - https:/energy.referencedata.eu/NorNed-EQ – for the equipment of NorNed HVDC

8.5 Dataset Distribution

8.5.1 Manifest

ENTSO-E Metadata and document header data exchange specification defines how manifest can be structured and exchanged. The document also includes examples of manifest. Business processes can optimise the data exchange by using this approach. This approach provides linkage between different datasets and information on the content which is important to know prior importing all the datasets and processing their headers.

8.5.2 File Naming

Specifications of NC profiles do not specify file naming convention as it is required that all relevant metadata is provided via the dataset header and separate manifest dataset which conforms to the ENTSO-E Metadata and document header data exchange specification. The core idea of having manifest dataset and DCAT is to avoid implementation to rely on naming standards. There shall be no information derived from the file name by the tools handling the profiles. However, for human readability, the following file naming convention is recommended:

<dcat:startDate>_<dcterms:publisher>_<prov:wasGeneratedBy>[_dcat:version]

where dcat:startDate, dcterms:publisher, prov:wasGeneratedBy, and dcat:version are properties exchanged as part of the dataset header.

- dcat:startDate: Date and Time when the data is valid for (YYYYMMDDThhmm). E.g. 20180118T0930. In case that we have a daily file, Thhmm is not required.
  - YYYY= Year
  - MM= Month
  - DD = Day
  - hh = hour
  - mm = minutes (30)
- dcterms:publisher: Party sending the dataset. For instance, Elia, Coreso. This is defined in the list of publishers.
- prov:wasGeneratedBy: Taking into account that the prov:wasGeneratedBy represents the action, it includes information about the process, the timeframe, the coordination run and the profile keyword.
- dcat:version: The dcat:version follows Semantic Versioning 2.0, i.e. it has three components and it is provided only if it is different from version 1 (e.g. different from 1.0.0). As the "." is used for file extension separator the "." in the version in the file name is replaces by "-".

Examples:

  - 20180118T0930Z_APG_CGM-1D-SSH.xml
  - 20180117T2230Z_APG_CGM-1D-EQ.xml
  - 20180117T2230Z_APG_CGM-EQ_1-2-0.xml
  - 20180118T1130Z_TSCNET-EU_CGM-1D-SV.xml
  - 20180118T1130Z_TSCNET-EU-APG_CGM-1D-SSH.xml
  - 20230512T2230Z_APG_CGM-RA_2-0-0.xml
  - 20230512T2230Z_APG_CGM-1D-1-RAS.xml

8.5.3 Serialisation Syntax

Different serialisation syntaxes are used when providing the datasets conforming to reference data, common data, constraints, CGMES profiles, and NC profiles. These serialisations will evolve over time following best practices and new specifications by W3C and IEC. The following list is provided for information.

Table 13 – Serialisation options

Dataset category	Current serialisation	Expected future serialisation
Common data: mainly based on EQ and ER profiles	CIM XML (IEC 61970-552)	JSON-LD
Reference data	RDFXML (W3C), TURTLE (W3C), JSON-LD (W3C)	RDFXML (W3C), TURTLE (W3C), JSON-LD (W3C)
CGMES	CIMXML (IEC 61970-552)	JSON-LD
NC Profiles	CIMXML (IEC 61970-552)	JSON-LD
Manifest	JSON-LD, CIMXML (IEC 61970-552)	JSON-LD
Boundary set	CIMXML (IEC 61970-552)	JSON-LD
SHACL based constraints	TURTLE (W3C) mainly to facilitate human readability. Other RDF serialisations are possible.	TURTLE (W3C) mainly to facilitate human readability. Other RDF serialisations are possible.

8.5.4 Exchange and Packaging

CIM based data exchanges allow for exchanging information based on multiple profiles in a single dataset. Example for this is the exchange of equipment, operation and short circuit profiles' datasets in a single file. When this happens the dataset header shall include the property dcterms:conformsTo to indicate to which profiles and constraints this data conforms to. In an exchange which is structured and follows certain exchange rules, combining different profiles cannot happen randomly and needs to be agreed so that receiving systems are prepared to receive such information and process it accordingly.

