

# Package ‘CNAIM’

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**Type** Package

**Title** Common Network Asset Indices Methodology (CNAIM)

**Version** 2.1.0

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**Description** Implementation of the CNAIM standard in R. Contains a series of algorithms which determine the probability of failure, consequences of failure and monetary risk associated with electricity distribution companies' assets such as transformers and cables. Results are visualized in an easy-to-understand risk matrix.

**URL** <https://www.cnaim.io/>

**BugReports** <https://github.com/Utiligize/CNAIM/issues>

**License** MIT + file LICENSE

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beta_1	<i>Initial Ageing Rate</i>
--------	----------------------------

---

### Description

This function calculates the initial ageing rate for an electric network asset. See section 6.1.5 on page 36 in CNAIM (2021).

### Usage

```
beta_1(expected_life_years)
```

### Arguments

expected\_life\_years  
 Numeric. The output returned by the function `expected_life()`.

### Value

Numeric. Initial ageing rate for an electric network asset.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
beta_1(expected_life_years = 10)
```

---

beta_2	<i>Forecast Ageing Rate</i>
--------	-----------------------------

---

**Description**

This function calculates the forecast Ageing Rate for an electric network asset. See section 6.1.8 on page 38 in CNAIM (2021).

**Usage**

```
beta_2(current_health_score, age)
```

**Arguments**

current_health_score	Numeric. The output returned by the function <code>current_health()</code> .
age	Numeric. Age of the asset.

**Value**

Numeric. Forecast ageing rate for an electric network asset.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
beta_2(current_health_score = 1, age = 25)
```

---

cof *Consequences of Failure*

---

**Description**

This function calculates consequences of failure (cf.section 7, page 75, CNAIM, 2021).

**Usage**

```
cof(financial_cof, safety_cof, environmental_cof, network_cof)
```

**Arguments**

financial\_cof    Numeric. Financial consequences of failure.  
safety\_cof      Numeric. Safety consequences of failure.  
environmental\_cof  
                  Numeric. Environmental consequences of failure.  
network\_cof     Numeric. Network cost of failure.

**Value**

Numeric. Consequences of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

---

cof\_transformer\_04\_10kv  
*Consequences of Failure for a 0.4/10 kV transformer*

---

**Description**

This function calculates consequences of failure for a 6.6/11 kV transformer (cf.section 7, page 75, CNAIM, 2021).

**Usage**

```

cof_transformer_04_10kv(
  kva,
  type,
  type_risk,
  location_risk,
  prox_water,
  bunded,
  no_customers,
  kva_per_customer
)

```

**Arguments**

kva	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).
type	String. Relates to the accessibility of the transformer Options: type = c("Type A", "Type B", "Type C", "Default"). A setting of "Type A" - Normal access. A setting of "Type B" - Constrained access or confined working space. A setting of "Type C" - Underground substation. A setting of "Default" - Normal access thus same as "Type A" setting (cf. table 221, page 180, CNAIM, 2021).
type_risk	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: type_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
location_risk	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: location_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

**Value**

Numeric. Consequences of failure for a 0.4/10 kV transformer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Consequences of failure for a 0.4/10 kV transformer
cof_transformer_04_10kv(kva = 500, type = "Type C",
                      type_risk = "High", location_risk = "High",
                      prox_water = 50, bunded = "No",
                      no_customers = 500, kva_per_customer = 1)
```

---

cof\_transformer\_11kv *Consequences of Failure for a 6.6/11 kV transformer*

---

**Description**

This function calculates consequences of failure for a 6.6/11 kV transformer (cf. section 7, page 75, CNAIM, 2021).

**Usage**

```
cof_transformer_11kv(
  kva,
  type,
  type_risk,
  location_risk,
  prox_water,
  bunded,
  no_customers,
  kva_per_customer
)
```

**Arguments**

kva	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).
type	String. Relates to the accessibility of the transformer Options: type = c("Type A", "Type B", "Type C", "Default"). A setting of "Type A" - Normal access. A setting of "Type B" - Constrained access or confined working space. A setting of "Type C" - Underground substation. A setting of "Default" - Normal access thus same as "Type A" setting (cf. table 221, page 180, CNAIM, 2021).



type_risk	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: type_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
location_risk	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: location_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

**Value**

Numeric. Consequences of failure for a 6.6/11 kV transformer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Consequences of failure for a 6.6/11 kV transformer
cof_transformer_11kv(kva = 500, type = "Type C",
                    type_risk = "High", location_risk = "High",
                    prox_water = 50, bunded = "No",
                    no_customers = 500, kva_per_customer = 1)
```

---

current\_health

*Current Health score*

---

**Description**

This function calculates the current health score for a given electric network asset (cf. CNAIM, 2021. Page 23, section 4.3.2).

## Usage

```
current_health(  
    initial_health_score,  
    health_score_factor,  
    health_score_cap = "Default",  
    health_score_collar = "Default",  
    reliability_factor = "Default"  
)
```

## Arguments

`initial_health_score`  
Numeric. The output from the function `initial_health()`.

`health_score_factor`  
Numeric. E.g. output from the function `health_score_excl_ehv_132kv_tf()`.

`health_score_cap`  
Numeric. Specifies the maximum value of current health score. The cap is used in situations where a good result from a condition inspection or measurement implies that the health score should be no more than the specified value. The cap is derived as the minimum of the observed condition cap and the measured condition cap. Measured and observed condition caps are found in lookup tables depending in the asset category, when determine the observed and measured condition factors. A setting of "Default" sets the `health_score_cap` to 10.

`health_score_collar`  
Numeric. Specifies the minimum value of Current Health Score. The collar is used in situations where a poor result from a condition inspection or measurement implies that the health score should be at least the specified value. The collar is derived as the minimum of the observed condition collar and the measured condition collar. Measured and observed condition collars are found in lookup tables depending in the asset category, when determine the observed and measured condition factors. A setting of "Default" sets the `health_score_collar` to 0.5.

`reliability_factor`  
Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).

## Value

Numeric. The Current health score.

## Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
current_health(initial_health_score = 0.5,
               health_score_factor = 0.33,
               health_score_cap = 10,
               health_score_collar = 0.5,
               reliability_factor = 1)
```

---

dga_test_modifier	<i>DGA Test Modifier</i>
-------------------	--------------------------

---

**Description**

This function calculates the DGA test modifier for 33/10kV, 66/10kV and 132kV transformers. See e.g. section 6.12 on page 65 in CNAIM (2017).

**Usage**

```
dga_test_modifier(
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default"
)
```

**Arguments**

hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.

methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.

**Value**

Data table.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# DGA test modifier
dga_test_modifier(hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default")
```

---

duty\_factor\_cables      *Duty Factor for all cables (incl. submarine cables).*

---

**Description**

This function calculates the duty factor for under all types of cables depending on the maximum percentage utilisation under normal operating conditions. The duty factor is used in the derivation of the expected life of an asset. See e.g. `expected_life()`. For more general information about the derivation of the duty factor see section 6.6 on page 51 in CNAIM (2021)

**Usage**

```
duty_factor_cables(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  voltage_level = "EHV"
)
```

**Arguments**

`utilisation_pct`  
Numeric. The max percentage of utilisation under normal operating conditions.

`operating_voltage_pct`  
Numeric. The ratio in percent of operating/design voltage.

`voltage_level` String. Specify the voltage level. Options: `voltage_level = c("EHV", "HV")`. Choose "EHV" for cables  $\geq$  33kV and "HV" for cables  $<$  33kV .

**Value**

Numeric. Duty factor for cables.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
duty_factor_cables(utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  voltage_level = "EHV")
```

---

duty\_factor\_transformer\_11\_20kv

*Duty Factor for 6.6/11kV and 20kV Transformers*

---

**Description**

This function calculates the duty factor for 6.6/11kV and 20kV transformers depending on the maximum percentage utilisation under normal operating conditions. The duty factor is used in the derivation of the expected life of an asset. See e.g. `expected_life()`. For more general information about the derivation of the duty factor see section 6.6 on page 51 in CNAIM (2021)

**Usage**

```
duty_factor_transformer_11_20kv(utilisation_pct = "Default")
```

**Arguments**

utilisation\_pct

Numeric. The max percentage of utilisation under normal operating conditions.

**Value**

Numeric. Duty factor for 6.6/11kV or 20kV transformer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
duty_factor_transformer_11_20kv(utilisation_pct = 95)
```

---

duty\_factor\_transformer\_33\_66kv

*Duty Factor for 33/10kV and 66/10kV Transformers and Tapchanger*

---

**Description**

This function calculates the duty factor for 33/10kV and 66/10kV transformers depending on the maximum percentage utilisation under normal operating conditions. And the tapchanger depending on the average number of daily taps. The duty factor is used in the derivation of the expected life of an asset. See e.g. `expected_life()`. For more general information about the derivation of the duty factor see section 6.6 on page 51 in CNAIM (2021)

**Usage**

```
duty_factor_transformer_33_66kv(
  utilisation_pct = "Default",
  no_taps = "Default"
)
```

**Arguments**

utilisation\_pct

Numeric. The max percentage of utilisation under normal operating conditions.

no\_taps

Numeric. Average number of daily taps (tapchanger).

**Value**

Data table. Duty factor for the transformer and for the tapcharger

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
duty_factor_transformer_33_66kv(utilisation_pct = 95,
no_taps = 25)
```

---

```
environmental_cof_cables_60_30kv
```

*Environmental cost of Failure for 30-60 kV UG cables*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear `ehv_asset_category = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)")`. The default setting is `ehv_asset_category = "60kV UG Cable (Gas)"`.

**Usage**

```
environmental_cof_cables_60_30kv(ehv_asset_category, prox_water, bundled)
```

**Arguments**

<code>ehv_asset_category</code>	Asset category for the analysis
<code>prox_water</code>	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
<code>bundled</code>	String. Options: <code>bundled = c("Yes", "No", "Default")</code> . A setting of "Default" will result in a bundling factor of 1.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_cables_60_30kv(ehv_asset_category = "30kV UG Cable (Oil)",
prox_water = 95, bundled = "Yes")
```

---

 environmental\_cof\_ehv\_cables

*Environmental cost of Failure for EHV UG cables & 132 kV UG cables*


---

### Description

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear

### Usage

```
environmental_cof_ehv_cables(ehv_asset_category, prox_water, bundled)
```

### Arguments

ehv_asset_category	String	The type of EHV asset category
prox_water	Numeric.	Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bundled	String.	Options: bundled = c("Yes", "No", "Default"). A setting of "Default" will result in a bundling factor of 1.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
environmental_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)",
  prox_water = 95, bundled = "Yes")
```

---

 environmental\_cof\_ehv\_fittings

*Environmental cost of Failure for EHV/132kV fittings*


---

### Description

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear



**Usage**

```
environmental_cof_ehv_fittings(ehv_asset_category)
```

**Arguments**

```
ehv_asset_category
    String The type of EHV asset category
```

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_ehv_fittings(ehv_asset_category = "33kV Fittings")
```

---

```
environmental_cof_ehv_switchgear
```

*Environmental cost of Failure for EHV swicthgear & 132kV CB*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#'` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_ehv_switchgear(
  ehv_asset_category,
  type_env_factor,
  prox_water,
  bunded
)
```

**Arguments**

