

# Package ‘CNAIM’

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**Type** Package

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

**Version** 2.1.4

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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

**Encoding** UTF-8

**LazyData** TRUE

**Depends** R (>= 3.5.0)

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tibble

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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 | <i>Consequences of Failure</i> |
|-----|--------------------------------|

---

**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,
  bundled,
  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 | <i>Current Health score</i> |
|----------------|-----------------------------|

---

**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      *DGA Test Modifier*

---

### 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 >= 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\_board\_04kv

*Environmental cost of Failure for 0.4kV Board*


---

### 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 0.4kV board Outputted in DKK

### Usage

```
environmental_cof_board_04kv()
```

### 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_board_04kv()
```

---

 environmental\_cof\_cables\_04\_10kv

*Environmental cost of Failure for 0.4kV and 10kV UG Cables*


---

### Description

This function calculates environmental consequences of failure Outputted in DKK hv\_asset\_category = c("10kV UG Cable (Oil)", "10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)").

### Usage

```
environmental_cof_cables_04_10kv(hv_asset_category, prox_water, bundled)
```

### Arguments

|                   |   |
|-------------------|---|
| hv_asset_category | String The type of HV asset category 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 |
| prox_water        | Numeric. Specify the proximity to a water course in meters.   |
| bundled           | String. Options: bundled = c("Yes", "No", "Default"). A setting of "Default" will result in a bundling factor of 1.   |

**Examples**

```
environmental_cof_cables_04_10kv(hv_asset_category = "10kV UG Cable (Oil)",
prox_water = 95, bundled = "Yes")
```

---

```
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, banded)
```

## Arguments

ehv\_asset\_category

String The type of EHV cable distribution asset category Options: ehv\_asset\_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").

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_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)",
prox_water = 95, banded = "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 Options: ehv\_asset\_category = c("33kV Fittings", "66kV Fittings", "132kV 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

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

---

```
environmental_cof_ehv_switchgear
```

*Environmental cost of Failure for EHV switchgear & 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 switcgear & 132kV CB Options: ehv_asset_category = c( "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 RMU", "33kV Switch (GM)", "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)") |
| 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_hv_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 HV 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 switchgear distribution asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Secondary", "6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)", "20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)") |
| type_env_factor   | String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").  |
| 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,
  bunded = "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,
  bunded
)
```

**Arguments**

|                   |  |
|-------------------|--|
| hv_asset_category | String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")  |
| type_env_factor   | String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").  |
| 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_primary(
  hv_asset_category = "6.6/11kV CB (GM) Primary",
  type_env_factor = "Oil",
  prox_water = 95, bunded = "Yes")
```

---

```
environmental_cof_lv_switchgear_and_other
```

*Environmental cost of Failure for LV swicthgear 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 Options: lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)") |
|-------------------|--|

**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 Option: lv\_asset\_category = "LV UGB"

**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().#`

**Usage**

```
environmental_cof_ohl_cond(ohl_cond_asset_category)
```

**Arguments**

`ohl_cond_asset_category`

String The type of Pole asset category Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`.

**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**

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

---

`environmental_cof_ohl_cond_50kv`*Environmental cost of Failure for 50kV Overhead Line Conductors*

---

**Description**

This function calculates environmental consequences of failure Outputted in DKK

**Usage**

```
environmental_cof_ohl_cond_50kv()
```

**Examples**

```
environmental_cof_ohl_cond_50kv()
```

---

```
environmental_cof_ohl_fittings_50kv
```

*Environmental cost of Failure for 50kV Fittings*

---

**Description**

This function calculates environmental consequences of failure Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
environmental_cof_ohl_fittings_50kv()
```

**Value**

Numeric. Financial consequences of failure for 50kv fittings Outputted in DKK.

**Examples**

```
environmental_cof_ohl_fittings_50kv()
```

---

```
environmental_cof_pillar_04kv
```

*Environmental cost of Failure for 0.4kv Pillar*

---

**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()`.

**Usage**

```
environmental_cof_pillar_04kv()
```

**Value**

Numeric. Financial consequences of failure for 0.4kV pillar Outputted in DKK.

**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_pillar_04kv()
```

---

```
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()`.

**Usage**

```
environmental_cof_poles(pole_asset_category)
```

**Arguments**

```
pole_asset_category
```

String The type of pole asset category Options: `pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV Pole")`.

**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**

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

---

```
environmental_cof_poles_ohl_support_50kv
```

*Environmental cost of Failure for Poles OHL Support 50kV*

---

### Description

This function calculates environmental consequences of failure. Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`.# @return Numeric. Financial consequences of failure for Poles OHL support 50kV Outputted in DKK.

### Usage

```
environmental_cof_poles_ohl_support_50kv()
```

### Examples

```
environmental_cof_poles_ohl_support_50kv()
```

---

```
environmental_cof_relay
```

*Environmental cost of Failure for Relays*

---

### Description

This function calculates environmental consequences of failure. Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK. Financial consequences of failure for relay

### Usage

```
environmental_cof_relay(type_env_factor, prox_water, bundled)
```

### Arguments

|                 |  |
|-----------------|--|
| type_env_factor | String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Neither", "Default").  |
| 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 |
| bundled         | String. Options: bundled = c("Yes", "No", "Default"). A setting of "Default" will result in a bundling factor of 1.  |

**Examples**

```
environmental_cof_relay(  
  type_env_factor = "Oil",  
  prox_water = 95,  
  banded = "Yes")
```

---

environmental\_cof\_serviceline

*Environmental cost of Failure for Service Lines*

---

**Description**

This function calculates environmental consequences of failure Outputted in DKK

**Usage**

```
environmental_cof_serviceline(prox_water, banded)
```

**Arguments**

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

**Examples**

```
environmental_cof_serviceline(prox_water = 95, banded = "Yes")
```

---

environmental\_cof\_submarine\_10kv

*Environmental cost of Failure for 10kV Submarine 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 10kV submarine cables Outputted in DKK.

**Usage**

```
environmental_cof_submarine_10kv()
```

**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_submarine_10kv()
```

---

```
environmental_cof_submarine_30_60kv
```

*Environmental cost of Failure for 30kV and 60kV Submarine 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 30kV and 60kV submarine cables Outputted in DKK.

**Usage**

```
environmental_cof_submarine_30_60kv()
```

**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_submarine_30_60kv()
```

---

```
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()`.

**Usage**

```
environmental_cof_sub_cables(sub_cable_asset_category)
```

**Arguments**

```
sub_cable_asset_category
    String The type of Submarine cable asset category Options: sub_cable_asset_category
    = c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable").
```

**Value**

Numeric. Financial consequences of failure for sub cables

**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_switchgear_30_60kv
```

*Environmental cost of Failure for 30kV and 60kV Switchgear*

---

**Description**

This function calculates environmental consequences of failure Environmental consequences of failure is used in the derivation of consequences of failure see `cof().#` Outputted in DKK.

**Usage**

```
environmental_cof_switchgear_30_60kv(
  ehv_asset_category,
  type_env_factor,
  prox_water,
  bunded
)
```

**Arguments**

|                    |  |
|--------------------|--|
| ehv_asset_category | String The type of EHV asset category Options: ehv_asset_category = c("30kv", "60kv").   |
| type_env_factor    | String The type environment factor of 30kV and 60kV switchgear Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").   |
| 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 |
| bunded             | String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.  |

**Value**

Numeric. Financial consequences of failure for 30kV and 60kV switchgear

**Examples**

```
environmental_cof_switchgear_30_60kv(ehv_asset_category = "30kv",
type_env_factor = "Oil",
prox_water = 95,
bunded = "Yes")
```

---

environmental\_cof\_switchgear\_primary\_10kv

*Environmental cost of Failure for 10kV Switchgear Primary*

---

**Description**

This function calculates environmental consequences of failure Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
environmental_cof_switchgear_primary_10kv(type_env_factor, prox_water, bunded)
```

**Arguments**

|                 |  |
|-----------------|--|
| type_env_factor | String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").  |
| 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 |
| bunded          | String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.  |



**Value**

Numeric. Financial consequences of failure for 10kV switchgear

**Examples**

```
environmental_cof_switchgear_primary_10kv(
  type_env_factor = "Oil",
  prox_water = 95, bundled = "Yes")
```

---

```
environmental_cof_switchgear_secondary_10kv
```

*Environmental cost of Failure for 10kV Switchgear Secondary*

---

**Description**

This function calculates environmental consequences of failure. Environmental consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK. Financial consequences of failure for 10 kV switchgear secondary

**Usage**

```
environmental_cof_switchgear_secondary_10kv(
  type_env_factor,
  prox_water,
  bundled
)
```

**Arguments**

|                 |  |
|-----------------|--|
| type_env_factor | String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").  |
| 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 |
| bundled         | String. Options: bundled = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.   |

**Examples**

```
environmental_cof_switchgear_secondary_10kv(
  type_env_factor = "Oil", prox_water = 95,
  bundled = "Yes")
```

---

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()`.

### Usage

```
environmental_cof_towers(tower_asset_category)
```

### Arguments

tower\_asset\_category

String The type of tower asset category Options: tower\_asset\_category = c("33kV Tower", "66kV Tower", "132kV Tower").

### Value

Numeric. Financial 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

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

---

environmental\_cof\_tower\_ohl\_support\_50kv

*Environmental cost of Failure for Tower OHL Support 50 kV*

---

### Description

This function calculates environmental consequences of failure Environmental consequences of failure is used in the derivation of consequences of failure see `cof()`.

### Usage

```
environmental_cof_tower_ohl_support_50kv()
```

**Value**

Numeric. Financial consequences of failure for tower ohl support 50 kV Outputted in DKK.

**Examples**

```
environmental_cof_tower_ohl_support_50kv()
```

---

```
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,  
  bunded,  
  size_kva_mva = NULL,  
  size_conversion = NULL  
)
```

**Arguments**

|                                |  |
|--------------------------------|--|
| <code>tf_asset_category</code> | String The type of Transformer asset category Options: <code>tf_asset_category = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)")</code> .          |
| <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>bunded</code>            | String. Options: <code>bunded = 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")
```

---

```
environmental_cof_transformer_30_60kv
```

*Environmental cost of Failure for 30/10kV and 60/10kV Transformers*

---

**Description**

This function calculates environmental consequences of failure Outputted in DKK.