NC profiles can be used for exchange of data related to one CCR or multiple CCR. For example, Assessed element profile includes references to regions at object level, which allows for combining a list of assessed elements for all CCRs in a single dataset. The setup of the data exchange does not require exchange of single dataset, but it is recommended to use all means to avoid exchange od duplicate data. Business processes need to agree on what stages of the process data is handled in separate datasets and at which step of the process a combined dataset is necessary. This should take into account that manifest dataset can be used to exchange (report) on a combined set of data without the need to regroup the data within a single dataset (file). Therefore, it is recommended to utilise the manifest way of exchange in order to minimise the post processing of the data and bring essential clarify on the source if the data including possibilities to exchange the provenance of it.

Datasets serialised in CIMXML tend to have big file size and archive (zip) was traditionally used in CGMES based datasets. Similar to CGMES archive-in-archive is not allowed. ENTSO-E Metadata and document header data exchange specification recommends using .cimx extension of the archived files which are in reality zip archives. It is important that applications support this extension and ensure that reading archives is done via stream or other service that does not require full unzipping of the data, saving it and then parsing the information. The recommended approach is to access the archive read the manifest, then assess parts of the archive in the necessary sequence and then parsing the information without prior unzipping and storage. This specification does not limit the usage of .cimx, i.e. this extension can be used when archiving single datasets as well. However if .cimx is used the manifest file is required, if .zip is used the content of the .zip shall follow the .zip rules.

8.6 Dataset Validation

Dataset validation is important part of the business process related data exchanges. In general, datasets shall conform to the profile specifications on which the datasets are based on. In addition, there are sets of constraints / consistency rules that are defined for the business processes. NC profiles are supplying data for multiple business processes and there are requirements by methodologies to define consistency rules for different processes. The document NC Data Quality Management Provisions will be developed in Q2 2024 as required by CSAm. It will define the data validation framework and SHACL based constrains (both for consistencies within a dataset and across datasets) that are business specific and apply to either all regions or to a particular region. The objective is to minimise the number of constraints that apply to a particular region.

9 Dependencies Between Business Processes

This section will be completed in next versions of RCP DES in which other business processes such as OPC, CCC, cost-sharing, etc will be covered.

10 Conformity Assessment Scheme Setup Guidelines

Different applications can be designed to support different parts of the business processes and therefore utilise some or all NC profiles. The conformity assessment categories defined in this section should be used in the Conformity Assessment Scheme designed for the conformity process related to NC profiles (NC CAS). The use cases defined in RCP DES are direct input to the Test Use Cases (TUC) part of NC CAS. Along with TUC it is important to define different datasets (models and related data) that are needed to perform the test use cases. These datasets to be used in the conformity are called Test Configuration (TC).

This section defines the Application Functions that are considered important to cover the use cases outlined in the RCP DES. A set of Test configurations and their high level content is also defined.

<u>**The section will be revised during the Standard Vetting IOP 2024 organised on the NC Profiles.**</u>

10.1 Application Functions

Table 14 – Application functions defines necessary Application Functions to be included in the NC CAS.

Table 14 – Application functions

Name	Description	Prerequisite	Required profiles
Export of single dataset	The Application supports NC profiles' datasets that are either exported individually or together as a package.	Handling of reference data and common data	Applied for all NC profiles supported by the Application
Import of single dataset	The Application supports NC profiles' datasets that are either imported individually or together as a package.	Handling of reference data and common data	Applied for all NC profiles supported by the Application
Maintenance	The Application supports NC profiles' datasets and can perform maintenance operations (e.g. update, replace) on the data.	Handling of reference data and common data Import and export	Applied for all NC profiles supported by the Application
Structural data setup	The Application supports profiles related to the structural data of a business process.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	Equipment Reliability (ER), Monitoring Area (MA), Contingency (CO), Remedial Action (RA), Assessed Element (AE)

		- Export of single profile for the related profiles	
Scheduled data setup	The Application shall support profiles related to the scheduled and per time unit data exchange.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Export of single profile for the related profiles	State Instruction Schedule (SIS), Steady State Instruction (SSI),
Coordination Confirmation	The Application the interactions between parties sending data and parties receiving data.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Export of single profile for the related profiles - Import of single profile for the related profiles	Remedial Action Schedule (RAS), Security Analysis Results (SAR)
Security analysis	The Application supports security analysis using power system model and information on contingencies and assessed elements. The Application can export the result of the security analysis.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Structural data - Scheduled data - Export of single profile for the related profiles	Security Analysis Results (SAR)
Remedial action optimization	The Application supports optimization of the remedial actions and can export the result.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Export of single profile for the related profiles	Remedial Action Schedule (RAS), Impact assessment Matrix (IAM)