```
ehv_asset_category
    String The type of EHV asset category

type_env_factor
    String The type environment factor of EHV asset category

prox_water
    Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).

bunded
    String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
```

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_ehv_switchgear(ehv_asset_category = "33kV RMU",
type_env_factor = "Oil",
prox_water = 95,
bunded = "Yes")
```

---

environmental\_cof\_hv\_switchgear\_distribution

*Environmental cost of Failure for HV switchgear distribution*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#' @return Numeric`. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_hv_switchgear_distribution(
  hv_asset_category,
  type_env_factor,
  prox_water,
  bunded
)
```

**Arguments**

hv_asset_category	String The type of HV asset category
type_env_factor	String The type environment factor of HV asset category
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_hv_switchgear_distribution(
  hv_asset_category = "6.6/11kV CB (GM) Secondary",
  type_env_factor = "Oil", prox_water = 95,
  banded = "Yes")
```

---

```
environmental_cof_hv_switchgear_primary
  Environmental cost of Failure for HV switchgear primary
```

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#'` @return Numeric. Financial consequences of failure for HV switchgear

**Usage**

```
environmental_cof_hv_switchgear_primary(
  hv_asset_category,
  type_env_factor,
  prox_water,
  banded
)
```

**Arguments**

hv_asset_category	String The type of HV asset category
type_env_factor	String The type environment factor of HV asset category
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
banded	String. Options: banded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_hv_switchgear_primary(
hv_asset_category = "6.6/11kV CB (GM) Primary",
type_env_factor = "Oil",
prox_water = 95, banded = "Yes")
```

---

```
environmental_cof_lv_switchgear_and_other
    Environmental cost of Failure for LV swichgear and others
```

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#'` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_lv_switchgear_and_other(lv_asset_category)
```

**Arguments**

```
lv_asset_category
    String The type of LV asset category
```

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_lv_switchgear_and_other(lv_asset_category = "LV Board (WM)")
```

---

`environmental_cof_lv_ugb`*Environmental cost of Failure for LV UGB*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV UGB

**Usage**

```
environmental_cof_lv_ugb(lv_asset_category)
```

**Arguments**

```
lv_asset_category  
String The type of LV asset category
```

**Value**

Numeric. Environmental consequences of failure for LV UGB

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_lv_ugb(lv_asset_category = "LV UGB")
```

---

`environmental_cof_ohl_cond`*Environmental cost of Failure for Overhead line conductors*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_ohl_cond(ohl_cond_asset_category)
```

**Arguments**

ohl\_cond\_asset\_category  
String The type of Overhead Line Conductors

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_ohl_cond(ohl_cond_asset_category = "33kV OHL (Tower Line) Conductor")
```

---

```
environmental_cof_poles
```

*Environmental cost of Failure for Poles*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_poles(pole_asset_category)
```

**Arguments**

pole\_asset\_category  
String The type of Pole

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_poles(pole_asset_category = "33kV Pole")
```

---

`environmental_cof_sub_cables`*Environmental cost of Failure for sub cables*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_sub_cables(sub_cable_asset_category)
```

**Arguments**

```
sub_cable_asset_category
```

String The type of sub cable asset category

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2017: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_sub_cables(sub_cable_asset_category = "HV Sub Cable")
```

---

`environmental_cof_towers`*Environmental cost of Failure for towers*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_towers(tower_asset_category)
```

**Arguments**

```
tower_asset_category
```

String The type of tower

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_towers(tower_asset_category = "33kV Tower")
```

---

```
environmental_cof_transformers
```

*Environmental cost of Failure for Transformers*

---

**Description**

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#'` @return Numeric. Financial consequences of failure for LV switchgear

**Usage**

```
environmental_cof_transformers(  
  tf_asset_category,  
  prox_water,  
  banded,  
  size_kva_mva = NULL,  
  size_conversion = NULL  
)
```

**Arguments**

<code>tf_asset_category</code>	String The type of Transformer
<code>prox_water</code>	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
<code>banded</code>	String. Options: <code>banded = c("Yes", "No", "Default")</code> . A setting of "Default" will result in a bunding factor of 1.
<code>size_kva_mva</code>	Numeric The MVA KVA rating for the transformer
<code>size_conversion</code>	String The size conversion for the transformer



**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
environmental_cof_transformers(tf_asset_category = "33kV Transformer (GM)",
prox_water = 95, banded = "Yes", size_kva_mva = 20, size_conversion = "33/20kV")
```

---

expected_life	<i>Expected Life</i>
---------------	----------------------

---

**Description**

This function calculates the expected life of an electric network asset measured in years when it would be expected to first observe significant deterioration. The expected life is derived based on the assets normal expected life, duty factor and location factor. See section 6.1.4 on page 36 in CNAIM (2021).

**Usage**

```
expected_life(normal_expected_life, duty_factor, location_factor)
```

**Arguments**

normal_expected_life	Numeric. The number of years a new asset is expected to normally last. I.e. technical life time. See page 107, table 20 in CNAIM (2021).
duty_factor	Numeric. E.g. the output returned by the function <a href="#">duty_factor_transformer_11_20kv()</a> .
location_factor	Numeric. The output returned by the function <a href="#">location_factor()</a> .

**Value**

Numeric. Expected life.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

## Examples

```
# An asset e.g. a transformer with an expected life of 50 years
expected_life(normal_expected_life = 50,
              duty_factor = 1,
              location_factor = 1)
```

---

e\_cof\_tf

*Environmental Consequences of Failure for transformers*


---

## Description

This function calculates environmental consequences of failure for all type of transformers. (cf. section 7.5, page 84, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`.

## Usage

```
e_cof_tf(
  asset_type_tf,
  rated_capacity = "Default",
  prox_water = "Default",
  banded = "Default"
)
```

## Arguments

asset_type_tf	String. Transformer types. Options: asset_type_tf = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)").
rated_capacity	Numeric. The rated capacity for a transformer. For type "6.6/11kV Transformer (GM)" and "20kV Transformer (GM)" use kVA ratings. For "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)" use MVA ratings. A setting of "Default" will result in a size environmental factor of 1 (cf. table 230, page 187, CNAIM, 2021).
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
banded	String. Options: banded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.

## Value

Numeric. Financial cost of failure for a 10kV transformer.

## Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

## Examples

```
# Environmental consequences of failure for a 6.6/11 kV transformer
e_cof_tf(asset_type_tf = "6.6/11kV Transformer (GM)",
  rated_capacity = 750, prox_water = 100, banded = "Yes")
```

---

ffa_test_modifier	<i>Oil Test Modifier</i>
-------------------	--------------------------

---

## Description

This function calculates the FFA test modifier based on the levels of furfuraldehyde in the transformer oil. This function applies for 33/10kV, 66/10kV and 132kV transformers. See e.g. section 6.13 on page 71 in CNAIM (2021).

## Usage

```
ffa_test_modifier(furfuraldehyde = "Default")
```

## Arguments

**furfuraldehyde** Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.

## Value

Data table.

## Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

## Examples

```
# FFA test modifier
ffa_test_modifier(furfuraldehyde = 50)
```

---

financial\_cof\_cables\_60\_30kv

*Financial cost of Failure for 30-60 kV UG cables*

---

### Description

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. `ehv_asset_category = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)")` . The default setting is `ehv_asset_category = "60kV UG Cable (Gas)"`.

### Usage

```
financial_cof_cables_60_30kv(ehv_asset_category)
```

### Arguments

`ehv_asset_category`  
Asset category for the analysis

### Value

Numeric. Financial consequences of failure for EHV switchgear

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
financial_cof_cables_60_30kv(ehv_asset_category = "30kV UG Cable (Oil)")
```

---

financial\_cof\_ehv\_cables

*Financial cost of Failure for EHV UG cables & 132 kV UG cables*

---

### Description

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
financial_cof_ehv_cables(ehv_asset_category)
```

**Arguments**

ehv\_asset\_category  
String The type of EHV cable distribution asset category

**Value**

Numeric. Financial consequences of failure for EHV switchgear

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)")
```

---

```
financial_cof_ehv_fittings
    Financial cost of Failure for EHV/132kV fittings
```

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_ehv_fittings(
  ehv_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria
)
```

**Arguments**

ehv\_asset\_category  
String The type of EHV Fittings asset category

type\_financial\_factor\_criteria  
String. Type Financial factor criteria for EHV fittings

access\_factor\_criteria  
String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for EHV fittings

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_ehv_fittings(ehv_asset_category = "33kV Fittings",  
type_financial_factor_criteria = "Tension",  
access_factor_criteria = "Type A")
```

---

```
financial_cof_ehv_switchgear
```

*Financial cost of Failure for EHV swichgear & 132kV CB*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_ehv_switchgear(ehv_asset_category, access_factor_criteria)
```

**Arguments**

`ehv_asset_category`

String The type of EHV swichgear & 132kV CB

`access_factor_criteria`

String. Asses Financial factor criteria for EHV swichgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for EHV swichgear & 132kV CB

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_ehv_switchgear(ehv_asset_category = "33kV RMU", access_factor_criteria = "Type A")
```

---

financial\_cof\_hv\_switchgear\_distribution  
*Financial cost of Failure for HV swithgear distribution*

---

### Description

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
financial_cof_hv_switchgear_distribution(  
    hv_asset_category,  
    access_factor_criteria  
)
```

### Arguments

`hv_asset_category`  
String The type of HV switchgear distribution asset category

`access_factor_criteria`  
String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021).

### Value

Numeric. Financial consequences of failure for LV switchgear

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
financial_cof_hv_switchgear_distribution(  
    hv_asset_category = "6.6/11kV CB (GM) Secondary",  
    access_factor_criteria = "Type A")
```

---

financial\_cof\_hv\_switchgear\_primary

*Financial cost of Failure for HV swithgear primary*

---

### Description

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

### Usage

```
financial_cof_hv_switchgear_primary(hv_asset_category, access_factor_criteria)
```

### Arguments

hv\_asset\_category

String The type of HV switchgear distribution asset category

access\_factor\_criteria

String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021).