**Usage**

```
environmental_cof_transformer_30_60kv(
  tf_asset_category,
  prox_water,
  banded,
  size_kva_mva = NULL
)
```

**Arguments**

|                   |  |
|-------------------|--|
| tf_asset_category | String The type of Transformer Options: tf_asset_category = c("30kV Transformer (GM)", "60kV Transformer (GM)").   |
| 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 |
| banded            | String. Options: banded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.  |
| size_kva_mva      | Numeric The MVA KVA rating for the transformer   |

**Examples**

```
environmental_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
prox_water = 95, banded = "Yes", size_kva_mva = 20)
```

---

|               |                      |
|---------------|----------------------|
| 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_board_04kv`*Financial cost of Failure for 0.4kV Board*

---

### Description

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in (DKK).

### Usage

```
financial_cof_board_04kv(  
  type_financial_factor_criteria = "Asbestos clad",  
  access_factor_criteria  
)
```

### Arguments

`type_financial_factor_criteria`  
String Type Financial factor criteria for 0.4kV board (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `type_financial_factor_criteria = c("Non Asbestos clad", "Asbestos clad")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for 0.4kV board setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

### Value

Numeric. Financial consequences of failure for 0.4kV board

### 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_board_04kv(  
  type_financial_factor_criteria = "Asbestos clad",  
  access_factor_criteria = "Type A")
```



---

 financial\_cof\_cables\_04\_10kv

*Financial cost of Failure for 0.4kV and 10kV UG Cables*


---

**Description**

This function calculates financial consequences of failure Outputted in DKK

**Usage**

```
financial_cof_cables_04_10kv(hv_asset_category)
```

**Arguments**

hv\_asset\_category

String The type of HV asset category hv\_asset\_category = c("10kV UG Cable (Oil)", "10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)").

**Value**

Numeric. Financial consequences of failure for 0.4kV and 10kV UG cables

**Examples**

```
financial_cof_cables_04_10kv(hv_asset_category = "10kV UG Cable (Oil)")
```

---

 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 Options: ehv\_asset\_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").

**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 asset category Options: `ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")`

`type_financial_factor_criteria`

String. Type Financial factor criteria for EHV fittings `type_financial_factor_criteria = c("Suspension", "Tension")`.

`access_factor_criteria`

String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021). `access_factor_criteria = c("Type A", "Type B")`.

**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 swithgear & 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 swithgear & 132kV CB Options: ehv\_asset\_category = c("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 RMU", "33kV Switch (GM)", "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)")

access\_factor\_criteria

String. Asses Financial factor criteria for EHV swithgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021). Options: access\_factor\_criteria = c("Type A", "Type B", "Type C").

## 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

```
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 switchgear 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 Options: `hv_asset_category = c("6.6/11kV CB (GM) Secondary", "6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)", "20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)")`

`access_factor_criteria`

String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

## 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 Options: `hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")`

`access_factor_criteria`

String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

### 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 switchgear 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 Options: `lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")`

`type_financial_factor_criteria`  
String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `type_financial_factor_criteria = c("Non Asbestos clad", "Asbestos clad")`

`access_factor_criteria`  
String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

### 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 Option: lv\_asset\_category = "LV UGB"

**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 Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`.

`access_factor_criteria`  
 String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B")`.

**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_ohl_cond_50kv`

*Financial cost of Failure for 50kV Overhead Line Conductors*

---

**Description**

This function calculates financial consequences of failure Outputted in DKK

**Usage**

```
financial_cof_ohl_cond_50kv(access_factor_criteria)
```

**Arguments**

`access_factor_criteria`  
 String. Asses Financial factor criteria for Overhead Line Conductors. Options: `access_factor_criteria = c("Type A", "Type B")`.

**Value**

Numeric. Financial consequences of failure for Overhead Line Conductors

## Examples

```
financial_cof_ohl_cond_50kv(  
  access_factor_criteria = "Type A")
```

---

```
financial_cof_ohl_fittings_50kv  
  Financial cost of Failure for 50kV Fittings
```

---

## Description

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK

## Usage

```
financial_cof_ohl_fittings_50kv(  
  type_financial_factor_criteria,  
  access_factor_criteria  
)
```

## Arguments

`type_financial_factor_criteria`  
String. Type Financial factor criteria for EHV fittings Options: `type_financial_factor_criteria = c("Suspension", "Tension")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for EHV fittings setting. Options: `access_factor_criteria = c("Type A", "Type B")`.

## Value

Numeric. Financial consequences of failure for EHV fittings

## Examples

```
financial_cof_ohl_fittings_50kv(  
  type_financial_factor_criteria = "Tension",  
  access_factor_criteria = "Type A")
```

---

`financial_cof_pillar_04kv`*Financial cost of Failure for 0.4kV Pillar*

---

**Description**

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
financial_cof_pillar_04kv(  
    type_financial_factor_criteria = "Asbestos clad",  
    access_factor_criteria  
)
```

**Arguments**

`type_financial_factor_criteria`  
String Type Financial factor criteria for 0.4kV Pillar (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `type_financial_factor_criteria = c("Non Asbestos clad", "Asbestos clad")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for 0.4kV Pillar setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

**Value**

Numeric. Financial consequences of failure for 0.4kV Pillar

**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_pillar_04kv(  
    type_financial_factor_criteria = "Asbestos clad",  
    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 Options: `pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV Pole")`.

`type_financial_factor_criteria`  
String. Type Financial factor criteria for Pole Options: `type_financial_factor_criteria = c("Pole (supporting conductor only)", "Pole (supporting plant or equipment)", "Small footprint steel masts")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B")`.

### 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_poles_ohl_support_50kv`*Financial cost of Failure for Poles OHL Support 50kV*

---

## Description

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

## Usage

```
financial_cof_poles_ohl_support_50kv(  
    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 Options: `type_financial_factor_criteria` = c("Pole (supporting conductor only)", "Pole (supporting plant or equipment)", "Small footprint steel masts").

`access_factor_criteria`

String. Asses Financial factor criteria for Pole setting. Options: `access_factor_criteria` = c("Type A", "Type B").

## Value

Numeric. Financial consequences of failure for Poles

## Examples

```
financial_cof_poles_ohl_support_50kv(  
    type_financial_factor_criteria = "Small footprint steel masts",  
    access_factor_criteria = "Type A")
```

---

financial\_cof\_relay     *Financial cost of Failure for Relays*

---

**Description**

This function calculates financial consequences of failure Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
financial_cof_relay(access_factor_criteria)
```

**Arguments**

access\_factor\_criteria

String. Asses Financial factor criteria for relay setting. Options: access\_factor\_criteria = c("Type A", "Type B", "Type C").

**Examples**

```
financial_cof_relay(access_factor_criteria = "Type A")
```

---

financial\_cof\_serviceline  
*Financial cost of Failure for Service Lines*

---

**Description**

This function calculates financial consequences of failure Outputted in DKK

**Usage**

```
financial_cof_serviceline()
```

**Value**

Numeric. Financial consequences of failure for service line

**Examples**

```
financial_cof_serviceline()
```

---

`financial_cof_submarine_cables_10kv`*Financial cost of Failure for 10kV Submarine 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()`. Outputted in DKK.

**Usage**`financial_cof_submarine_cables_10kv()`**Value**

Numeric. Financial consequences of failure for 10kV submarine 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_submarine_cables_10kv()`

---

`financial_cof_submarine_cables_30_60kv`*Financial cost of Failure for 30kV and 60kV Submarine 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()`. Outputted in DKK.

**Usage**`financial_cof_submarine_cables_30_60kv()`**Value**

Numeric. Financial consequences of failure for 30kV and 60kV submarine 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_submarine_cables_30_60kv()
```

---

```
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 Options: sub\_cable\_asset\_category = c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable").

**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_switchgear_30_60kv`*Financial cost of Failure for 30kV and 60kV Switchgear*

---

**Description**

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
financial_cof_switchgear_30_60kv(ehv_asset_category, access_factor_criteria)
```

**Arguments**

`ehv_asset_category`

String. The type of 30kV and 60kV switchgear. Options: `ehv_asset_category = c("30kV", "60kV")`.

`access_factor_criteria`

String. Assesses financial factor criteria for 30kV and 60kV switchgear setting. Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

**Value**

Numeric. Financial consequences of failure for 30kV and 60kV switchgear.

**Examples**

```
financial_cof_switchgear_30_60kv(ehv_asset_category = "30kV",  
access_factor_criteria = "Type A")
```

---

`financial_cof_switchgear_primary_10kv`*Financial cost of Failure for 10kV Switchgear Primary*

---

**Description**

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
financial_cof_switchgear_primary_10kv(access_factor_criteria)
```

**Arguments**

`access_factor_criteria`

String. Asses Financial factor criteria for 10KV switchgear setting. Options:  
`access_factor_criteria = c("Type A", "Type B", "Type C")`.

**Value**

Numeric. Financial consequences of failure for HV switchgear primary

**Examples**

```
financial_cof_switchgear_primary_10kv(access_factor_criteria = "Type A")
```

---

```
financial_cof_switchgear_secondary_10kv
```

*Financial cost of Failure for 10 kV Swicthgear Secondary*

---

**Description**

This function calculates financial consequences of failure Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
financial_cof_switchgear_secondary_10kv(access_factor_criteria)
```

**Arguments**

`access_factor_criteria`

String. Asses Financial factor criteria for 10 kV Swicthgear Secondary setting.  
Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.