3116

3117 ## 10.2 Test Configurations

3118 ### 10.2.1 Requirements

3119 Test configurations are necessary to perform test use cases defined for conformity.

- Test configurations (TC) shall not be big models to allow for easy orientation.
- TC shall be designed on CGMES v3.0 IGMs and CGMs.
- There should be at least 4 TSOs represented in the test configuration.
- There should be at least 2 CCR (Capacity Coordinating Regions) in the test configurations.
- Test configurations shall cover all time frames – day ahead, intraday, year ahead, etc.
- All test configurations shall be consistent and have proper header information as well be aligned with reference data in order to allow testing in OPDE at later stage.
- There shall be a set of reference data according to equipment reliability profiles as well as other reference data and boundary information which shall be commonly shared between all test configurations. Using different sets of reference data shall be avoided as this causes issues and increases maintenance effort. However, it shall be possible to demonstrate an update of reference and boundary information.
- Test configurations shall demonstrate the exchange of the following NC related profiles as well as all combinations of dependencies between below mentioned profiles and CGMES profiles:
    - Assessed element profile (AE)
    - Availability schedule profile (AS)
    - Contingency profile (CO)
    - Equipment reliability profile (ER)
    - Grid Disturbance profile (GD)
    - Impact assessment matrix profile (IAM)
    - Monitoring area (MA)
    - Object registry profile (OR)
    - Power schedule (PS)
    - Power system project (PSP)
    - Remedial action profile (RA)
    - Remedial action schedule profile (RAS)
    - Security analysis result profile (SAR)
    - Sensitivity matrix profile (SM)
    - State instruction schedule profile (SIS)
    - Steady state hypothesis schedule profile (SHS)
    - Steady state instruction profile (SSI)
- Test configurations shall be developed as conform test configurations. Non-conform test configurations shall be developed as a second phase once it is proven that conform TCs and profiles reach a good level of stability.

- Remedial actions shall cover at least the following types:
  - Simple Remedial Actions of different types – change of setpoint, redispatch
  - Remedial Action dependent on a specific Contingency
  - Remedial Action dependent on a specific Assessed Element
  - Voltage Angle Remedial Actions
  - Voltage Magnitude Remedial Actions
  - PST
  - PST in a group
  - Topology change
- Assessed element shall include lines, transformers, PSTs, busbar coupler, special monitoring for voltage angle and magnitude.
- Contingencies shall include at least:
  - N-1
  - N-x
  - Busbar tripping (even if it might be considered N-1)
- Equipment reliability shall contain variants on the limits (Current Limits, Voltage Angle Limits, Voltage Magnitude Limits) and SIPS configuration.
- GLSK shall cover at least:
  - Generation ramping up
  - Generation ramping down
  - Load "cut-off" example
  - Example of energy blocks on power plants with several hours of start-up time

10.2.2 Types

Table 15 lists some test configurations that are considered important. Additional TCs can be added in the NC CAS.

Table 15 – Test configurations

Test configuration	Description
FullModelNC	This TC contains at least one instance of all classes and their attributes and associations defined in the NC Profiles.
OptimizedCSA	This TC is developed using available models SmallGrid, Svedala and MicroGrid. This allows for inclusion of four TSOs with different granularity. In case of four TSOs that following setup is realised: •The 4 TSOs (A, B, C and D) have the following 3 borders indicated by the adjacency of the border to the TSOs (A-B, B-C, D-A).

	•The CCR1 covers the borders AB and BC, while CCR2 covers the border DA. •TSOs A, B and C participate to CCR1, whose impact extends to TSO D. •TSOs A and D participate to CCR2 whose impact extends to TSO B. •TSO A participates in both CCRs, TSO B in CCR1 but not CCR2 (although it is impacted by CCR2), TSO C participates in CCR 1 and it is not impacted by CCR2, and finally TSO D participates to CCR2 but not CCR1 (although it is impacted by CCR1). The resulting overlapping zone thus spans TSOs A, B and D. The test configuration includes minimum 24 and maximum 72 (or 96) hours/time stamps. The following profiles are included in addition to the IGM and CGM instance data: Equipment reliability profile (ER), Remedial action profile (RA), Remedial action schedule profile (RAS), Assessed element profile (AE), Contingency profile (CO), Availability schedule profile (AS), Steady state instruction profile (SSI), State instruction schedule profile (SIS), Impact assessment matrix profile (IAM), Sensitivity matrix profile (SM), Security analysis result profile (SAR), Object registry profile (OR)
PerformanceNC	This TC is used to test performance of applications. The focus is on the volume of data and not on the complexity of the data.