### Value

Numeric. Financial consequences of failure for HV switchgear primary

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
financial_cof_hv_switchgear_primary(  
hv_asset_category = "6.6/11kV CB (GM) Primary",  
access_factor_criteria = "Type A")
```

---

financial\_cof\_lv\_switchgear\_and\_other

*Financial cost of Failure for LV swithgear and others*

---

### Description

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).



**Usage**

```
financial_cof_lv_switchgear_and_other(
    lv_asset_category,
    type_financial_factor_criteria,
    access_factor_criteria
)
```

**Arguments**

`lv_asset_category`  
String The type of LV asset category

`type_financial_factor_criteria`  
String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021).

`access_factor_criteria`  
String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for LV switchgear

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_lv_switchgear_and_other(lv_asset_category = "LV Board (WM)",
    type_financial_factor_criteria = "Asbestos clad",
    access_factor_criteria = "Type A")
```

---

`financial_cof_lv_ugb` *Financial cost of Failure for LV UGB*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_lv_ugb(lv_asset_category)
```

**Arguments**

lv\_asset\_category  
String The type of LV asset category

**Value**

Numeric. Financial consequences of failure for LV UGB

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_lv_ugb(lv_asset_category = "LV UGB")
```

---

financial\_cof\_ohl\_cond

*Financial cost of Failure for Overhead Line Conductors*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_ohl_cond(ohl_cond_asset_category, access_factor_criteria)
```

**Arguments**

ohl\_cond\_asset\_category  
String The type of Pole asset category

access\_factor\_criteria  
String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for Poles

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_ohl_cond(  
  ohl_cond_asset_category = "33kV OHL (Tower Line) Conductor",  
  access_factor_criteria = "Type A")
```

---

financial\_cof\_poles     *Financial cost of Failure for Poles*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_poles(  
  pole_asset_category,  
  type_financial_factor_criteria,  
  access_factor_criteria  
)
```

**Arguments**

`pole_asset_category`  
String The type of Pole asset category

`type_financial_factor_criteria`  
String. Type Financial factor criteria for Pole

`access_factor_criteria`  
String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for Poles

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_poles(pole_asset_category = "33kV Pole",  
  type_financial_factor_criteria = "Small footprint steel masts",  
  access_factor_criteria = "Type A")
```

---

`financial_cof_sub_cables`*Financial cost of Failure for Sub cables*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_sub_cables(sub_cable_asset_category)
```

**Arguments**

```
sub_cable_asset_category  
String The type of Submarine cable asset category
```

**Value**

Numeric. Financial consequences of failure for Sub cables

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_sub_cables(sub_cable_asset_category = "HV Sub Cable")
```

---

`financial_cof_towers` *Financial cost of Failure for Towers*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_towers(  
  tower_asset_category,  
  type_financial_factor_criteria,  
  access_factor_criteria  
)
```

**Arguments**

`tower_asset_category`  
String The type of Pole asset category

`type_financial_factor_criteria`  
String The type financial factor for Tower

`access_factor_criteria`  
String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for Poles

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_towers(tower_asset_category = "33kV Tower",  
type_financial_factor_criteria = "Suspension",  
access_factor_criteria = "Type A")
```

---

`financial_cof_transformers`

*Financial cost of Failure for Transformers*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
financial_cof_transformers(  
  tf_asset_category,  
  type_financial_factor_size = NULL,  
  type_financial_factor_kva_mva = NULL,  
  access_factor_criteria  
)
```

**Arguments**

tf_asset_category	String	The type of Transformer asset category
type_financial_factor_size	String	The type financial factor size for Transformer
type_financial_factor_kva_mva	Numeric	The type financial factor kVA MVA for Transformer
access_factor_criteria	String	Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for Transformer

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
financial_cof_transformers(tf_asset_category = "33kV Transformer (GM)",
type_financial_factor_size = "33/20kV, CMR equivalent",
type_financial_factor_kva_mva = 20,
access_factor_criteria = "Type A")
```

---

f\_cof\_transformer\_11kv

*Financial Consequences of Failure for a 6.6/11 kV Transformer*

---

**Description**

This function calculates financial consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
f_cof_transformer_11kv(kva = "Default", type = "Default")
```

**Arguments**

kva	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).
type	String. Relates to the accessibility of the transformer Options: type = c("Type A", "Type B", "Type C", "Default"). A setting of "Type A" - Normal access. A setting of "Type B" - Constrained access or confined working space. A setting of "Type C" - Underground substation. A setting of "Default" - Normal access thus same as "Type A" setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for a 6.6/11 kV transformer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Financial consequences of failure for a 6.6/11 kV transformer
f_cof_transformer_11kv(kva = 700, type = "Default")
```

---

```
health_score_excl_ehv_132kv_tf
```

*Health Score Factor for all Assets Categories excl. EHV and 132kV Transformers*

---

**Description**

This function calculates the health score factor for all asset categories exclusive the assets EHV and 132kV transformers. For EHV and 132kV transformers see `mmi()`. The function combines observed and measured condition factors using the simplified maximum and multiple increment (MMI) technique to construct the health score factor (cf. CNAIM, 2021, page 56, table 9).

**Usage**

```
health_score_excl_ehv_132kv_tf(
  observed_condition_factor,
  measured_condition_factor
)
```

**Arguments**

observed\_condition\_factor  
   Numeric.  
 measured\_condition\_factor  
   Numeric.

**Value**

Numeric. Health score factor.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# An asset with an observed condition factor of 1 and a measured condition
# factor of 0.33
health_score_excl_ehv_132kv_tf(observed_condition_factor = 1,
measured_condition_factor = 0.33)
```

---

initial\_health

*Initial Health*

---

**Description**

Calculating the initial health score for a given asset. See section 6.1.6 on page 36 in CNAIM (2021).

**Usage**

```
initial_health(b1, age)
```

**Arguments**

b1                            Numeric. The output returned by the function `beta_1()`.  
 age                           Numeric. The current age of the asset.

**Value**

Numeric. Initial health for an electric network asset.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)



## Examples

```
# 6.6/ 11 kv transformer age 10 years and an initial age rate of 0.05
initial_health(b1 = 0.05,
              age = 10)
```

---

location_factor	<i>Location Factor (Excl.Submarine Cables)</i>
-----------------	--

---

## Description

This function calculates the location factor for an electric network asset based in the specific location of the asset. See section 6.4 on page 46 in CNAIM (2021). For calculating the location factor for submarine cables please see the function `location_factor_sub()`. Note the location factor for all other cables are always equal to 1 hence the function will return a location factor of 1 for other cables than submarine cables.

## Usage

```
location_factor(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  asset_type = "6.6/11kV Transformer (GM)",
  sub_division = NULL
)
```

## Arguments

placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
asset_type	String. A sting that refers to the specific asset category. For LV UGB and non-submarine cables a location factor of 1 is assigned. See See page 17, table 1 in CNAIM (2021). Options: asset_type = c("LV Poles", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)", "LV Board (WM)", "LV UGB", "LV Board (X-type Network) (WM)", "6.6/11kV Poles", "20kV Poles", "6.6/11kV CB (GM) Primary", "6.6/11kV CB (GM) Secondary", "6.6/11kV Switch (GM)", "6.6/11kV RMU", "6.6/11kV X-type RMU", "20kV CB (GM) Primary", "20kV CB (GM) Secondary", "20kV Switch (GM)", "20kV RMU", "6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Pole", "66kV Pole", "33kV OHL (Tower Line) Conductor", "33kV Tower", "33kV Fittings", "66kV OHL (Tower Line) Conductor", "66kV Tower", "66kV Fittings", "33kV UG Cable (Non Pressurised)", "33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "33kV CB (Air Insulated Busbars)(ID) (GM)", "33kV CB (Air Insulated Busbars)(OD) (GM)", "33kV CB (Gas Insulated Busbars)(ID) (GM)", "33kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Switch (GM)", "33kV RMU", "66kV CB (Air Insulated Busbars)(ID) (GM)", "66kV CB (Air Insulated Busbars)(OD) (GM)", "66kV CB (Gas Insulated Busbars)(ID) (GM)", "66kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV OHL (Tower Line) Conductor", "132kV Tower", "132kV Fittings", "132kV UG Cable (Non Pressurised)", "132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV CB (Air Insulated Busbars)(ID) (GM)", "132kV CB (Air Insulated Busbars)(OD) (GM)", "132kV CB (Gas Insulated Busbars)(ID) (GM)", "132kV CB (Gas Insulated Busbars)(OD) (GM)", "132kV Transformer (GM)")
sub_division	String. Refers to material the sub division in the asset category

**Value**

Numeric. Location factor

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Location factor for a 6.6/11 kV Transformer with default values
location_factor(placement = "Default", altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
asset_type = "6.6/11kV Transformer (GM)")
```

---

location\_factor\_sub     *Location Factor (Excl.Submarine Cables)*

---

### Description

This function calculates the location factor for submarine cables based in the specific location of the cable. See section 6.5 on page 48 in CNAIM (2021). For calculating the location factor for all other network assets please see the function `location_factor()`.

### Usage

```
location_factor_sub(
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no"
)
```

### Arguments

topography	String. Describe the topography around the submarine cable. Options: topography = c("Low Detrimental Topography", "Medium Detrimental Topography", "High Detrimental Topography", "Very High Detrimental Topography", "Default")
situation	String. Describes how the submarine cable af fixed to the sea floor. Options: situation=c("Laid on bed", "Covered", "Buried", "Default")
wind_wave	Numeric. Options: wind_wave=c(1, 2, 3, "Default"). Settings: <ul style="list-style-type: none"> <li>• wind_wave = 1: Sheltered sea loch, Wind &lt;200 W/m2</li> <li>• wind_wave = 2: Wave &lt;15kW/m, Wind 200-800 W/m2</li> <li>• wind_wave = 3: Wave &lt;15kW/m, Wind 200-800 W/m2</li> <li>• wind_wave = "Default": No data available</li> </ul>
intensity	String. Combined wave and current energy factor. Options: intensity=c("Low", "Moderate", "High", "Default").
landlocked	String. Options: landlocked = c("yes", "no"). Default setting for landlocked = "no".

### Value

Numeric. Location factor

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Location factor for a non-landlocked submarine cable
location_factor_sub(topography = "Default",
                    situation = "Default",
                    wind_wave = "Default",
                    intensity = "Default",
                    landlocked = "no")
```

---

matrix\_adjusted\_circles

*Adjust circles for matrix visualization*

---

**Description**

This function manipulates the data structure before inputting into javascript D3 risk matrix visualization

**Usage**

```
matrix_adjusted_circles(risk_data_matrix, dots_vector, dot_radius)
```

**Arguments**

risk_data_matrix	Long format matrix data.
dots_vector	Coordinates of the dots.
dot_radius	Radius of the dots.

**Value**

Long format matrix data. circles for D3 matrix visualization adjusted

---

matrix\_adjusted\_intervals

*Adjust banding for matrix visualization*

---

**Description**

This function manipulates the data structure before inputting into javascript D3 risk matrix visualization

**Usage**

```
matrix_adjusted_intervals(risk_data_matrix, x_intervals, y_intervals)
```

**Arguments**

risk_data_matrix	Long format matrix data.
x_intervals	An array of x spacing in percent (sum to 100)
y_intervals	An array of y spacing in percent (sum to 100)

**Value**

Long format matrix data. intervals for matrix D3 visualization adjusted

---

 mmi

---

*Maximum and Multiple Increment (MMI) Technique*


---

**Description**

This function returns a combined factor using a maximum and multiple increment (MMI) technique (cf. CNAIM, 2021. page 54, section 6.7.2). The function can be used to derive the health score factor for EHV and 132kV transformers. For derivation of the health score factor for all other assets see [health\\_score\\_excl\\_ehv\\_132kv\\_tf](#). To derive the health score factor for EHV and 132kV transformers one needs to use `mmi()` to derive the health score factor for the main transformer and for the tapchanger respectively. The constants `factor_divider_1`, `factor_divider_2` and `max_no_combined_factors` are all available in the lookup table 10 and 11 on page 57 and 58 in CNAIM (2021). For an in dept description see also section 6.8 on page 57 in CNAIM (2021). The `mmi()` can also be used in the derivation of observed and measured condition factors for all assets, using measured and observed input factors. The constants `factor_divider_1`, `factor_divider_2` and `max_no_combined_factors` can be found in table 13 on page 63 (observed condition factors) and in table 15 on page 67 (measured condition factors).

**Usage**

```
mmi(factors, factor_divider_1, factor_divider_2, max_no_combined_factors)
```

**Arguments**

factors	Numeric vector. Factors to me combined.
factor_divider_1	Numeric. Constant that specifies the degree to which additional “good” or “bad” factors are able further drive the combined factor.
factor_divider_2	Numeric. Constant that specifies the degree to which additional “good” or “bad” factors are able further drive the combined factor.
max_no_combined_factors	Numeric. Specifies how many factors are able to simultaneously affect the combined factor.

**Value**

Numeric. Combined factor.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
mmi(factors = c(1,
1.5),
factor_divider_1 = 1.5,
factor_divider_2 = 1.5,
max_no_combined_factors = 1)
```

---

network\_cof\_cables\_60\_30kv

*Network cost of Failure for 30-60 kV UG cables*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`. `ehv_asset_category = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)")`. The default setting is `ehv_asset_category = "60kV UG Cable (Gas)"`.