**Examples**

```
financial_cof_switchgear_secondary_10kv(  
access_factor_criteria = "Type A")
```

---

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 tower asset category Options: `tower_asset_category = c("33kV Tower", "66kV Tower", "132kV Tower")`.

`type_financial_factor_criteria`  
String The type financial factor for Tower `type_financial_factor_criteria = c("Suspension", "Tension", "Terminal")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for Tower setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B")`.

### 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\_tower\_ohl\_support\_50kv

*Financial cost of Failure for Tower OHL Support 50 kV*

---

### Description

This function calculates financial consequences of failure. Financial consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

### Usage

```
financial_cof_tower_ohl_support_50kv(  
    type_financial_factor_criteria,  
    access_factor_criteria  
)
```

### Arguments

`type_financial_factor_criteria`  
String. The type financial factor for Tower Options: `type_financial_factor_criteria = c("Suspension", "Tension", "Terminal")`.

`access_factor_criteria`  
String. Asses Financial factor criteria for Tower Options: `access_factor_criteria = c("Type A", "Type B")`.

### Value

Numeric. Financial consequences of failure for tower ohl support 50 kV

### Examples

```
financial_cof_tower_ohl_support_50kv(  
    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 Options: tf\_asset\_category = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)").

**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")
```

---

financial\_cof\_transformer\_30\_60kv

*Financial cost of Failure for 30/10 kV and 60/10 kV Transformers*

---

**Description**

This function calculates financial consequences of failure Outputted in DKK.

**Usage**

```
financial_cof_transformer_30_60kv(
  tf_asset_category,
  type_financial_factor_kva_mva = NULL,
  access_factor_criteria
)
```

**Arguments**

**tf\_asset\_category**  
String The type of Transformer asset category Options: tf\_asset\_category = c("30kV Transformer (GM)", "60kV Transformer (GM)").

**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). Options: access\_factor\_criteria = c("Type A", "Type B", "Type C").

**Value**

Numeric. Financial consequences of failure for Transformer

**Examples**

```
financial_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
  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\_board\_04kv

*Network cost of Failure for 0.4kV Board*

---

**Description**

This function calculates network cost of failure for 0.4kV board (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure Outputted in DKK is used in the derivation of consequences of failure see `cof()`.

**Usage**

```
network_cof_board_04kv(no_customers, kva_per_customer = "Default")
```

**Arguments**

`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_board_04kv(no_customers = 750, kva_per_customer = 51)
```

---

```
network_cof_cables_04_10kv
```

*Network cost of Failure for 0.4kV and 10kV UG Cables*

---

**Description**

This function calculates network cost of failure for 0.4kV and 10kV UG cables, outputted in DKK  
 hv\_asset\_category = c("10kV UG Cable (Oil)", "10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)").

**Usage**

```
network_cof_cables_04_10kv(hv_asset_category, actual_load_mva, secure = T)
```

**Arguments**

|                   |          |  |
|-------------------|----------|--|
| hv_asset_category | String   | The type of HV 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.

**Examples**

```
network_cof_cables_04_10kv(hv_asset_category = "10kV UG Cable (Oil)",  
actual_load_mva = 15)
```

---

```
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**

```
ehv_asset_category      Asset category for the analysis
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_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 cable distribution asset category Options: ehv_asset_category
                        = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV
                        UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "132kV
                        UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").
```



|                 |  |
|-----------------|--|
| 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 Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings") |
| 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 Poles*

---

**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 asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV 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

|                                       |  |
|---------------------------------------|--|
| <code>sub_cable_asset_category</code> | String The type of Submarine cable asset category Options: <code>sub_cable_asset_category = c("EHV Sub Cable", "132kV Sub Cable")</code> . |
| <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_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 switchgear & 132kV CB Options: ehv\_asset\_category = c( "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 RMU", "33kV Switch (GM)", "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)" )

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,EHV 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 asset category Options: `pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV 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

|                                       |   |
|---------------------------------------|---|
| <code>sub_cable_asset_category</code> | String The type of Submarine cable asset category Option: <code>sub_cable_asset_category = "HV Sub Cable"</code> .  |
| <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 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

**hv\_asset\_category** String The type of HV switchgear distribution asset category Options: hv\_asset\_category = c("6.6/11kV CB (GM) Secondary", "6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)", "20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (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_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 Options: hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")   |
| 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 swicthgear 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

|                   |  |
|-------------------|--|
| lv_asset_category | String The type of LV asset category Options: lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)") |
| no_customers      | Numeric. The numner 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_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 Option: lv_asset_category = "LV UGB"   |
| 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 Pole asset category Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower 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\_ohl\_cond\_50kv

*Network cost of Failure for 50kV Overhead Line Conductors*

---

### Description

This function calculates network cost of failure Outputted in DKK

### Usage

```
network_cof_ohl_cond_50kv(actual_load_mva, secure = T)
```

### Arguments

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.

### Examples

```
network_cof_ohl_cond_50kv(
  actual_load_mva = 15)
```

---

network\_cof\_ohl\_fittings\_50kv

*Network cost of Failure for 50kV Fittings*

---

### Description

This function calculates network cost of failure for 50kV fittings Network cost of failure is used in the derivation of consequences of failure. `cof()`. Outputted in DKK.

### Usage

```
network_cof_ohl_fittings_50kv(actual_load_mva, secure = T)
```

### Arguments

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.

**Examples**

```
network_cof_ohl_fittings_50kv(  
actual_load_mva = 15)
```

---

```
network_cof_pillar_04kv
```

*Network cost of Failure for 0.4kV Pillar*

---

**Description**

This function calculates network cost of failure for 0.4kV Pillar 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()`. Outputted in DKK.

**Usage**

```
network_cof_pillar_04kv(no_customers, kva_per_customer = "Default")
```

**Arguments**

`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_pillar_04kv(no_customers = 750, kva_per_customer = 51)
```

---

network\_cof\_poles\_ohl\_support\_50kv

*Network cost of Failure for Poles OHL Support 50kV*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
network_cof_poles_ohl_support_50kv(
  pole_asset_category,
  actual_load_mva,
  secure = T
)
```

### Arguments

|                     |          |  |
|---------------------|----------|--|
| pole_asset_category | String   | The type of Pole 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.

### Examples

```
network_cof_poles_ohl_support_50kv(
  actual_load_mva = 15)
```

---

network\_cof\_relay

*Network cost of Failure for Relays*

---

### Description

This function calculates network cost of failure for Relays Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
network_cof_relay(no_customers, kva_per_customer = "Default")
```

**Arguments**

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.

**Examples**

```
network_cof_relay(  
no_customers = 100, kva_per_customer = 40)
```

---

network\_cof\_serviceline

*Network cost of Failure for Service Lines*

---

**Description**

This function calculates network cost of failure for service line, outputted in DKK

**Usage**

```
network_cof_serviceline(actual_load_mva, secure = T)
```

**Arguments**

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.

**Examples**

```
network_cof_serviceline(actual_load_mva = 0.5)
```

---

network\_cof\_submarine\_cables\_10kv

*Network cost of Failure for 10kV Submarine 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()`. Outputted in DKK.

### Usage

```
network_cof_submarine_cables_10kv(no_customers, kva_per_customer = "Default")
```

### Arguments

`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_submarine_cables_10kv(  
no_customers = 250, kva_per_customer = 51)
```



---

`network_cof_submarine_cables_30_60kv`*Network cost of Failure for 30kV and 60kV Submarine 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()`. Outputted in DKK.

### Usage

```
network_cof_submarine_cables_30_60kv(  
    no_customers,  
    kva_per_customer = "Default"  
)
```

### Arguments

`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_submarine_cables_30_60kv(  
    no_customers = 250, kva_per_customer = 51)
```

---

network\_cof\_switchgear\_30\_60kv

*Network cost of Failure for 30kV and 60kV Switchgear*

---

### Description

This function calculates network cost of failure for 30kV and 60kV switchgear. Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
network_cof_switchgear_30_60kv(ehv_asset_category, actual_load_mva, secure = T)
```

### Arguments

|                    |   |
|--------------------|---|
| ehv_asset_category | String The type of 30kV and 60kV switchgear category Options: ehv_asset_category = c("30kV", "60kV"). |
| 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.

### Examples

```
network_cof_switchgear_30_60kv(ehv_asset_category = "30kV",
actual_load_mva = 15)
```

---

network\_cof\_switchgear\_primary\_10kv

*Network cost of Failure for 10kV Switchgear Primary*

---

### Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
network_cof_switchgear_primary_10kv(no_customers, kva_per_customer = "Default")
```

**Arguments**

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 .

**Value**

Numeric. Network cost of failure.

**Examples**

```
network_cof_switchgear_primary_10kv(  
no_customers = 750, kva_per_customer = 51)
```

---

```
network_cof_switchgear_secondary_10kv  
Network cost of Failure for 10kV Switchgear Secondary
```

---

**Description**

This function calculates network cost of failure for 10kV Switchgear Secondary Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

**Usage**

```
network_cof_switchgear_secondary_10kv(  
  no_customers,  
  kva_per_customer = "Default"  
)
```

**Arguments**

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.