10.3 Test Use Cases

This section defines basic test use cases that are considered important to initiate the Conformity Assessment Scheme related to NC profiles. Additional test use cases can be added during the development of NC CAS and it is maintenance.

10.3.1 TUC 1: Exchange of Initial Information

- TSO A, TSO B, TSO C, TSO D export the following information (in real cases some of these could be optional, but for the purpose of the test full scope is considered):
    - IGM
    - remedial actions
    - assessed elements
    - contingency
    - equipment reliability which includes SIPS configuration, security limits and power transfer corridor definitions
    - steady state instruction
    - GLSK
    - Availability schedule

  - Object registry
- RCC A and RCC B import all information. Consistency checks are performed.
- CGMs are merged and available.

10.3.2 TUC 2: Perform Regional Security Analysis and Export Results

- RCC A and RCC B perform regional security analysis on a CGM
- RCC A and RCC B export security analysis results

10.3.3 TUC 3: Perform RAO and Export Results, perform Coordination and Export results

This includes the workflow of the coordination runs

- RCC A and RCC B perform RAO
- RCC A and RCC B export security analysis results after RAO and proposed remedial actions schedules (using remedial action schedule profile)
- RCC A and RCC B perform impact assessment on proposed remedial actions and exports impact assessment matrix
- TSO A, TSO B, TSO C and TSO D send agreed and rejected remedial actions or eventually propose alternatives (coordination): Alternatives could be available RAs to be considered for the next iteration of RAO, or RA schedules to be further assessed. Please note that currently the RCCs and the CCRs have not yet agreed on a common process and rules for the evaluation and inclusion of alternative RA schedules.
- RCC A and RCC B perform security analysis after Coordination. RCC A and RCC B export security analysis results and updated impact assessment matrix.
- TSO A, TSO B, TSO C and TSO D update IGMs (SSH, TP, SV) if needed.

11 Annex A: Document Revision History

Version[8]	Date	Paragraph	Comments
1.0.0	2021-04-21		SOC approved.
2.0.0	2022-02-16		The specification was enriched with the following extensions and related profiles: • Equipment Reliability (Including energy areas and roles related to network codes, Direct Current related to DC Poles for Corridors). The content of this profile will be integrated as optional extension to the EQ profile of CGMES (similar to e.g. Equipment ShortCircuit). • Steady State Instruction • System Integrity Protection Schemes (SIPS) as part of the Remedial Action profile • Power Transfer Corridors (PTC) as part of Equipment Reliability profile. • Availability plan

[8] Versioning of the document follows Semantic Versioning 2.0.0 where a version number is having four components {major}.{minor}.{patch}-{pre-release}.

			• Generation and Load Shift Keys (Time phase, contingency induced balance, variation of losses) • Security limits as part of Equipment Reliability SOC approved.
2.1.0	2022-09-21		The specification considers the following changes: • Availability plan was renamed to Availability Schedule • A new profile for sensitivity matrix was included • Small changes to solve bugs and improve consistency of the profiles. • Comments received during v2.0 were considered. SOC approved.
2.2.0	2023-04-20		This new version of the specification is mainly focused on covering gaps identified by CCRs. Most important changes are related to: • Redispatch and countertrade • Schedules • Sensitivity factors • Updates of the control model for power electronics devices and transformers. • Several clarifications were introduced to facilitate the usage of the profiles.
2.2.0	2023-05-10		Reference metadata table updated to be consistent with a bug fix from the maintenance request “Change in Metadata and document header data exchange specification” from May 2023 the 8th. ICTC approved.
2.3.0-alpha	2024-01-29		On request by SOC StG REC the document was renamed to Network Codes Data Exchange Specification to envision that it will cover specifications and implementation guidance for all business processes. The document is significantly updated to include explanations on different used cases.
2.3.0-beta	2024-03-16		On request by SOC the document was renamed to Regional Coordination Processes Data Exchange Specification to envision that it will cover specifications and implementation guidance for all business processes. The document is updated based on the feedback from review of version v2.3.0-alpha.
2.3.0-gamma	2024-04-09		Version after the CIM WG review and send for the approval process via written voting procedure by ICTC (lead) and SOC (in copy).