**Usage**

```
network_cof_cables_60_30kv(ehv_asset_category, actual_load_mva, secure = T)
```

**Arguments**

<code>ehv_asset_category</code>	Asset category for the analysis
<code>actual_load_mva</code>	Numeric. The actual load on the asset
<code>secure</code>	Boolean If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_cables_60_30kv(ehv_asset_category = "30kV UG Cable (Oil)",
actual_load_mva = 15)
```

---

```
network_cof_ehv_cables
```

*Network cost of Failure for EHV UG cables & 132 kV UG cables*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_ehv_cables(ehv_asset_category, actual_load_mva, secure = T)
```

**Arguments**

ehv_asset_category	String The type of EHV asset category
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)",
actual_load_mva = 15)
```

---

network\_cof\_ehv\_fittings

*Network cost of Failure for EHV/132kV Fittings*

---

### Description

This function calculates network cost of failure for EHV fittings (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
network_cof_ehv_fittings(ehv_asset_category, actual_load_mva, secure = T)
```

### Arguments

ehv_asset_category	String	The type of EHV asset category
actual_load_mva	Numeric.	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_ehv_fittings(ehv_asset_category = "33kV Fittings",  
actual_load_mva = 15)
```

---

network\_cof\_ehv\_pole *Network cost of Failure for EHV Pole*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`.



**Usage**

```
network_cof_ehv_pole(pole_asset_category, actual_load_mva, secure = T)
```

**Arguments**

```
pole_asset_category  
    String The type of Pole  
actual_load_mva  
    Numeric. The actual load on the asset  
secure  
    Boolean If the asset is in a secure network or not
```

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_ehv_pole(pole_asset_category = "33kV Pole",  
actual_load_mva = 15)
```

---

```
network_cof_ehv_sub_cable
```

*Network cost of Failure for EHV /132 kV sub cables*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_ehv_sub_cable(  
  sub_cable_asset_category,  
  actual_load_mva,  
  secure = T  
)
```

**Arguments**

sub_cable_asset_category	String	The type of sub cable asset category
actual_load_mva	Numeric	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_ehv_sub_cable(sub_cable_asset_category = "EHV Sub Cable",
actual_load_mva = 15, secure = TRUE)
```

---

```
network_cof_ehv_switchgear
```

*Network cost of Failure for EHV switchgear & 132kV CB*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_ehv_switchgear(ehv_asset_category, actual_load_mva, secure = T)
```

**Arguments**

ehv_asset_category	String	The type of EHV asset category
actual_load_mva	Numeric	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_ehv_switchgear(ehv_asset_category = "33kV RMU",
actual_load_mva = 15)
```

---

```
network_cof_hv_lv_poles
```

*Network cost of Failure for LV/HV Poles*

---

**Description**

This function calculates network cost of failure for Poles (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_hv_lv_poles(
  pole_asset_category,
  no_customers,
  kva_per_customer = "Default"
)
```

**Arguments**

pole_asset_category	String The type of Pole
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_hv_lv_poles(pole_asset_category = "20kV Poles",
no_customers = 750, kva_per_customer = 51)
```

---

```
network_cof_hv_sub_cables
```

*Network cost of Failure for HV Sub cables*

---

**Description**

This function calculates network cost of failure for Sub cables (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
network_cof_hv_sub_cables(
  sub_cable_asset_category,
  no_customers,
  kva_per_customer = "Default"
)
```

**Arguments**

`sub_cable_asset_category` String The type of sub cable asset category

`no_customers` Numeric. The number of customers fed by an individual asset.

`kva_per_customer` Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_hv_sub_cables(sub_cable_asset_category = "HV Sub Cable",
no_customers = 750, kva_per_customer = 51)
```

---

`network_cof_hv_switchgear_distribution`*Network cost of Failure for HV Switchgear distribution*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
network_cof_hv_switchgear_distribution(  
    hv_asset_category,  
    no_customers,  
    kva_per_customer = "Default"  
)
```

### Arguments

<code>hv_asset_category</code>	String The type of LV asset category
<code>no_customers</code>	Numeric. The number of customers fed by an individual asset.
<code>kva_per_customer</code>	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_hv_switchgear_distribution(hv_asset_category = "LV Board (WM)",  
no_customers = 750, kva_per_customer = 51)
```

---

network\_cof\_hv\_switchgear\_primary

*Network cost of Failure for HV Switchgear Primary*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

### Usage

```
network_cof_hv_switchgear_primary(  
    hv_asset_category,  
    no_customers,  
    kva_per_customer = "Default"  
)
```

### Arguments

`hv_asset_category` String The type of HV asset category

`no_customers` Numeric. The number of customers fed by an individual asset.

`kva_per_customer` Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_hv_switchgear_primary(hv_asset_category = "6.6/11kV CB (GM) Secondary",  
no_customers = 750, kva_per_customer = 51)
```

---

`network_cof_lv_switchgear_and_other`*Network cost of Failure for LV swithgear and others*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
network_cof_lv_switchgear_and_other(  
    lv_asset_category,  
    no_customers,  
    kva_per_customer = "Default"  
)
```

### Arguments

<code>lv_asset_category</code>	String The type of LV asset category
<code>no_customers</code>	Numeric. The numner of customers fed by an individual asset.
<code>kva_per_customer</code>	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_lv_switchgear_and_other(lv_asset_category = "LV Board (WM)",  
no_customers = 750, kva_per_customer = 51)
```

---

network_cof_lv_ugb	<i>Network cost of Failure for LV UGB</i>
--------------------	---

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

### Usage

```
network_cof_lv_ugb(  
    lv_asset_category,  
    no_customers,  
    kva_per_customer = "Default"  
)
```

### Arguments

lv_asset_category	String The type of LV asset category
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_lv_ugb(lv_asset_category = "LV UGB",  
no_customers = 750, kva_per_customer = 51)
```



---

network\_cof\_ohl\_cond    *Network cost of Failure for Overhead Line Conductors*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

### Usage

```
network_cof_ohl_cond(ohl_cond_asset_category, actual_load_mva, secure = T)
```

### Arguments

ohl_cond_asset_category	String	The type of Overhead line conductor
actual_load_mva	Numeric.	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
network_cof_ohl_cond(ohl_cond_asset_category = "33kV OHL (Tower Line) Conductor",  
actual_load_mva = 15)
```

---

network\_cof\_tower    *Network cost of Failure for Towers*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_tower(tower_asset_category, actual_load_mva, secure = T)
```

**Arguments**

tower_asset_category	String	The type of Tower
actual_load_mva	Numeric.	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_tower(tower_asset_category = "33kV Tower",
  actual_load_mva = 15)
```

---

```
network_cof_transformers
```

*Network cost of Failure for Transformers*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
network_cof_transformers(tf_asset_category, actual_load_mva, secure = T)
```

**Arguments**

tf_asset_category	String	The type of Tower
actual_load_mva	Numeric.	The actual load on the asset
secure	Boolean	If the asset is in a secure network or not

**Value**

Numeric. Network cost of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
network_cof_transformers(tf_asset_category = "33kV Transformer (GM)",
actual_load_mva = 15)
```

---

n\_cof\_excl\_ehv\_132kv\_tf

*Network cost of Failure for all Assets Categories excl. EHV and 132kV Transformers*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
n_cof_excl_ehv_132kv_tf(
  asset_type_ncf,
  no_customers,
  kva_per_customer = "Default"
)
```

**Arguments**

asset\_type\_ncf String. asset\_type\_ncf = c("LV Poles", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)", "LV Board (WM)", "LV UGB", "LV Board (X-type Network) (WM)", "6.6/11kV Poles", "20kV Poles", "HV Sub Cable", "6.6/11kV CB (GM) Primary", "6.6/11kV CB (GM) Secondary", "6.6/11kV Switch (GM)", "6.6/11kV RMU", "6.6/11kV X-type RMU", "20kV CB (GM) Primary", "20kV CB (GM) Secondary", "20kV Switch (GM)", "20kV RMU", "6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Pole", "66kV Pole", "33kV OHL (Tower Line) Conductor", "33kV Tower", "33kV Fittings", "66kV OHL (Tower Line) Conductor", "66kV Tower", "66kV Fittings", "33kV UG Cable (Non Pressurised)", "33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "33kV CB (Air Insulated Busbars)(ID) (GM)", "33kV

CB (Air Insulated Busbars)(OD) (GM)", "33kV CB (Gas Insulated Busbars)(ID) (GM)", "33kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Switch (GM)", "33kV RMU", "66kV CB (Air Insulated Busbars)(ID) (GM)", "66kV CB (Air Insulated Busbars)(OD) (GM)", "66kV CB (Gas Insulated Busbars)(ID) (GM)", "66kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)")

no\_customers Numeric. The number of customers fed by an individual asset.

kva\_per\_customer

Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

### Value

Numeric. Network cost of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
# Network cost of failure for a 6.6/11 kV transformer with 750 customers
# and 51 kVA per customer.
n_cof_excl_ehv_132kv_tf(asset_type_ncf = "6.6/11kV Transformer (GM)",
no_customers = 750, kva_per_customer = 51)
```

---

oil_test_modifier	<i>Oil Test Modifier</i>
-------------------	--------------------------

---

### Description

This function calculates the oil test modifier for 33/10kV, 66/10kV and 132kV transformers and tapchangers. See e.g. section 6.11 on page 68 in CNAIM (2021).

### Usage

```
oil_test_modifier(
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  transformer_type_all = "20kV Transformer (GM)"
)
```

**Arguments**

moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.
acidity	Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
transformer_type_all	String. A sting that refers to the specific transformer type. Options: transformer_type_all = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)"). The default setting is transformer_type = "66kV Transformer (GM)"

**Value**

Data table.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Oil test modifier
oil_test_modifier(moisture = 15,
acidity = 0.15,
bd_strength = 30,
transformer_type_all = "20kV Transformer (GM)")
```

---

pof\_132kv\_cb

*Current Probability of Failure for 132kV Switchgear*

---

**Description**

This function calculates the current annual probability of failure per kilometer 132kV Switchgear. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_132kv_cb(
  cb_asset_category = "132kV CB (Air Insulated Busbars)(ID) (GM)",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)
```

**Arguments**

cb_asset_category	String	The type of 132kV asset category
placement	String	Specify if the asset is located outdoor or indoor.
number_of_operations		The number of operations for duty factor
altitude_m	Numeric	Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric	Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer	Specify the corrosion index category, 1-5.
age	Numeric	The current age in years of the conductor.
measured_condition_inputs	Named list	observed_conditions_input
observed_condition_inputs	Named list	observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric	reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for EHV Switthgear
pof_132kv_cb(
  cb_asset_category = "132kV CB (Air Insulated Busbars)(ID) (GM)",
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default"),
  "support_structure" = list("Condition Criteria: Observed Condition" = "Default"),
  "air_systems" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductortest" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test/ Gas Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
  "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
  reliability_factor = "Default")
```