**Examples**

```
network_cof_switchgear_secondary_10kv(  
no_customers = 750, kva_per_customer = 51)
```

---

|                   |   |
|-------------------|---|
| network_cof_tower | <i>Network cost of Failure for Towers</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_tower(tower_asset_category, actual_load_mva, secure = T)
```

### Arguments

|                      |   |
|----------------------|---|
| tower_asset_category | String The type of tower asset category Options: tower_asset_category = c("33kV Tower", "66kV Tower", "132kV 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_tower_ohl_support_50kv`*Network cost of Failure for Tower OHL Support 50 kV*

---

**Description**

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. Network cost of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

**Usage**

```
network_cof_tower_ohl_support_50kv(actual_load_mva, secure = T)
```

**Arguments**`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.

**Examples**

```
network_cof_tower_ohl_support_50kv(  
  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 Transformer asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) "). |
| 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)
```

---

```
network_cof_transformer_30_60kv
```

*Network cost of Failure for 30/10kV and 60/10kV Transformers*

---

**Description**

This function calculates network cost of failure for Outputted in DKK.

**Usage**

```
network_cof_transformer_30_60kv(tf_asset_category, actual_load_mva, secure = T)
```

**Arguments**

|                   |  |
|-------------------|--|
| tf_asset_category | String The type of Tower Options: tf_asset_category = c("30kV Transformer (GM)", "60kV Transformer (GM)"). |
| 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.

**Examples**

```
network_cof_transformer_30_60kv(tf_asset_category = "30kV 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)")
```

---

|          |                                       |
|----------|---------------------------------------|
| plot_pof | <i>Plot of probability of failure</i> |
|----------|---------------------------------------|

---

**Description**

This function is plotting the probability of failure for an electric network asset in a percentage.

**Usage**

```
plot_pof(pof_function = "Default")
```

**Arguments**

**pof\_function**      String. Choosing an pof function, Options: pof\_function = c(pof\_cables\_04kv\_pex, pof\_cables\_10kv\_pex, pof\_cables\_10kv\_oil, pof\_cables\_60\_30kv, pof\_ohl\_cond\_50kv, pof\_submarine\_cables\_10kv\_oil, pof\_submarine\_cables\_10kv\_pex, pof\_submarine\_cables\_30kv, pof\_transformer\_04\_10kv, pof\_building, pof\_serviceline, "Default").

**Examples**

```
# probability of failure curve
```

---

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**

DataFrame Current probability of failure per annum per kilometer along with 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 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"),
  "ductor_test" = 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\_board\_04kv

*Current Probability of Failure for 0.4kV Board***Description**

This function calculates the current annual probability of failure for 0.4kV Board. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. A string that refers to the specific asset category.

**Usage**

```
pof_board_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0069,
  c_value = 1.087,
  normal_expected_life = 60
)
```

**Arguments**

|                           |  |
|---------------------------|--|
| 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. 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. 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")   |
| 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).  |

|                      |   |
|----------------------|---|
| k_value              | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110. |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110                                      |
| normal_expected_life | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.                            |

### Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

### Examples

```
# Current annual probability of failure for 0.4kV board
pof_board_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
  "insulation" = 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",
  k_value = 0.0069,
  c_value = 1.087,
  normal_expected_life = 60)
```

---

|              |  |
|--------------|--|
| pof_building | <i>Current Probability of Failure for Primary Substation Building and Secondary Substation Building.</i> |
|--------------|--|

---

### Description

This function calculates the current annual probability of failure for primary substation building and secondary substation building. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_building(
  substation_type = "Secondary",
  material_type = "Wood",
  placement = "Outdoor",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  temperature_reading = "Default",
  coolers_radiator = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life_building = "Default"
)

```

**Arguments**

|                          |  |
|--------------------------|--|
| substation_type          | String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"  |
| material_type            | String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"   |
| 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. 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. 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 building.   |
| temperature_reading      | String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").   |
| coolers_radiator         | String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substant Deterioration", "Default"). in CNAIM (2021).                            |
| kiosk                    | String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |

|                               |   |
|-------------------------------|---|
| 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").. |
| 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).                                     |
| k_value                       | Numeric. k_value = "Default" by default. This number is given in a percentage.  |
| c_value                       | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life_building | Numeric. normal_expected_life_building = "Default" by default.  |

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.

**Examples**

```
pof_building(substation_type = "Secondary",
material_type = "Wood",
placement = "Outdoor",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 43,
temperature_reading = "Default",
coolers_radiator = "Default",
kiosk = "Default",
cable_boxes = "Default",
reliability_factor = "Default",
k_value = "Default",
c_value = 1.087,
normal_expected_life_building = "Default")
```

---

pof\_cables\_04kv\_pex     *Current Probability of Failure for 0.4kV UG PEX Non Pressurised Cables*

---

**Description**

This function calculates the current annual probability of failure per kilometer for a 0.4kV Pex non Pressurised cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_cables_04kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80
)
```

**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.

**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")`.

**partial\_discharge** String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: `partial_discharge = c("Low", "Medium", "High", "Default")`.

**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.

**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.

**k\_value** Numeric. `k_value = 0.0658` by default.

**c\_value** Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life** Numeric. `normal_expected_life = 80` by default.

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.



**Examples**

```
# Current annual probability of failure for 0.4kV non pressurised pex cable, 50 years old
pof_cables_04kv_pex(
  utilisation_pct = 80,
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80)
```

---

pof\_cables\_10kv\_oil     *Current Probability of Failure for 10kV UG Oil Non Preesurised Cables (Armed Paper Lead)*

---

**Description**

This function calculates the current annual probability of failure per kilometer for a Oil non Preesurised cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.24,
  c_value = 1.087,
  normal_expected_life = 80
)
```

**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.

**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").

|                      |   |
|----------------------|---|
| partial_discharge    | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| 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.   |
| k_value              | Numeric. k_value = 0.24 by default.   |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 80 by default.  |

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.

**Examples**

```
# Current annual probability of failure for 10kV oil cable, 50 years old
pof_cables_10kv_oil(
  utilisation_pct = 80,
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.24,
  c_value = 1.087,
  normal_expected_life = 80)
```

---

|                     |  |
|---------------------|--|
| pof_cables_10kv_pex | <i>Current Probability of Failure for 10kV UG PEX Non Pressurised Cables</i> |
|---------------------|--|

---

**Description**

This function calculates the current annual probability of failure per kilometer for a 10kV PEX non Pressurised cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80
)
```

**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.

**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")`.

**partial\_discharge** String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: `partial_discharge = c("Low", "Medium", "High", "Default")`.

**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.

**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.

**k\_value** Numeric. `k_value = 0.0658` by default.

**c\_value** Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life** Numeric. `normal_expected_life = 80` by default.

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.

**Examples**

```
# Current annual probability of failure for 10kV pex cable, 50 years old
pof_cables_10kv_pex(
  utilisation_pct = 80,
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80)
```

---

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**

DataFrame Current probability of failure per annum per kilometer along with 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 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**

DataFrame Current probability of failure per annum per kilometer along with 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 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)
```

---

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**

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for
# "66kV UG Cable (Non Pressurised)", 50 years old
pof_cables_66_33kv(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)
```

---

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**

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for EHV Switchgear
pof_ehv_fittings(
  ehv_asset_category = "33kV Fittings",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("insulator_elec_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "insulator_mech_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "conductor_fitting_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "tower_fitting_cond" =
  list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("thermal_imaging" =
  list("Condition Criteria: Thermal Imaging Result" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Result" = "Default")),
  reliability_factor = "Default")
```

---

pof\_ehv\_switchgear      *Current Probability of Failure for EHV Switchgear*

---

**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

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for EHV Switchgear
pof_ehv_switchgear(
  ehv_asset_category = "33kV RMU",
  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")),
  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 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\_future\_board\_04kv *Future Probability of Failure for 0.4kV Board*

---

**Description**

This function calculates the future annual probability of failure per kilometer 0.4kV board. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_future_board_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0069,
```

```

    c_value = 1.087,
    normal_expected_life = 60,
    simulation_end_year = 100
  )

```

### Arguments

**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. 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. 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")`

**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).

**k\_value** Numeric. `k_value = 0.0069` by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

**c\_value** Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life** Numeric. `normal_expected_life = 60` by default. The default value is accordingly to the CNAIM standard on page 107.

**simulation\_end\_year** Numeric. The last year of simulating probability of failure. Default is 100.

### Value

DataFrame. Future probability of failure along with future health score

### Examples

```

# Future annual probability of failure for 0.4kV board
pof_future_board_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",

```

```

corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = 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",
k_value = 0.0069,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)

```

---

pof\_future\_building     *Future Probability of Failure for Primary Substation Building and Secondary Substation Building.*

---

### Description

This function calculates the future annual probability of failure for primary substation building and secondary substation building. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```

pof_future_building(
  substation_type = "Secondary",
  material_type = "Wood",
  placement = "Outdoor",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  temperature_reading = "Default",
  coolers_radiator = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life_building = "Default",
  simulation_end_year = 100
)

```

**Arguments**

|                               |  |
|-------------------------------|--|
| substation_type               | String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"  |
| material_type                 | String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"   |
| 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. 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. 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 building.   |
| temperature_reading           | String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").   |
| coolers_radiator              | String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substant Deterioration", "Default"). in CNAIM (2021).                            |
| kiosk                         | String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |
| 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").                                 |
| 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).  |
| k_value                       | Numeric. k_value = "Default" by default. This number is given in a percentage.   |
| c_value                       | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110   |
| normal_expected_life_building | Numeric. normal_expected_life_building = "Default" by default.   |
| simulation_end_year           | Numeric. The last year of simulating probability of failure. Default is 100.   |

**Value**

DataFrame. Future probability of failure along with future health score



**Examples**

```
# Future probability of failure for a Secondary substation Building
pof_future_building(substation_type = "Secondary",
material_type = "Wood",
placement = "Outdoor",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 1,
temperature_reading = "Default",
coolers_radiator = "Default",
kiosk = "Default",
cable_boxes = "Default",
reliability_factor = "Default",
k_value = "Default",
c_value = 1.087,
normal_expected_life_building = "Default",
simulation_end_year = 100)
```

---

pof\_future\_cables\_04kv\_pex

*Future Probability of Failure for 0.4kV UG PEX Non Pressurised Cables*

---

**Description**

This function calculates the future annual probability of failure per kilometer for a 0.4kV PEX non Pressurised cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_future_cables_04kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80,
  simulation_end_year = 100
)
```

**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.  |
| 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").                     |
| partial_discharge     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| 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.   |
| k_value               | Numeric. k_value = 0.0658 by default.   |
| c_value               | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life  | Numeric. normal_expected_life = 80 by default.  |
| simulation_end_year   | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# future annual probability of failure for 0.4kV cable pex, 50 years old
pof_future_cables_04kv_pex(
  utilisation_pct = 80,
  operating_voltage_pct = 60,
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80,
  simulation_end_year = 100)
```

---

pof\_future\_cables\_10kv\_oil

*Future Probability of Failure for 10kV UG Oil Non Preesurised Cables  
(Armed Paper Lead)*

---

## Description

This function calculates the future #<sup>7</sup> annual probability of failure per kilometer for a 10kV Oil non Preesurised cables The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

## Usage

```
pof_future_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.24,
  c_value = 1.087,
  normal_expected_life = 80,
  simulation_end_year = 100
)
```

## 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.  |
| 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").                     |
| partial_discharge     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| 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.

k\_value                Numeric. k\_value = 0.24 by default.

c\_value                Numeric. c\_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

normal\_expected\_life                Numeric. normal\_expected\_life = 80 by default.

simulation\_end\_year                Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# future annual probability of failure for 10kV oil cable, 50 years old
pof_future_cables_10kv_oil(
  utilisation_pct = 80,
  operating_voltage_pct = 60,
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.24,
  c_value = 1.087,
  normal_expected_life = 80,
  simulation_end_year = 100)
```

---

pof\_future\_cables\_10kv\_pex

*Future Probability of Failure for 10kV UG PEX Non Pressurised Cables*

---

**Description**

This function calculates the future #’ annual probability of failure per kilometer for a 10kV PEX non Pressurised cables The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_future_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
```

```

    fault_hist = "Default",
    reliability_factor = "Default",
    age,
    k_value = 0.0658,
    c_value = 1.087,
    normal_expected_life = 80,
    simulation_end_year = 100
  )

```

### 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.

**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")`.

**partial\_discharge**  
String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: `partial_discharge = c("Low", "Medium", "High", "Default")`.

**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.

**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.

**k\_value**  
Numeric. `k_value = 0.0658` by default.

**c\_value**  
Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life**  
Numeric. `normal_expected_life = 80` by default.

**simulation\_end\_year**  
Numeric. The last year of simulating probability of failure. Default is 100.

### Value

DataFrame. Future probability of failure along with future health score

### Examples

```

# future annual probability of failure for 10kV cable pex, 50 years old
pof_future_cables_10kv_pex(
  utilisation_pct = 80,
  operating_voltage_pct = 60,

```

```

sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
reliability_factor = "Default",
age = 50,
k_value = 0.0658,
c_value = 1.087,
normal_expected_life = 80,
simulation_end_year = 100)

```

---

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**

DataFrame. Future probability of failure along with future 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**

```
# 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

DataFrame. Future probability of failure along with future 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

```
# Future probability of failure for 60kV UG Cable (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)
```

---

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

DataFrame. Future probability of failure per annum per kilometre for 33-66kV cables along with future 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

```
# Future probability of failure for 66kV UG Cable (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)
```

---

pof\_future\_meter      *Future Probability of Failure for Meters*

---

### Description

This function calculates the future annual probability of failure meters. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_meter(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 25,
  simulation_end_year = 100
)
```

### Arguments

|                           |  |
|---------------------------|--|
| 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. 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. 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")   |
| 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).  |

|                      |  |
|----------------------|--|
| k_value              | Numeric. k_value = 0.128 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110. |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110                                     |
| normal_expected_life | Numeric. normal_expected_life = 50 by default. The default value is accordingly to the CNAIM standard on page 107.                           |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.   |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# future annual probability of failure for meter
pof_future_meter(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 1,
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 25,
  simulation_end_year = 100)
```

## 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

DataFrame. Future probability of failure along with future 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

```
# Future annual probability of failure for 66kV OHL (Tower Line) Conductor
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 = 10,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
```

```

visual_cond = "Default",
midspan_joints = "Default",
reliability_factor = "Default",
simulation_end_year = 100)

```

---

pof\_future\_ohl\_cond\_50kv

*Future Probability of Failure for 50kV OHL Conductors*

---

### Description

This function calculates the future annual probability of failure per kilometer 50kV OHL conductors. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```

pof_future_ohl_cond_50kv(
  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",
  k_value = 0.008,
  c_value = 1.087,
  normal_expected_life = "Default",
  simulation_end_year = 100
)

```

### Arguments

|              |   |
|--------------|---|
| 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).   |
| k_value                  | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.   |
| c_value                  | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life     | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year      | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 50kV OHL (Tower Line) Conductor
```

```

pof_future_ohl_cond_50kv(
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default",
  k_value = 0.0080,
  c_value = 1.087,
  normal_expected_life = "Default",
  simulation_end_year = 100)

```

---

pof\_future\_ohl\_fittings\_50kv

*Future Probability of Failure for 50 kV Fittings*

---

### Description

This function calculates the future annual probability of failure per kilometer for a 50 kV fittings. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```

pof_future_ohl_fittings_50kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0096,
  c_value = 1.087,
  normal_expected_life = 40,
  simulation_end_year = 100
)

```

### Arguments

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")<br>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).   |
| k_value                   | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.   |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year       | Numeric. The last year of simulating probability of failure. Default is 100.code  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 50kV fittings
pof_future_ohl_fittings_50kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("insulator_elec_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
```

```

"insulator_mech_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"conductor_fitting_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"tower_fitting_cond" =
list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("thermal_imaging" =
list("Condition Criteria: Thermal Imaging Result" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.0096,
c_value = 1.087,
normal_expected_life = 40,
simulation_end_year = 100)

```

---

pof\_future\_pillar\_04kv

*Future Probability of Failure for 0.4kV Pillar*

---

## Description

This function calculates the future annual probability of failure per kilometer 0.4kV Pillar. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

## Usage

```

pof_future_pillar_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0046,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

## Arguments

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")<br>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).   |
| k_value                   | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.   |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year       | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 0.4kV Pillar
pof_future_pillar_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_cond" =
  list("Condition Criteria: Observed Condition" = "Default"),
```

```

"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = 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",
k_value = 0.0046,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)

```

---

pof\_future\_poles

*Future Probability of Failure for Poles*


---

## Description

This function calculates the future annual probability of failure per kilometer for a 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_future_poles(
  pole_asset_category = "20kV Poles",
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  pole_decay = "default",
  observed_condition_inputs,
  reliability_factor = "Default",
  simulation_end_year = 100
)

```

## 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.   |
| pole_decay                | Numeric Pole Decay  |
| observed_condition_inputs | Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default")<br>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).   |
| 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 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**

```
# Future annual probability of failure for HV Poles
pof_future_poles(
  pole_asset_category = "20kV Poles",
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("visual_pole_cond" =
  list("Condition Criteria: Pole Top Rot Present?" = "Default"),
  "pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
  "bird_animal_damage" =
```

```
list("Condition Criteria: Bird/Animal Damage?" = "Default"),
"top_rot" = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
pole_decay = "Default",
reliability_factor = "Default",
simulation_end_year = 100)
```

---

pof\_future\_poles\_ohl\_support\_50kv

*Future Probability of Failure for Poles OHL support 50 kV*

---

### Description

This function calculates the future annual probability of failure per kilometer for a Poles OHL support 50 kV. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_poles_ohl_support_50kv(
  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",
  k_value = 0.0285,
  c_value = 1.087,
  normal_expected_life = "Default",
  simulation_end_year = 100
)
```

### Arguments

|                        |   |
|------------------------|---|
| sub_division           | String Sub Division   |
| 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")<br>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). |
| k_value                   | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                             |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year       | Numeric. The last year of simulating probability of failure. Default is 100.  |

### Value

DataFrame. Future probability of failure along with future health score

### Examples

```
# Future annual probability of failure for Poles OHL support 50 kV
pof_future_poles_ohl_support_50kv(
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("visual_pole_cond" =
  list("Condition Criteria: Pole Top Rot Present?" = "Default"),
  "pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
  "bird_animal_damage" =
  list("Condition Criteria: Bird/Animal Damage?" = "Default"),
  "top_rot" = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
  measured_condition_inputs =
  list("pole_decay" =
  list("Condition Criteria: Degree of Decay/Deterioration" = "Default")),
  reliability_factor = "Default",
  k_value = 0.0285,
  c_value = 1.087,
```

```
normal_expected_life = "Default",
simulation_end_year = 100)
```

---

pof\_future\_relay      *Future Probability of Failure for Relay*

---

### Description

This function calculates the future annual probability of failure relay. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_relay(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 30,
  simulation_end_year = 100
)
```

### Arguments

|                           |  |
|---------------------------|--|
| 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")<br>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). |
| k_value                   | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                             |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year       | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# future annual probability of failure for relay
pof_future_relay(
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 30,
  simulation_end_year = 100)
```

---

pof\_future\_rtu

*Future Probability of Failure for RTU*

---

### Description

This function calculates the future annual probability of failure RTU. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_rtu(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 20,
  simulation_end_year = 100
)
```

### Arguments

|                           |   |
|---------------------------|---|
| 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). |
| k_value              | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                             |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

## Value

DataFrame. Future probability of failure along with future health score

## Examples

```
# future annual probability of failure for RTU
pof_future_rtu(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 1,
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 20,
  simulation_end_year = 100)
```