---

pof\_cables\_132kv

*Current Probability of Failure for 132kV cables*

---

**Description**

This function calculates the current annual probability of failure per kilometer for a 132kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_cables_132kv(
  cable_type = "132kV UG Cable (Gas)",
```

```

sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = "Default",
operating_voltage_pct = "Default",
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age
)

```

### Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("132kV UG Cable (Gas)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)"). The default setting is cable_type = "132kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 157, table 184 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 157, table 185 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 157, table 186 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 158, table 187 (oil) and 188 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.

### Value

Numeric. Current probability of failure per annum per kilometre for 132kV cables.



**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for
# "132kV UG Cable (Non Pressurised)", 50 years old
pof_cables_132kv_non <-
pof_cables_132kv(cable_type = "132kV UG Cable (Non Pressurised)",
sub_division = "Lead sheath - Copper conductor",
utilisation_pct = 80,
operating_voltage_pct = 60,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 50) * 100

paste0(sprintf("Probability of failure %.4f", pof_cables_132kv_non),
" percent per annum")
```

---

pof\_cables\_60\_30kv      *Current Probability of Failure for 30-60kV cables*

---

**Description**

This function calculates the current annual probability of failure per kilometer for a 30-60kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_cables_60_30kv(
  cable_type = "60kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age
)
```

**Arguments**

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)"). The default setting is cable_type = "60kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.

**Value**

Numeric. Current probability of failure per annum per kilometre for 60/30kV cables.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for
# "60kV UG Cable (Non Pressurised)", 50 years old
pof_cables_60_30kv(cable_type = "66kV UG Cable (Non Pressurised)",
sub_division = "Lead sheath - Copper conductor",
utilisation_pct = 80,
operating_voltage_pct = 60,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 50) * 100
```

---

pof\_cables\_66\_33kv      *Current Probability of Failure for 33-66kV cables*

---

**Description**

This function calculates the current annual probability of failure per kilometer for a 33-66kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_cables_66_33kv(
  cable_type = "66kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age
)
```

**Arguments**

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("33kV UG Cable (Gas)", "66kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Non Pressurised)", "33kV UG Cable (Oil)", "66kV UG Cable (Oil)"). The default setting is cable_type = "66kV UG Cable (Gas)".
------------	---

sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.

**Value**

Numeric. Current probability of failure per annum per kilometre for 66/33kV cables.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for
# "66kV UG Cable (Non Pressurised)", 50 years old
```

---

pof\_ehv\_fittings      *Current Probability of Failure for EHV/132kV Fittings*

---

### Description

This function calculates the current annual probability of failure per kilometer EHV Fittings. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```
pof_ehv_fittings(
  ehv_asset_category = "33kV Fittings",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)
```

### Arguments

ehv_asset_category	String. The type of EHV asset category.
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default"). See page 161, table 199 and 201 in CNAIM (2021).

**reliability\_factor**

Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for EHV Switchgear
```

---

<code>pof_ehv_switchgear</code>	<i>Current Probability of Failure for EHV Switchgear</i>
---------------------------------	--

---

**Description**

This function calculates the current annual probability of failure per kilometer EHV Switchgear. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_ehv_switchgear(
  ehv_asset_category = "33kV RMU",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)
```

**Arguments**

- ehv\_asset\_category  
String The type of EHV asset category
- placement  
String. Specify if the asset is located outdoor or indoor.
- number\_of\_operations  
The number of operations for duty factor
- altitude\_m  
Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude\_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset\_type.
- distance\_from\_coast\_km  
Numeric. Specify the distance from the coast measured in kilometers. distance\_from\_coast\_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset\_type.
- corrosion\_category\_index  
Integer. Specify the corrosion index category, 1-5.
- age  
Numeric. The current age in years of the conductor.
- measured\_condition\_inputs  
Named list observed\_conditions\_input
- observed\_condition\_inputs  
Named list observed\_conditions\_input conductor\_samp = c("Low", "Medium/Normal", "High", "Default")  
See page 161, table 199 and 201 in CNAIM (2021).
- reliability\_factor  
Numeric. reliability\_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability\_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for EHV Swicthgear
```

---

pof\_future\_cables\_132kv

*Future Probability of Failure for 132kV cables*

---

## Description

This function calculates the future annual probability of failure per kilometer for a 132kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```
pof_future_cables_132kv(
  cable_type = "132kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age,
  simulation_end_year = 100
)
```

## Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("132kV UG Cable (Gas)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)"). The default setting is cable_type = "132kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 157, table 184 in CNAIM (2021).



partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 157, table 185 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 157, table 186 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/moderate", "High", "Very High", "Default"). See page 158, table 187 (oil) and 188 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric array. Future probability of failure per annum per kilometre for 132kV cables.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Future probability of failure for 132kV UG Cable (Non Pressurised)
pof_future_cables_132kv(cable_type = "132kV UG Cable (Non Pressurised)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = 75,
  operating_voltage_pct = 50,
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age = 1,
  simulation_end_year = 100)
```

---

pof\_future\_cables\_60\_30kv

*Future Probability of Failure for 30-60kV cables*

---

### Description

This function calculates the future annual probability of failure per kilometer for a 30-60kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```
pof_future_cables_60_30kv(
  cable_type = "60kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age,
  simulation_end_year = 100
)
```

### Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)"). The default setting is cable_type = "60kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).

partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric array. Future probability of failure per annum per kilometre for 30-60kV cables.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Future probability of failure for 60kV UG Cable (Non Pressurised)
pof_60kv_non_pressurised <-
pof_future_cables_60_30kv(cable_type = "60kV UG Cable (Non Pressurised)",
sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = 75,
operating_voltage_pct = 50,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 1,
simulation_end_year = 100)
# Plot
plot(pof_60kv_non_pressurised$PoF * 100,
type = "line", ylab = "%", xlab = "years",
main = "PoF per kilometre - 66kV UG Cable (Non Pressurised)")
```

---

pof\_future\_cables\_66\_33kv

*Future Probability of Failure for 33-66kV cables*

---

### Description

This function calculates the future annual probability of failure per kilometer for a 33-66kV cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```
pof_future_cables_66_33kv(
  cable_type = "66kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age,
  simulation_end_year = 100
)
```

### Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("33kV UG Cable (Gas)", "66kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Non Pressurised)", "33kV UG Cable (Oil)", "66kV UG Cable (Oil)"). The default setting is cable_type = "66kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).

partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

### Value

Numeric array. Future probability of failure per annum per kilometre for 33-66kV cables.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
# Future probability of failure for 66kV UG Cable (Non Pressurised)
pof_66kV_non_pressurised <-
pof_future_cables_66_33kv(cable_type = "66kV UG Cable (Non Pressurised)",
sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = 75,
operating_voltage_pct = 50,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 1,
simulation_end_year = 100)
# Plot
plot(pof_66kV_non_pressurised$PoF * 100,
type = "line", ylab = "%", xlab = "years",
main = "PoF per kilometre - 66kV UG Cable (Non Pressurised)")
```

---

pof\_future\_ohl\_cond\_132\_66\_33kv

*Future Probability of Failure for 33-132kV OHL Conductors*

---

## Description

This function calculates the future annual probability of failure per kilometer 33-132kV OHL conductors. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```
pof_future_ohl_cond_132_66_33kv(
  ohl_conductor = "66kV OHL (Tower Line) Conductor",
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default",
  simulation_end_year = 100
)
```

## Arguments

- |               |   |
|---------------|---|
| ohl_conductor | String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: ohl_conductor = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor"). The default setting is ohl_conductor = "66kV OHL (Tower Line) Conductor".   |
| sub_division  | String. Refers to material the conductor is made of. Options: sub_division = c("ACSR - greased", "ACSR - non-greased", "AAAC", "Cad Cu", "Cu", "Other") . See page 107, table 20 in CNAIM (2021).   |
| placement     | String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments. |

altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age	Numeric. The current age in years of the conductor.
conductor_samp	String. Conductor sampling. Options: conductor_samp = c("Low", "Medium/Normal", "High", "Default"). See page 161, table 199 and 201 in CNAIM (2021).
corr_mon_survey	String. Corrosion monitoring survey. Options: corr_mon_survey = c("Low", "Medium/Normal", "High"). See page 161, table 200 and 202 in CNAIM (2021).
visual_cond	String. Visual condition. Options: visual_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 146, table 140 and 142 in CNAIM (2021).
midspan_joints	Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 146, table 141 and 143 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Future annual probability of failure for 66kV OHL (Tower Line) Conductor
```

---

pof\_future\_submarine\_cables

*Future Probability of Failure for Submarine Cables*

---

### Description

This function calculates the Future annual probability of failure per kilometer for submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```
pof_future_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  simulation_end_year = 100
)
```

### Arguments

sub_cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: sub_cable_type = c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable"). The deafult setting is sub_cable_type = "EHV Sub Cable".
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String. Describe the topography around the submarine cable. Options: typography = c("Low Detrimental Topography", "Medium Detrimental Topography", "High Detrimental Topography", "Very High Detrimental Topography", "Default")
situation	Situation of the cable



wind_wave	Numeric. Options: wind_wave=c(1, 2, 3, "Default"). Settings: <ul style="list-style-type: none"> <li>• wind_wave = 1: Sheltered sea loch, Wind &lt;200 W/m2</li> <li>• wind_wave = 2: Wave &lt;15kW/m, Wind 200-800 W/m2</li> <li>• wind_wave = 3: Wave &lt;15kW/m, Wind 200-800 W/m2</li> <li>• wind_wave = "Default": No data available</li> </ul>
intensity	String. Combined wave and current energy factor. Options: intensity=c("Low", "Moderate", "High", "Default").
landlocked	String. Options: landlocked = c("yes", "no"). Default setting for landlocked = "no".
sheath_test	String. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 158, table 189 in CNAIM (2021).
partial_discharge	String. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 158, table 190 in CNAIM (2021).
fault_hist	Numeric. The calculated fault rate for the cable per annum per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 158, table 191 in CNAIM (2021).
condition_armour	String. Indicating the external condition of the submarine cables armour. Options: condition_armour = c("Good", "Poor", "Critical", "Default")
age	Numeric. The current age in years of the cable.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric. Current probability of failure per annum per kilometre.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for 1 km EHV Sub Cable
pof_future_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
```

```

operating_voltage_pct = "Default",
topography = "Default",
situation = "Default",
wind_wave = "Default",
intensity = "Default",
landlocked = "no",
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
condition_armour = "Default",
age = 10,
reliability_factor = "Default",
simulation_end_year = 100)