---

pof\_future\_serviceline

*Future Probability of Failure for Service Line*

---

### Description

This function calculates the future annual probability of failure per kilometer for a service line. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_serviceline(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.0329,
  c_value = 1.087,
  normal_expected_life = 75,
  simulation_end_year = 100
)
```

### Arguments

|                       |   |
|-----------------------|---|
| utilisation_pct       | Numeric Utilisation Percentage  |
| operating_voltage_pct | Numeric Operating Voltage Percentage  |
| sheath_test           | String Sheath Test  |
| partial_discharge     | String Partial Discharge  |
| fault_hist            | String Fault Histogram  |
| 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 conductor.   |
| k_value               | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                             |
| c_value               | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |

normal\_expected\_life  
 Numeric. normal\_expected\_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.

simulation\_end\_year  
 Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# future annual probability of failure for service line, 50 years old
pof_future_serviceline(
  utilisation_pct = 80,
  operating_voltage_pct = 60,
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age = 50,
  k_value = 0.0329,
  c_value = 1.087,
  normal_expected_life = 75,
  simulation_end_year = 100)
```

---

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:

- wind\_wave = 1: Sheltered sea loch, Wind <200 W/m2
- wind\_wave = 2: Wave <15kW/m, Wind 200-800 W/m2
- wind\_wave = 3: Wave <15kW/m, Wind 200-800 W/m2
- 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).

simulation\_end\_year Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

DataFrame. Future probability of failure along with future 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 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\_submarine\_cables\_10kv\_oil

*Future Probability of Failure for 10kV Oil Submarine Cables*

---

**Description**

This function calculates the future annual probability of failure per kilometer for a 10kV Oil submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_submarine_cables_10kv_oil(
  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",
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

**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.  |
| topography            | String Topography   |
| situation             | String Situation  |
| wind_wave             | String Wind Wave  |
| intensity             | String Intensity  |
| landlocked            | String Land Locked  |
| 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").                     |
| partial_discharge     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| condition_armour      | String Condition Armour   |
| 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). |
| k_value              | Numeric. k_value = 0.0658 by default.   |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 80 by default.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 1 km 10kV Oil Sub Cable
pof_future_submarine_cables_10kv_oil(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

---

pof\_future\_submarine\_cables\_10kv\_pex

*Future Probability of Failure for 10kV Non Pressurised submarine cables*

---

**Description**

This function calculates the future annual probability of failure per kilometer for a 10kV non pressurised submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_submarine_cables_10kv_pex(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

**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.  |
| topography            | String Topography   |
| situation             | String Situation  |
| wind_wave             | String Wind Wave  |
| intensity             | String Intensity  |
| landlocked            | String Land Locked  |
| 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").                     |
| partial_discharge     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| condition_armour      | String Condition Armour   |
| 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). |
| k_value              | Numeric. k_value = 0.0658 by default.   |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 80 by default.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 1 km 10kV non pressurised Sub Cable
pof_future_submarine_cables_10kv_pex(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

---

pof\_future\_submarine\_cables\_30\_60kv\_oil

*Future Probability of Failure for 30kV and 60kV Oil Submarine Cables*

---

**Description**

This function calculates the future annual probability of failure per kilometer for a 30kV and 60kV oil submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_submarine_cables_30_60kv_oil(
  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",
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

**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.  |
| topography            | String Topography   |
| situation             | String Situation  |
| wind_wave             | String Wind Wave  |
| intensity             | String Intensity  |
| landlocked            | String Land Locked  |
| 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").                     |
| partial_discharge     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").                       |
| 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. |
| condition_armour      | String Condition Armour   |
| 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). |
| k_value              | Numeric. k_value = 0.0658 by default.   |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 80 by default.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
pof_future_submarine_cables_30_60kv_oil(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

---

pof\_future\_submarine\_cables\_30\_60kv\_pex

*Future Probability of Failure for 30kV and 60kV Non Pressurised Submarine Cables*

---

**Description**

This function calculates the future annual probability of failure per kilometer for a 30kV and 60kV Non Pressurised submarine cables. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_submarine_cables_30_60kv_pex(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

**Arguments**

|                                    |   |
|------------------------------------|---|
| <code>utilisation_pct</code>       | Numeric. The max percentage of utilisation under normal operating conditions.   |
| <code>operating_voltage_pct</code> | Numeric. The ratio in percent of operating/design voltage.  |
| <code>topography</code>            | String Topography   |
| <code>situation</code>             | String Situation  |
| <code>wind_wave</code>             | String Wind Wave  |
| <code>intensity</code>             | String Intensity  |
| <code>landlocked</code>            | String Land Locked  |
| <code>sheath_test</code>           | String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: <code>sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default")</code> .       |
| <code>partial_discharge</code>     | String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: <code>partial_discharge = c("Low", "Medium", "High", "Default")</code> .         |
| <code>fault_hist</code>            | 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. |
| <code>condition_armour</code>      | String Condition Armour   |
| <code>age</code>                   | 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). |
| k_value              | Numeric. k_value = 0.0658 by default.   |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 80 by default.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
pof_future_submarine_cables_30_60kv_pex(
  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",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

---

pof\_future\_switchgear\_30\_60kv

*Future Probability of Failure for 30kV and 60kV Switchgear*

---

**Description**

This function calculates the future annual probability of failure 30kV and 60kV switchgear. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_switchgear_30_60kv(
  asset_type = "30kV",
  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",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100
)

```

**Arguments**

|                           |   |
|---------------------------|---|
| asset_type                | String Asset Type   |
| placement                 | String Placement  |
| number_of_operations      | String Number of Operations   |
| altitude_m                | String Altitude   |
| distance_from_coast_km    | String Distance from coast  |
| corrosion_category_index  | String Corrosion Category Index   |
| age                       | Numeric Age   |
| measured_condition_inputs | Named list observed_conditions_input  |
| observed_condition_inputs | Named list observed_conditions_input  |
| reliability_factor        | String Reliability Factor   |
| k_value                   | Numeric. k_value = 0.0077 by default. This number is given in a percentage. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 34. |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 55 by default. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 33.                              |
| simulation_end_year       | Numeric. The last year of simulating probability of failure. Default is 100.  |

**Value**

Numeric. Current probability of failure per annum.

**Examples**

```
# Future annual probability of failure for 30kV and 60kV Swicthgear
pof_future_switchgear_30_60kv(
  asset_type = "30kV",
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil 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",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

---

pof\_future\_switchgear\_primary\_10kv

*Future Probability of Failure for 10kV Switchgear Primary*

---

**Description**

This function calculates the future annual probability of failure 10kV switchgear Primary. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_switchgear_primary_10kv(
  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",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100
)

```

**Arguments**

|                           |  |
|---------------------------|--|
| 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. 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. 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")   |
| 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).  |
| k_value                   | Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.  |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110   |

normal\_expected\_life  
 Numeric. normal\_expected\_life = 55 by default. The default value is according to the CNAIM standard on page 107.

simulation\_end\_year  
 Numeric. The last year of simulating probability of failure. Default is 100.

**Value**

DataFrame. Future probability of failure along with future health score

**Examples**

```
# Future annual probability of failure for 10 kV Switchgear (GM) Primary
pof_future_switchgear_primary_10kv(
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil 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",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

---

pof\_future\_switchgear\_secondary\_10kv

*Future Probability of Failure for 10kV Switchgear Secondary*

---

**Description**

This function calculates the future annual probability of failure 10kV switchgear secondary. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_future_switchgear_secondary_10kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0067,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100
)

```

**Arguments**

|                           |   |
|---------------------------|---|
| 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).   |
| k_value                   | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.   |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life      | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |

simulation\_end\_year

Numeric. The last year of simulating probability of failure. Default is 100.

### Value

DataFrame. Future probability of failure along with future health score

### Examples

```
pof_future_switchgear_secondary_10kv(
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.0067,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

---

pof\_future\_transformer\_04\_10kv

*Future Probability of Failure for 0.4/10kV Transformers*

---

### Description

This function calculates the future annual probability of failure for 0.4/10kV Transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```
pof_future_transformer_04_10kv(
  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",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100
)

```

### Arguments

|                          |   |
|--------------------------|---|
| 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.   |
| 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. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).   |
| acidity              | String Acidity  |
| bd_strength          | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).  |
| k_value              | Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                             |
| c_value              | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life | Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.  |
| simulation_end_year  | Numeric. The last year of simulating probability of failure. Default is 100.  |

## Value

DataFrame. Future probability of failure along with future health score

## Examples

```
pof_future_transformer_04_10kv(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",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55,
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.  |
| 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. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| 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. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |
| simulation_end_year      | Numeric. The last year of simulating probability of failure. Default is 100.   |

**Value**

DataFrame. Future probability of failure along with future 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

```
# 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)
```

---

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.   |
| 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. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).

acidity Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).

bd\_strength Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).