```

---

pof\_future\_transformer\_11\_20kv

*Future Probability of Failure for 6.6/11kV and 20kV Transformers*

---

## Description

This function calculates the future annual probability of failure for 6.6/11kV and 20kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```

pof_future_transformer_11_20kv(
  hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default",
  simulation_end_year = 100
)

```

**Arguments**

hv_transformer_type	String. Refers to the high voltage transformer type the calculation is done for. Options: hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)"). The default setting is hv_transformer_type = 6.6/11kV Transformer (GM).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 153, table 172 in CNAIM (2021).
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration", "Default"). See page 130, table 81 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.

oil_acidity	Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric array. Future probability of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Future probability of a 6.6/11 kV transformer
future_pof_transformer <-
pof_future_transformer_11_20kv(hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 20,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default",
  simulation_end_year = 100)
plot(future_pof_transformer$PoF * 100,
  type = "line", ylab = "%", xlab = "years",
  main = "PoF")
```

---

pof\_future\_transformer\_132kv

*Future Probability of Failure for 132kV Transformers*

---

## Description

This function calculates the future annual probability of failure for 132kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```
pof_future_transformer_132kv(  
  transformer_type = "132kV Transformer (GM)",  
  year_of_manufacture,  
  utilisation_pct = "Default",  
  no_taps = "Default",  
  placement = "Default",  
  altitude_m = "Default",  
  distance_from_coast_km = "Default",  
  corrosion_category_index = "Default",  
  age_tf,  
  age_tc,  
  partial_discharge_tf = "Default",  
  partial_discharge_tc = "Default",  
  temperature_reading = "Default",  
  main_tank = "Default",  
  coolers_radiator = "Default",  
  bushings = "Default",  
  kiosk = "Default",  
  cable_boxes = "Default",  
  external_tap = "Default",  
  internal_tap = "Default",  
  mechnism_cond = "Default",  
  diverter_contacts = "Default",  
  diverter_braids = "Default",  
  moisture = "Default",  
  acidity = "Default",  
  bd_strength = "Default",  
  hydrogen = "Default",  
  methane = "Default",  
  ethylene = "Default",  
  ethane = "Default",  
  acetylene = "Default",  
  hydrogen_pre = "Default",  
  methane_pre = "Default",  
  ethylene_pre = "Default",  
  ethane_pre = "Default",  
  acetylene_pre = "Default",  
  furfuraldehyde = "Default",  
  reliability_factor = "Default",  
  simulation_end_year = 100
```

)

**Arguments**

transformer_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("132kV Transformer (GM)")
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).

temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 155, table 177 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.
acidity	Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.

bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric. Current probability of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)



**Examples**

```
# Future probability of failure for a 66/10kV transformer
pof_future_transformer_132kv(transformer_type = "132kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
simulation_end_year = 100)
```

---

pof\_future\_transformer\_33\_66kv

*Future Probability of Failure for 33/10kV and 66/10kV Transformers*

---

**Description**

This function calculates the future annual probability of failure for 33/10kV and 66/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for

an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```
pof_future_transformer_33_66kv(  
  transformer_type = "66kV Transformer (GM)",  
  year_of_manufacture = 1980,  
  utilisation_pct = "Default",  
  no_taps = "Default",  
  placement = "Default",  
  altitude_m = "Default",  
  distance_from_coast_km = "Default",  
  corrosion_category_index = "Default",  
  age_tf,  
  age_tc,  
  partial_discharge_tf = "Default",  
  partial_discharge_tc = "Default",  
  temperature_reading = "Default",  
  main_tank = "Default",  
  coolers_radiator = "Default",  
  bushings = "Default",  
  kiosk = "Default",  
  cable_boxes = "Default",  
  external_tap = "Default",  
  internal_tap = "Default",  
  mechnism_cond = "Default",  
  diverter_contacts = "Default",  
  diverter_braids = "Default",  
  moisture = "Default",  
  acidity = "Default",  
  bd_strength = "Default",  
  hydrogen = "Default",  
  methane = "Default",  
  ethylene = "Default",  
  ethane = "Default",  
  acetylene = "Default",  
  hydrogen_pre = "Default",  
  methane_pre = "Default",  
  ethylene_pre = "Default",  
  ethane_pre = "Default",  
  acetylene_pre = "Default",  
  furfuraldehyde = "Default",  
  reliability_factor = "Default",  
  simulation_end_year = 100  
)
```

**Arguments**

transformer_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("33kV Transformer (GM)", "66kV Transformer (GM)"). The default setting is transformer_type = "66kV Transformer (GM)"
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 154, table 173 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 175 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 154, table 174 in CNAIM (2021).

main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.
acidity	Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.

methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

Numeric. Current probability of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Future probability of failure for a 66/10kV transformer
pof_future_transformer_33_66kv(transformer_type = "66kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
```

```

placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
simulation_end_year = 100)

```

---

pof\_hv\_switchgear\_distribution

*Current Probability of Failure for HV Switchgear Distribution*

---

### **Description**

This function calculates the current annual probability of failure per kilometer HV Switchgear Distribution. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### **Usage**

```
pof_hv_switchgear_distribution(
```

```

hv_asset_category = "6.6/11kV CB (GM) Secondary",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age,
measured_condition_inputs,
observed_condition_inputs,
reliability_factor = "Default"
)

```

### Arguments

hv_asset_category	String The type of LV asset category
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

### Value

Numeric. Current probability of failure per annum per kilometer.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for HV Switchgear distribution
```

---

```
pof_hv_switchgear_primary
```

*Current Probability of Failure for HV Switchgear Primary*

---

**Description**

This function calculates the current annual probability of failure per kilometer HV Switchgear Primary. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_hv_switchgear_primary(
  hv_asset_category = "6.6/11kV CB (GM) Primary",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)
```

**Arguments**

hv_asset_category	String	The type of HV asset category
placement	String	Specify if the asset is located outdoor or indoor.
number_of_operations		The number of operations for duty factor
altitude_m	Numeric	Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric	Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.



corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for HV Switthgear Primary
```

---

```
pof_lv_switchgear_and_other
```

*Current Probability of Failure for LV switchgear and others*

---

**Description**

This function calculates the current annual probability of failure for LV switchgear and others The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_lv_switchgear_and_other(
  lv_asset_category = "LV Circuit Breaker",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
```

```

    measured_condition_inputs,
    observed_condition_inputs,
    reliability_factor = "Default"
)

```

### Arguments

**lv\_asset\_category** String The type of LV asset category

**placement** String. Specify if the asset is located outdoor or indoor.

**altitude\_m** Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude\_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset\_type.

**distance\_from\_coast\_km** Numeric. Specify the distance from the coast measured in kilometers. distance\_from\_coast\_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset\_type.

**corrosion\_category\_index** Integer. Specify the corrosion index category, 1-5.

**age** Numeric. The current age in years of the conductor.

**measured\_condition\_inputs** Named list observed\_conditions\_input

**observed\_condition\_inputs** Named list observed\_conditions\_input conductor\_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).

**reliability\_factor** Numeric. reliability\_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability\_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

### Value

Numeric. Current probability of failure per annum per kilometer.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```

# Current annual probability of failure for LV Switchgear and other
pof_lv_switchgear_and_other(
  lv_asset_category = "LV Circuit Breaker",
  placement = "Default",

```

```

altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("operational_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default")

```

---

pof\_lv\_ugb

---

*Current Probability of Failure for LV UGB*


---

### Description

This function calculates the current annual probability of failure for LV UGB. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```

pof_lv_ugb(
  lv_asset_category = "LV UGB",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)

```

### Arguments

lv_asset_category	String The type of LV asset category
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for 10kV OHL (Tower Line) Conductor
pof_lv_ugb(
lv_asset_category = "LV UGB",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("steel_cover_and_pit_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"water_moisture" = list("Condition Criteria: Observed Condition" = "Default"),
"bell_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default")
```

---

pof\_ohl\_cond\_132\_66\_33kv

*Current Probability of Failure for 33-132kV OHL Conductors*

---

## Description

This function calculates the current annual probability of failure per kilometer 33-132kV OHL conductors. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```
pof_ohl_cond_132_66_33kv(
  ohl_conductor = "66kV OHL (Tower Line) Conductor",
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default"
)
```

## Arguments

- |               |   |
|---------------|---|
| ohl_conductor | String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: ohl_conductor = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor"). The default setting is ohl_conductor = "66kV OHL (Tower Line) Conductor".   |
| sub_division  | String. Refers to material the conductor is made of. Options: sub_division = c("ACSR - greased", "ACSR - non-greased", "AAAC", "Cad Cu", "Cu", "Other") . See page 107, table 20 in CNAIM (2021).   |
| placement     | String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments. |
| altitude_m    | Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table  |

23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset\_type.

distance\_from\_coast\_km

Numeric. Specify the distance from the coast measured in kilometers. distance\_from\_coast\_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset\_type.

corrosion\_category\_index

Integer. Specify the corrosion index category, 1-5. corrosion\_category\_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset\_type.

age

Numeric. The current age in years of the conductor.

conductor\_samp

String. Conductor sampling. Options: conductor\_samp = c("Low", "Medium/Normal", "High", "Default"). See page 161, table 199 and 201 in CNAIM (2021).

corr\_mon\_survey

String. Corrosion monitoring survey. Options: corr\_mon\_survey = c("Low", "Medium/Normal", "High"). See page 161, table 200 and 202 in CNAIM (2021).

visual\_cond

String. Visual condition. Options: visual\_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 146, table 140 and 142 in CNAIM (2021).

midspan\_joints

Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 146, table 141 and 143 in CNAIM (2021).

reliability\_factor

Numeric. reliability\_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability\_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

### Value

Numeric. Current probability of failure per annum per kilometer.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
# Current annual probability of failure for 66kV OHL (Tower Line) Conductor
```

pof\_poles

*Current Probability of Failure for Poles***Description**

This function calculates the current annual probability of failure per kilometer Poles The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_poles(
  pole_asset_category = "20kV Poles",
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)
```

**Arguments**

pole_asset_category	String The type of asset category
sub_division	String. Refers to material the pole is made of.
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input

observed\_condition\_inputs

Named list observed\_conditions\_input conductor\_samp = c("Low", "Medium/Normal", "High", "Default")  
See page 161, table 199 and 201 in CNAIM (2021).

reliability\_factor

Numeric. reliability\_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability\_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

### Value

Numeric. Current probability of failure per annum per kilometer.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
# Current annual probability of failure for HV Poles
```

---

pof\_submarine\_cables *Current Probability of Failure for Submarine Cables*

---

### Description

This function calculates the current annual probability of failure per kilometer for submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### Usage

```
pof_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
```



```

    reliability_factor = "Default"
)

```

### Arguments

**sub\_cable\_type** String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: sub\_cable\_type = c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable"). The deafult setting is sub\_cable\_type = "EHV Sub Cable".

**utilisation\_pct** Numeric. The max percentage of utilisation under normal operating conditions.

**operating\_voltage\_pct** Numeric. The ratio in percent of operating/design voltage.

**topography** String. Describe the topography around the submarine cable. Options: typography = c("Low Detrimental Topography", "Medium Detrimental Topography", "High Detrimental Topography", "Very High Detrimental Topography", "Default")

**situation** Situation of the cable

**wind\_wave** Numeric. Options: wind\_wave=c(1, 2, 3, "Default"). Settings:

- wind\_wave = 1: Sheltered sea loch, Wind <200 W/m<sup>2</sup>
- wind\_wave = 2: Wave <15kW/m, Wind 200-800 W/m<sup>2</sup>
- wind\_wave = 3: Wave <15kW/m, Wind 200-800 W/m<sup>2</sup>
- wind\_wave = "Default": No data available

**intensity** String. Combined wave and current energy factor. Options: intensity=c("Low", "Moderate", "High", "Default").