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

DataFrame. Future probability of failure along with future 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

```
# 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\_30\_60kv

*Future Probability of Failure for 30/10kV and 60/10kV Transformers*

---

### Description

This function calculates the future annual probability of failure for 30/10kV and 60/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

### Usage

```

pof_future_transformer_30_60kv(
  transformer_type = "60kV 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",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default",
simulation_end_year = 100
)

```

## Arguments

**transformer\_type**  
String. A sting that refers to the specific asset category. Options: transformer\_type = c("30kV Transformer (GM)", "60kV Transformer (GM)"). The default setting is transformer\_type = "60kV Transformer (GM)"

**year\_of\_manufacture**  
Numeric. Normal expected life depends on the year for manufacture.

**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.

**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. 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. 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\_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").

|                      |  |
|----------------------|--|
| 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").   |
| temperature_reading  | String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").   |
| main_tank            | String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). 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"). in CNAIM (2021).                                   |
| bushings             | String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |
| kiosk                | String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |
| 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").   |
| external_tap         | String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).                                     |
| internal_tap         | String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). 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"). 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"). 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").                      |
| moisture             | Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| acidity              | Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).  |
| bd_strength          | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |

|                         |  |
|-------------------------|--|
| 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).      |
| k_value                 | Numeric. k_value = "0.0454" by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                                |
| c_value                 | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110   |
| normal_expected_life_tf | Numeric. normal_expected_life_tf = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.   |
| normal_expected_life_tc | Numeric. normal_expected_life_tc = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.   |
| simulation_end_year     | Numeric. The last year of simulating probability of failure. Default is 100.   |

### Value

DataFrame. Future probability of failure along with future health score

**Examples**

```

# Future probability of failure for a 60/10kV transformer
pof_future_transformer_30_60kv(transformer_type = "60kV 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",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "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.   |
| 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_brands   | String. Indicating the observed condition of the selector and diverter brands. Options: diverter_brands = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021).     |
| moisture          | Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).   |
| acidity           | Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).   |
| bd_strength       | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).  |
| 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**

DataFrame. Future probability of failure along with future 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**

```
# 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

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for HV Switchgear distribution
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 = 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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default")
```

---

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

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for HV Switthgear Primary
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 = 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")),
measured_condition_inputs = list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil 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\_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**

DataFrame Current probability of failure per annum per kilometer along with 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 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")<br>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

DataFrame Current probability of failure per annum per kilometer along with 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 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\_meter

*Current Probability of Failure for Meters*

---

### Description

This function calculates the current annual probability of failure meter The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_meter(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 25
)
```

**Arguments**

|                           |  |
|---------------------------|--|
| 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. 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. 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")   |
| 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).  |
| k_value                   | Numeric. k_value = 0.128 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.   |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110   |
| normal_expected_life      | Numeric. normal_expected_life = 50 by default. The default value is accordingly to the CNAIM standard on page 107.   |

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.

**Examples**

```
# Current annual probability of failure for meter
pof_meter(
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 25)
```

---

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

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for 66kV OHL (Tower Line) Conductor
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 = 10,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default")
```

---

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**

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for HV Poles
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 = 10,
  observed_condition_inputs =
  list("visual_pole_cond" =
  list("Condition Criteria: Pole Top Rot Present?" = "Default"),
  "pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
  "bird_animal_damage" =
  list("Condition Criteria: Bird/Animal Damage?" = "Default"),
  "top_rot" = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
  measured_condition_inputs =
  list("pole_decay" =
  list("Condition Criteria: Degree of Decay/Deterioration" = "Default")),
  reliability_factor = "Default")
```

---

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/m2
- wind\_wave = 2: Wave <15kW/m, Wind 200-800 W/m2
- wind\_wave = 3: Wave <15kW/m, Wind 200-800 W/m2
- 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

DataFrame Current probability of failure per annum per kilometer along with 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 annual probability of failure for 1 km EHV Sub Cable
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 = 10,
  reliability_factor = "Default"
)
```

---

pof\_switchgear\_primary\_10kv

*Current Probability of Failure for 10 kV Switchgear (GM) Primary*

---

### Description

This function calculates the current annual probability of failure 10 kV Switchgear (GM) Primary. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```

pof_switchgear_primary_10kv(
  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",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55
)

```

**Arguments**

|                           |  |
|---------------------------|--|
| 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. 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. 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")   |
| 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).  |
| k_value                   | Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.  |
| c_value                   | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110   |
| normal_expected_life      | Numeric. normal_expected_life = 55 by default. The default value is accordingly to the CNAIM standard on page 107.   |

**Value**

DataFrame Current probability of failure per annum per kilometer along with current health score.

**Examples**

```
# Current annual probability of failure for 10 kV Switchgear (GM) Primary
pof_switchgear_primary_10kv(
  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")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil 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",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55)
```

---

pof\_switchgear\_secondary\_10kV

*Current Probability of Failure for 10kV Switchgear secondary*

---

**Description**

This function calculates the current annual probability of failure 10kV Switchgear secondary The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_switchgear_secondary_10kV(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
```

```

corrosion_category_index = "Default",
age,
measured_condition_inputs,
observed_condition_inputs,
reliability_factor = "Default",
k_value = 0.0067,
c_value = 1.087,
normal_expected_life = 55
)

```

### Arguments

**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. 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. 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")`

**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).

**k\_value** Numeric. `k_value = 0.0067` by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

**c\_value** Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life** Numeric. `normal_expected_life = 55` by default. The default value is accordingly to the CNAIM standard on page 107.

### Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

### Examples

```

# Current annual probability of failure for 10kV Switchgear secondary
pof_switchgear_secondary_10kV(

```

```

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")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.0067,
c_value = 1.087,
normal_expected_life = 55)

```

---

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

DataFrame Current probability of failure per annum per kilometer along with 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 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\_tower\_ohl\_support\_50kv

*Current Probability of Failure for Towers OHL support 50kV*

---

**Description**

This function calculates the current annual probability of failure per kilometer EHV for Towers OHL support 50kV. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_tower_ohl_support_50kv(
  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",
```

```

k_value = 0.0545,
c_value = 1.087,
normal_expected_life = "Default"
)

```

### Arguments

**foundation\_type** String. Foundation type of the tower foundation\_type = c("Foundation - Fully Encased Concrete", "Foundation - Earth Grillage")

**paint\_type** String. Paint type of the tower foundation\_type = c(Paint System - Galvanising, Paint System - Paint )

**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. 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. 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")

**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).

**k\_value** Numeric. k\_value = 0.0545 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

**c\_value** Numeric. c\_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

**normal\_expected\_life** Numeric. normal\_expected\_life = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

### Value

DataFrame Current probability of failure per annum per kilometer along with current health score.



**Examples**

```
# Current annual probability of failure for Towers
pof_tower_ohl_support_50kv(
  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",
  k_value = 0.0545,
  c_value = 1.087,
  normal_expected_life = "Default")
```

---

pof\_transformer\_04\_10kv

*Current Probability of Failure for 0.4/10kV Transformers*

---

**Description**

This function calculates the current annual probability of failure for 0.4/10kV Transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

**Usage**

```
pof_transformer_04_10kv(
  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",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55
)

```

## Arguments

|                          |  |
|--------------------------|--|
| utilisation_pct          | Numeric Utilisation percentage   |
| 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. 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. 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.   |
| partial_discharge        | String. Indicating the level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").   |
| temperature_reading      | String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").   |
| 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"). |
| 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. the amount of moisture given in (ppm)   |
| acidity                  | Oil Acidity  |
| bd_strength              | Numeric. the amount of breakdown strength given in (kV)  |
| k_value                  | Numeric. k_value = 0.0077 by default. This number is given in a percentage. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 34.  |

`c_value` Numeric. `c_value` = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

`normal_expected_life` Numeric. `normal_expected_life` = 55 by default. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 33.

### Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

### Examples

```
# Current probability of failure for 0.4/10kV Transformers
pof_transformer_04_10kv(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",
  acidity = "Default",
  bd_strength = "Default",
  k_value = 0.0077,
  c_value = 1.087,
  normal_expected_life = 55)
```

---

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.

**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. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| 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. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |

### Value

DataFrame Current probability of failure per annum per kilometer along with 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 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")
```

## 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.   |
| 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_brands   | String. Indicating the observed condition of the selector and diverter brands. Options: diverter_brands = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021).     |
| moisture          | Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| acidity           | Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).  |
| bd_strength       | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |
| 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

DataFrame Current probability of failure per annum per kilometer along with 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 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\_30\_60kv

*Current Probability of Failure for 30/10kV and 60/10kV Transformers*

---

## Description

This function calculates the current annual probability of failure for 30/10kV and 60/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

## Usage

```

pof_transformer_30_60kv(
  transformer_type = "60kV 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",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default"
)

```

### Arguments

transformer\_type

String. A sting that refers to the specific asset category. Options: transformer\_type = c("30kV Transformer (GM)", "60kV Transformer (GM)"). The default setting is transformer\_type = "60kV Transformer (GM)"

year\_of\_manufacture

Numeric. Normal expected life depends on the year for manufacture.

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.   |
| 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. 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. 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_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").   |
| 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").   |
| temperature_reading      | String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").   |
| main_tank                | String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). 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"). in CNAIM (2021).                         |
| bushings                 | String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |
| kiosk                    | String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").   |
| 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").                                 |
| external_tap             | String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).                           |
| internal_tap             | String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). 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"). 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"). 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").                      |
| moisture          | Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| acidity           | Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).  |
| bd_strength       | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |
| 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). |
| k_value                 | Numeric. k_value = "0.0454" by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.                           |
| c_value                 | Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110  |
| normal_expected_life_tf | Numeric. normal_expected_life_tf = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.  |
| normal_expected_life_tc | Numeric. normal_expected_life_tc = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.  |

### Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

### Examples

```
# Current probability of failure for a 60/10kV transformer
pof_transformer_30_60kv(transformer_type = "60kV 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",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "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.   |
| 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. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).  |
| acidity            | Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).  |
| bd_strength        | Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).   |
| 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**

DataFrame Current probability of failure per annum per kilometer along with 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 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 risk matrix coordinates dimensions.

### Usage

```
risk_calculation(  
  matrix_dimensions,  
  id,  
  chs,  
  cof,  
  asset_type,  
  hi_bands = NULL,  
  ci_bands = NULL  
)
```

### Arguments

|                   |  |
|-------------------|--|
| matrix_dimensions | A data frame with the dimensions of the desired risk matrix.   |
| id                | An integer that identifies the asset   |
| chs               | The Current Health Score (CHS) of the asset  |
| cof               | The Consequence of Failure of the asset  |
| asset_type        | The asset type to be calculated for class  |
| hi_bands          | Specific Health Index (HI) bands for risk matrix. Default values are the same as defined in the CNAIM v2.1 standard            |
| ci_bands          | Specific Criticality Index (CI) bands for the risk matrix. Default values are the same as defined in the CNAIM v.2.1 standard. |

### 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