**landlocked** String. Options: landlocked = c("yes", "no"). Default setting for landlocked = "no".

**sheath\_test** String. Indicating the state of the sheath. Options: sheath\_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 158, table 189 in CNAIM (2021).

**partial\_discharge** String. Indicating the level of partial discharge. Options: partial\_discharge = c("Low", "Medium", "High", "Default"). See page 158, table 190 in CNAIM (2021).

**fault\_hist** Numeric. The calculated fault rate for the cable per annum per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 158, table 191 in CNAIM (2021).

**condition\_armour** String. Indicating the external condition of the submarine cables armour. Options: condition\_armour = c("Good", "Poor", "Critical", "Default")

**age** Numeric. The current age in years of the cable.

**reliability\_factor** Numeric. reliability\_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability\_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometre.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for 1 km EHV Sub Cable
```

---

pof\_towers

*Current Probability of Failure for Towers*

---

**Description**

This function calculates the current annual probability of failure per kilometer EHV Switchgear The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```
pof_towers(
  tower_asset_category = "33kV Tower",
  foundation_type = "Foundation - Fully Encased Concrete",
  paint_type = "Paint System - Paint",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  observed_condition_inputs_steelwork,
  observed_condition_inputs_paint,
  observed_condition_inputs_foundation,
  reliability_factor = "Default"
)
```

**Arguments**

tower\_asset\_category  
String The type of Tower asset category

foundation\_type  
String Foundation type of the tower

paint_type	String Paint type of the tower
placement	String. Specify if the asset is located outdoor or indoor.
number_of_operations	Numeric Number of operations for the tower
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
observed_condition_inputs_steelwork	Named list observed_conditions_input
observed_condition_inputs_paint	Named list observed_conditions_input
observed_condition_inputs_foundation	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure per annum per kilometer.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current annual probability of failure for Towers
pof_towers(
  tower_asset_category = "33kV Tower",
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
```

```

corrosion_category_index = "Default",
age = 10,
paint_type = "Paint System - Galvanising",
foundation_type = "Foundation - Earth Grillage",
observed_condition_inputs_steelwork =
list("tower_legs" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_bracings" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_crossarms" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_peak" = list("Condition Criteria: Observed Condition" = "Default")),
observed_condition_inputs_paint =
list("paintwork_cond" = list("Condition Criteria: Observed Condition" = "Default")),
observed_condition_inputs_foundation =
list("foundation_cond" = list("Condition Criteria: Observed Condition" = "Default")),
reliability_factor = "Default")

```

---

pof\_transformer\_11\_20kv

*Current Probability of Failure for 6.6/11kV and 20kV Transformers*

---

## Description

This function calculates the current annual probability of failure for 6.6/11kV and 20kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

## Usage

```

pof_transformer_11_20kv(
  hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default"
)

```

**Arguments**

hv_transformer_type	String. Refers to the high voltage transformer type the calculation is done for. Options: hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)"). The default setting is hv_transformer_type = 6.6/11kV Transformer (GM).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 153, table 172 in CNAIM (2021).
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration", "Default"). See page 130, table 81 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.

oil_acidity	Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.

**Value**

Numeric. Current probability of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current probability of failure for a 6.6/11 kV transformer
pof_transformer_11_20kv(hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default")
```

---

pof\_transformer\_132kv *Current Probability of Failure for 132kv Transformers*

---

**Description**

This function calculates the current annual probability of failure for 132kv transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

**Usage**

```

pof_transformer_132kv(
  transformer_type = "132kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default"
)

```

**Arguments**

transformer\_type

String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer\_type = c("132kV Transformer (GM)")

year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 155, table 177 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).



bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.
acidity	Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.

acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

### Value

Numeric. Current probability of failure.

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
# Current probability of failure for a 132kV transformer
pof_transformer_132kv(transformer_type = "132kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
```

```

coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default")

```

---

pof\_transformer\_33\_66kv

*Current Probability of Failure for 33/10kV and 66/10kV Transformers*

---

### **Description**

This function calculates the current annual probability of failure for 33/10kV and 66/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

### **Usage**

```

pof_transformer_33_66kv(
  transformer_type = "66kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,

```

```

partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default"
)

```

## Arguments

transformer_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("33kV Transformer (GM)", "66kV Transformer (GM)"). The default setting is transformer_type = "66kV Transformer (GM)"
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on

	the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 154, table 173 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 175 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 154, table 174 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).

external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021).
moisture	Numeric. Refers to the moisture level in the transformer oil. Moisture levels are measured in ppm. A setting of "Default" will result in the best possible result.
acidity	Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.
bd_strength	Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.

ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

**Value**

Numeric. Current probability of failure.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Current probability of failure for a 66/10kV transformer
pof_transformer_33_66kv(transformer_type = "66kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
```

```

hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default")

```

---

predict\_weibull\_model *Prediction function for Weibull model*

---

### Description

This function uses the Weibull model parameters trained by the function `train_weibull_model()`, together with the environmental factors for a specific transformer, and determines the probability of failure at a given age.

### Usage

```

predict_weibull_model(
  age,
  environmental_factors = data.frame(utilisation_pct = "Default", placement =
    "Default", altitude_m = "Default", distance_from_coast_km = "Default",
    corrosion_category_index = "Default", partial_discharge = "Default", oil_acidity =
    "Default", temperature_reading = "Default", observed_condition = "Default"),
  weibull_model_parameters = data.frame(shapes = c(3.597272, 2.528015, 2.273607,
    2.10145, 2.048909), scales.intercept = c(100.17922, 45.54622, 73.63507, 29.99655,
    31.19306), scales.1 = c(0.0028536801, 0.0014449054, 0.0011716558, -0.0003356626,
    -0.0017302242), scales.2 = c(-8.202209, -3.856043, -2.818854, -2.388243, -2.940468),
    scales.3 = c(-0.003023546, -0.001602048, -0.00134834, -0.00198866, -0.003149921),
    scales.4 = c(-0.040016081, -0.028129483, -0.017586604, -0.009426902, -0.02178312),
    scales.5 = c(-1.4776137, -0.6794045,
    -0.6000869, -0.3839049, -0.4445468),
    scales.6 = c(-0.811395564, 0.015705206, -9.815935489, -0.002548827, -0.085903822),
    scales.7 = c(-4.4776511, -0.3677058, 0.4590218, -0.6364809, -0.3314029), scales.8 =
    c(-1.5861982, 0, -0.1398528, -0.1721091, 0), scales.9 = c(-0.7914404, -0.2632199,
    -1.1882148, 0, 0))
)

```

### Arguments

`age` Numeric. Age of transformer which should be used in the prediction.



**environmental\_factors**

Data frame. Must contain the following fields: utilisation\_pct: Numeric or "Default", placement: "Indoor", "Outdoor" or "Default", altitude\_m: Numeric or "Default", distance\_from\_coast\_km: Numeric or "Default", corrosion\_category\_index: Numeric or "Default", partial\_discharge: "Low", "Medium", "High (Not Confirmed)", "High (Confirmed)" or "Default", oil\_acidity: Numeric or "Default", temperature\_reading: "Normal", "Moderately High", "Very High" or "Default", observed\_condition: "No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration" or "Default"  
 Default value if environmental\_factors is not provided: data frame with value "Default" for all fields

**weibull\_model\_parameters**

Data frame. The output returned by the function `train_weibull_model()`. Default value if weibull\_parameters is not provided: data frame with parameters trained on data set transformer\_11kv\_faults.rda

**Value**

Numeric. Probability of failure at the given age.

**Source**

<https://www.cnaim.io/docs/fault-analysis/>

**Examples**

```
predict_weibull_model(age = 50)
```

---

present\_value\_future\_risk

*Present Value of Future Risk*

---

**Description**

This function calculates the present value of future risk. See section 5.5 on page 32 in CNAIM (2021).

**Usage**

```
present_value_future_risk(pof, cof, r = 0.035)
```

**Arguments**

pof	A vector of the probability of failure of the asset over years
cof	The consequence of failure of the asset
r	discount rate

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
present_value_future_risk(c(0.1, 0.2, 0.5), 100)
```

---

risk_calculation	<i>Calculates risk and converts to matrix coordinates</i>
------------------	---

---

**Description**

This function calculates monetary risk, given probability of failure and consequence of failure inputs, as well as the desired risk matrix dimensions.

**Usage**

```
risk_calculation(matrix_dimensions, id, pof, cof, asset_type)
```

**Arguments**

matrix_dimensions	A data frame with the dimensions of the desired risk matrix
id	A string that describes the asset
pof	The probability of failure of the asset
cof	The consequences of failure of the asset
asset_type	The asset type to be calculated for class

---

risk_matrix_points_plot	<i>Make a risk matrix with individual asset points</i>
-------------------------	--

---

**Description**

This function makes a D3 visualization of monetary risk with each asset as a point on the grid.

**Usage**

```
risk_matrix_points_plot(risk_data_matrix, dots_vector, dot_radius)
```

**Arguments**

risk_data_matrix	Long format matrix data.
dots_vector	Coordinates of the dots.
dot_radius	Radius of the dots.

---

risk\_matrix\_structure *Makes a default risk matrix structure*

---

**Description**

This function makes a simple matrix structure that can be used as an input to the risk\_matrix\_points and risk\_matrix\_summary functions

**Usage**

```
risk_matrix_structure(cols, rows, value = NA)
```

**Arguments**

cols	Number of columns
rows	Number of rows
value	Default value of each cell

---

risk\_matrix\_summary\_plot  
*Make a risk matrix with non-linear spacing*

---

**Description**

This function makes a D3 visualization of monetary risk with non-linear x and y intervals.

**Usage**

```
risk_matrix_summary_plot(
  risk_data_matrix,
  x_intervals = rep(20, 5),
  y_intervals = rep(25, 4)
)
```

**Arguments**

risk_data_matrix	Long format matrix data.
x_intervals	An array of x spacing in percent (sum to 100)
y_intervals	An array of y spacing in percent (sum to 100)

---

safety\_cof\_cables\_60\_30kv

*Safety cost of Failure for 30-60 kV UG cables*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.  
`#' ehv_asset_category = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)")`. The default setting is `ehv_asset_category = "60kV UG Cable (Gas)"`.

### Usage

```
safety_cof_cables_60_30kv(ehv_asset_category)
```

### Arguments

```
ehv_asset_category
    Asset category for analysis
```

### Value

Numeric. Financial consequences of failure for 30-60 kV UG cables

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
safety_cof_cables_60_30kv(ehv_asset_category = "30kV UG Cable (Oil)")
```

---

safety\_cof\_ehv\_cables *Safety cost of Failure for EHV UG cables & 132 kV UG cables*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_ehv_cables(ehv_asset_category)
```

**Arguments**

ehv\_asset\_category  
String The type of EHV asset category

**Value**

Numeric. Financial consequences of failure for EEHV UG cabkes & 132 kV UG cables

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)")
```

---

safety\_cof\_ehv\_fittings

*Safety cost of Failure for EHV/132kV Fittings*

---

**Description**

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
safety_cof_ehv_fittings(ehv_asset_category, location_risk, type_risk)
```

**Arguments**

ehv\_asset\_category  
String The type of EHV asset category

location\_risk  
String Type Financial factor criteria for EHV fittings (cf. section D1.2.1, page 178, CNAIM, 2021).

type\_risk  
String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for EHV fittings

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_ehv_fittings(ehv_asset_category = "33kV Fittings",
location_risk = "Default",
type_risk = "Default")
```

---

```
safety_cof_ehv_switchgear
```

*Safety cost of Failure for EHV swithgear & 132kV CB*

---

**Description**

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
safety_cof_ehv_switchgear(ehv_asset_category, location_risk, type_risk)
```

**Arguments**

ehv_asset_category	String The type of EHV asset category
location_risk	String Type Financial factor criteria for EHV swithgear & 132kV CB (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String. Asses Financial factor criteria for EHV swithgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Financial consequences of failure for EHV swithgear & 132kV CB

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_ehv_switchgear(ehv_asset_category = "33kV RMU",
location_risk = "Default",
type_risk = "Default")
```

---

`safety_cof_hv_switchgear_distribution`*Safety cost of Failure for HV Switchgear Distribution*

---

## Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

## Usage

```
safety_cof_hv_switchgear_distribution(  
    hv_asset_category,  
    location_risk,  
    type_risk  
)
```

## Arguments

<code>hv_asset_category</code>	String The type of LV asset category
<code>location_risk</code>	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021).
<code>type_risk</code>	String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021).

## Value

Numeric. Financial consequences of failure for LV switchgear

## Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

## Examples

```
safety_cof_hv_switchgear_distribution(  
    hv_asset_category = "6.6/11kV CB (GM) Secondary",  
    location_risk = "Default",  
    type_risk = "Default")
```

---

safety\_cof\_hv\_switchgear\_primary

*Safety cost of Failure for HV Switchgear Primary*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_hv_switchgear_primary(hv_asset_category, location_risk, type_risk)
```

### Arguments

hv_asset_category	String	The type of HV asset category
location_risk	String	Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String	Asses Financial factor criteria for HV switchgear setting (cf. table 218, page 176, CNAIM, 2021).

### Value

Numeric. Financial consequences of failure for HV switchgear

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
safety_cof_hv_switchgear_primary(  
hv_asset_category = "6.6/11kV CB (GM) Primary",  
location_risk = "Default",  
type_risk = "Default")
```



---

safety\_cof\_lv\_switchgear\_and\_other

*Safety cost of Failure for LV swicthgear and others*

---

## Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safetyr consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

## Usage

```
safety_cof_lv_switchgear_and_other(lv_asset_category, location_risk, type_risk)
```

## Arguments

lv_asset_category	String The type of LV asset category
location_risk	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021).

## Value

Numeric. Financial consequences of failure for LV switchgear

## Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

## Examples

```
safety_cof_lv_switchgear_and_other(lv_asset_category = "LV Board (WM)",  
location_risk = "Default",  
type_risk = "Default")
```

---

safety\_cof\_lv\_ugb      *Safety cost of Failure for LV UGB*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_lv_ugb(lv_asset_category, location_risk, type_risk)
```

### Arguments

lv_asset_category	String	The type of LV asset category
location_risk	String	Type Financial factor criteria for LV UGB (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String	Asses Financial factor criteria for LV UGB setting (cf. table 221, page 178, CNAIM, 2021).

### Value

Numeric. Financial consequences of failure for LV UGB

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
safety_cof_lv_ugb(lv_asset_category = "LV UGB", location_risk = "Default", type_risk = "Default")
```

---

safety\_cof\_ohl\_cond      *Safety cost of Failure for Overhead Line Conductors*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_ohl_cond(ohl_cond_asset_category, location_risk, type_risk)
```

**Arguments**

ohl_cond_asset_category	String	The type of overhead line conductor asset category
location_risk	String	Type Financial factor criteria for Overhead Line Conductors (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String	Asses Financial factor criteria for Overhead Line Conductors setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Safety consequences of failure for Overhead Line Conductors

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_ohl_cond(
  ohl_cond_asset_category = "33kV OHL (Tower Line) Conductor",
  location_risk = "Default",
  type_risk = "Default")
```

---

safety_cof_poles	<i>Safety cost of Failure for Pole</i>
------------------	--

---

**Description**

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

**Usage**

```
safety_cof_poles(pole_asset_category, location_risk, type_risk)
```

**Arguments**

pole_asset_category	String	The type of pole asset category
location_risk	String	Type Financial factor criteria for Pole (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String	Asses Financial factor criteria for pole setting (cf. table 221, page 180, CNAIM, 2021).

**Value**

Numeric. Safety consequences of failure for poles

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_poles(pole_asset_category = "33kV Pole",  
location_risk = "Default",  
type_risk = "Default")
```

---

safety\_cof\_sub\_cables *Safety cost of Failure for Sub cables*

---

**Description**

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
safety_cof_sub_cables(sub_cable_asset_category)
```

**Arguments**

```
sub_cable_asset_category  
String The type of sub cable asset category
```

**Value**

Numeric. Safety consequences of failure for Sub cables

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
safety_cof_sub_cables(sub_cable_asset_category = "HV Sub Cable")
```

---

safety_cof_towers	<i>Safety cost of Failure for tower</i>
-------------------	---

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_towers(tower_asset_category, location_risk, type_risk)
```

### Arguments

tower_asset_category	String The type of tower asset category
location_risk	String Type Financial factor criteria for tower (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String. Asses Financial factor criteria for tower setting (cf. table 221, page 180, CNAIM, 2021).

### Value

Numeric. Safety consequences of failure for towers

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
safety_cof_towers(tower_asset_category = "33kV Tower",  
location_risk = "Default",  
type_risk = "Default")
```

---

safety\_cof\_transformers

*Safety cost of Failure for Transformer*

---

### Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
safety_cof_transformers(tf_asset_category, location_risk, type_risk)
```

### Arguments

tf_asset_category	String The type of Transformer
location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021).
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021).

### Value

Numeric. Safety consequences of failure for Transformers

### Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

### Examples

```
safety_cof_transformers(tf_asset_category = "33kV Transformer (GM)",  
location_risk = "Default",  
type_risk = "Default")
```

---

s\_cof\_swg\_tf\_ohl      *Safety Consequences of Failure for Switchgears, Transformers & Overhead Lines*

---

## Description

This function calculates safety consequences of failure for switchgear, transformers and overhead lines (cf. section 7.4, page 80, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

## Usage

```
s_cof_swg_tf_ohl(
  type_risk = "Default",
  location_risk = "Default",
  asset_type_scf
)
```

## Arguments

type_risk	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: type_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
location_risk	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: location_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
asset_type_scf	String. Options: asset_type_scf = c("LV Poles", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)", "LV Board (WM)", "LV UGB", "LV Board (X-type Network) (WM)", "6.6/11kV Poles", "20kV Poles", "6.6/11kV CB (GM) Primary", "6.6/11kV CB (GM) Secondary", "6.6/11kV Switch (GM)", "6.6/11kV RMU", "6.6/11kV X-type RMU", "20kV CB (GM) Primary", "20kV CB (GM) Secondary", "20kV Switch (GM)", "20kV RMU", "6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Pole", "66kV Pole", "33kV OHL (Tower Line) Conductor", "33kV Tower", "33kV Fittings", "66kV OHL (Tower Line) Conductor", "66kV Tower", "66kV Fittings", "33kV CB (Air Insulated Busbars)(ID) (GM)", "33kV CB (Air Insulated Busbars)(OD) (GM)", "33kV CB (Gas Insulated Busbars)(ID) (GM)", "33kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Switch (GM)", "33kV RMU", "66kV CB (Air Insulated Busbars)(ID) (GM)", "66kV CB (Air Insulated Busbars)(OD) (GM)", "66kV CB (Gas Insulated Busbars)(ID) (GM)", "66kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV OHL (Tower Line) Conductor", "132kV Tower", "132kV Fittings", "132kV CB (Air Insulated Busbars)(ID) (GM)", "132kV CB (Air Insulated Busbars)(OD) (GM)", "132kV CB (Gas Insulated Busbars)(ID) (GM)", "132kV CB (Gas Insulated Busbars)(OD) (GM)", "132kV Transformer (GM)")

**Value**

Numeric. Safety consequences of failure for switchgear, transformers and overhead lines.

**Source**

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: [https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno\\_common\\_network\\_asset\\_indices\\_methodology\\_v2.1\\_final\\_01-04-2021.pdf](https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf)

**Examples**

```
# Safety consequences failure for a 6.6/11 kV transformer
s_cof_swg_tf_ohl(type_risk = "Default", location_risk = "Default",
                 asset_type_scf = "6.6/11kV Transformer (GM)")
```

---

train_weibull_model	<i>Training function for Weibull model</i>
---------------------	--

---

**Description**

This function uses transformer fault statistics data to train a Weibull model: Based on the environmental factors determining a transformer's expected lifetime, the set of all data points is first partitioned into five parts. Then a multilinear estimate for the expected lifetime of a transformer is trained for each part separately, and the corresponding Weibull shape and scale parameters for the five parts are estimated. The function returns the shape and scale parameters needed for the function `predict_weibull_model()`.

**Usage**

```
train_weibull_model(transformer_faults_data)
```

**Arguments**

transformer\_faults\_data

Data frame. Contains past data on transformer faults, together with environmental factors. Must contain the following fields: utilisation\_pct: Numeric or "Default", placement: "Indoor", "Outdoor" or "Default", altitude\_m: Numeric or "Default", distance\_from\_coast\_km: Numeric or "Default", corrosion\_category\_index: Numeric or "Default", partial\_discharge: "Low", "Medium", "High (Not Confirmed)", "High (Confirmed)" or "Default", oil\_acidity: Numeric or "Default", temperature\_reading: "Normal", "Moderately High", "Very High" or "Default", observed\_condition: "No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration" or "Default" age: Numeric

**Value**

Data frame. All shape and scale parameters needed for the function `predict_weibull_model()`.



**Source**

<https://www.cnaim.io/docs/fault-analysis/>

**Examples**

```
train_weibull_model(transformer_faults_data = transformer_11kv_faults)
```

---

transformer\_11kv\_faults

*Failure statistics dataset for 10,000 6.6/11kV transformers*

---

**Description**

A dataset containing failure statistics for 10,000 6.6/11kV transformers from the CNAIM standard, simulated over 100 years. The variables are as follows:

**Usage**

```
transformer_11kv_faults
```

**Format**

A data frame with 103,848 rows and 13 variables:

**utilisation\_pct** Utilization of a transformer in %  
**placement** Is the transformer placed indoors or outdoors?  
**altitude\_m** Altitude above sea level (m)  
**distance\_from\_coast\_km** Distance from salt water (km)  
**corrosion\_category\_index** Corrosion zone the asset exists in  
**partial\_discharge** Condition converted from TEV %-measurement  
**oil\_acidity** Oil acidity (mg KOH/g)  
**temperature\_reading** Temperature condition band  
**observed\_condition** Observed condition band  
**age** Age of transformer (years)  
**pof** Probability of failure (current and future) when the transformer failed  
**transformer\_id** Id of transformer that died  
**dead** Monte carlo result showing if the transformer has died (TRUE)

**Source**

<https://www.cnaim.io/>

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