```
# Calculate risk matrix coordinates for an asset  
# 1. Make the risk matrix structure  
matrix_structure <- risk_matrix_structure(5,4,NA)  
  
# 2. Calculate risk matrix coordinates  
risk_calculation(matrix_dimensions = matrix_structure,
```

```
id = 1,  
chs = 4,  
cof = 15000,  
asset_type = "6.6/11kV Transformer (GM)")
```

---

risk\_matrix\_points\_plot

*Make a risk matrix with individual asset points*

---

### 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\_board\_04kv *Safety cost of Failure for 0.4kV Board*


---

### 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()`. Outputted in (DKK).

### Usage

```
safety_cof_board_04kv(location_risk, type_risk)
```

### Arguments

|               |  |
|---------------|--|
| location_risk | String Type Financial factor criteria for 0.4kV board (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk     | String. Asses Financial factor criteria for 0.4kV board setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |



**Value**

Numeric. Financial consequences of failure for 0.4kV board

**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_board_04kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

```
safety_cof_cables_04_10kv
```

*Safety cost of Failure for 0.4kV and 10kV UG Cables*

---

**Description**

This function calculates safety consequences of failure Outputted in DKK

**Usage**

```
safety_cof_cables_04_10kv(hv_asset_category)
```

**Arguments**

```
hv_asset_category
```

String The type of HV asset category hv\_asset\_category = c("10kV UG Cable (Oil)", "10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)").

**Value**

Numeric. Financial consequences of failure for 0.4kV and 10kV UG cables

**Examples**

```
safety_cof_cables_04_10kv(hv_asset_category = "10kV UG Cable (Oil)")
```

---

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 cable distribution asset category Options: ehv\_asset\_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").

**Value**

Numeric. Financial consequences of failure for EEHV UG cables & 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 Options: ehv\_asset\_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")

location\_risk

String Type Financial factor criteria for EHV fittings (cf. section D1.2.1, page 178, CNAIM, 2021). location\_risk = c("Low", "Medium", "High"). The default setting is location\_risk = "Medium".

type\_risk

String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021). type\_risk = c("Low", "Medium", "High"). The default setting is type\_risk = "Medium".

**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 swithgear & 132kV CB Options: ehv\_asset\_category = c("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 RMU", "33kV Switch (GM)", "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)")

location\_risk

String Type Financial factor criteria for EHV swithgear & 132kV CB (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location\_risk = c("Low", "Medium", "High"). The default setting is location\_risk = "Medium".

type\_risk

String. Asses Financial factor criteria for EHV swithgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021). Options: type\_risk = c("Low", "Medium", "High"). The default setting is type\_risk = "Medium".

**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). Safetyr 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**

|                   |  |
|-------------------|--|
| hv_asset_category | String The type of HV switchgear distribution asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Secondary", "6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)", "20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)") |
| location_risk     | String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".   |
| type_risk         | String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".  |

**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 Options: hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")  |
| location_risk     | String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk         | String. Asses Financial factor criteria for HV switchgear setting (cf. table 218, page 176, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

**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_lv_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 switchgear and others*

---

**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_switchgear_and_other(lv_asset_category, location_risk, type_risk)
```

**Arguments**

|                                |   |
|--------------------------------|---|
| <code>lv_asset_category</code> | String The type of LV asset category Options: <code>lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")</code> |
| <code>location_risk</code>     | String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: <code>location_risk = c("Low", "Medium", "High")</code> . The default setting is <code>location_risk = "Medium"</code> .            |
| <code>type_risk</code>         | String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: <code>type_risk = c("Low", "Medium", "High")</code> . The default setting is <code>type_risk = "Medium"</code> .               |

**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 | <i>Safety cost of Failure for LV UGB</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_lv_ugb(lv_asset_category, location_risk, type_risk)
```

### Arguments

|                   |   |
|-------------------|---|
| lv_asset_category | String The type of LV asset category Option: lv_asset_category = "LV UGB"   |
| location_risk     | String Type Financial factor criteria for LV UGB (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk         | String. Asses Financial factor criteria for LV UGB setting (cf. table 221, page 178, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

### 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 Pole asset category Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`.

`location_risk`     String Type Financial factor criteria for Overhead Line Conductors (cf. section D1.2.1, page 178, CNAIM, 2021). `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

`type_risk`     String. Asses Financial factor criteria for Overhead Line Conductors setting (cf. table 221, page 180, CNAIM, 2021). `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

### 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\_ohl\_cond\_50kv

*Safety cost of Failure for 50kV Overhead Line Conductors*

---

### Description

This function calculates safety consequences of failure Outputted in DKK

### Usage

```
safety_cof_ohl_cond_50kv(location_risk, type_risk)
```

### Arguments

**location\_risk** String Type Financial factor criteria for Overhead Line Conductors Options: location\_risk = c("Low", "Medium", "High"). The default setting is location\_risk = "Medium".

**type\_risk** String. Asses Financial factor criteria for Overhead Line Conductors Options: type\_risk = c("Low", "Medium", "High"). The default setting is type\_risk = "Medium".

### Value

Numeric. Safety consequences of failure for Overhead Line Conductors

### Examples

```
safety_cof_ohl_cond_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

safety\_cof\_ohl\_fittings\_50kv

*Safety cost of Failure for 50kV Fittings*

---

### Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
safety_cof_ohl_fittings_50kv(location_risk, type_risk)
```

**Arguments**

|               |   |
|---------------|---|
| location_risk | String Type Financial factor criteria for 50kV fittings Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".   |
| type_risk     | String. Asses Financial factor criteria for 50kV fittings setting Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium". |

**Value**

Numeric. Financial consequences of failure for EHV fittings

**Examples**

```
safety_cof_ohl_fittings_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

safety\_cof\_pillar\_04kv

*Safety cost of Failure for 0.4kV Pillar*

---

**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()`. Out-putted in DKK

**Usage**

```
safety_cof_pillar_04kv(location_risk, type_risk)
```

**Arguments**

|               |   |
|---------------|---|
| location_risk | String Type Financial factor criteria for 0.4kV Pillar (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk     | String. Asses Financial factor criteria for 0.4kV Pillar setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

**Value**

Numeric. Financial consequences of failure for 0.4kV Pillar

**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_pillar_04kv(
  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 Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV Pole").  |
| location_risk       | String Type Financial factor criteria for Pole (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk           | String. Asses Financial factor criteria for pole setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

**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\_poles\_ohl\_support\_50kv

*Safety cost of Failure for Poles OHL Support 50kV*


---

### Description

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

### Usage

```
safety_cof_poles_ohl_support_50kv(
  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 Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".    |
| type_risk           | String. Asses Financial factor criteria for pole setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium". |

### Value

Numeric. Safety consequences of failure for poles

### Examples

```
safety_cof_poles_ohl_support_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

 safety\_cof\_relay

*Safety cost of Failure for Relays*


---

### Description

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
safety_cof_relay(location_risk, type_risk)
```

**Arguments**

`location_risk` String Type Financial factor criteria for 50kV fittings Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

`type_risk` String. Asses Financial factor criteria for 50kV fittings setting Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

**Value**

Numeric. Financial consequences of failure for relay

**Examples**

```
safety_cof_relay(
  location_risk = "Default",
  type_risk = "Default")
```

---

```
safety_cof_serviceline
```

*Safety cost of Failure for Service Lines*

---

**Description**

This function calculates safety consequences of failure Outputted in DKK

**Usage**

```
safety_cof_serviceline()
```

**Value**

Numeric. Financial consequences of failure for service line

**Examples**

```
safety_cof_serviceline()
```

---

`safety_cof_submarine_cables_10kv`*Safety cost of Failure for 10kV Submarine 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()`. Outputted in DKK.

**Usage**`safety_cof_submarine_cables_10kv()`**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_submarine_cables_10kv()`

---

`safety_cof_submarine_cables_30_60kv`*Safety cost of Failure for 30kV and 60kV Submarine 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()`. Outputted in DKK.

**Usage**`safety_cof_submarine_cables_30_60kv()`**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_submarine_cables_30_60kv()
```

---

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 Submarine cable asset category Options: sub_cable_asset_category  
= c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable").
```

**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\_switchgear\_30\_60kv

*Safety cost of Failure for 30kV and 60kV Switchgear*


---

### Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

### Usage

```
safety_cof_switchgear_30_60kv(ehv_asset_category, location_risk, type_risk)
```

### Arguments

|                    |   |
|--------------------|---|
| ehv_asset_category | String The type of 30kV and 60kV switchgear Options: ehv_asset_category = c("30kV", "60kV").  |
| location_risk      | String Type Financial factor criteria for 30kV and 60kV switchgear Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".    |
| type_risk          | String. Asses Financial factor criteria for 30kV and 60kV switchgear setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium". |

### Value

Numeric. Financial consequences of failure for 30kV and 60kV switchgear

### Examples

```
safety_cof_switchgear_30_60kv(ehv_asset_category = "30kV",
  location_risk = "Default",
  type_risk = "Default")
```

---

 safety\_cof\_switchgear\_primary\_10kv

*Safety cost of Failure for 10kV Switchgear Primary*


---

### Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

**Usage**

```
safety_cof_switchgear_primary_10kv(location_risk, type_risk)
```

**Arguments**

**location\_risk** String Type Financial factor criteria for 10kV switchgear Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

**type\_risk** String. Asses Financial factor criteria for 10kV switchgear setting. Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

**Value**

Numeric. Financial consequences of failure for HV switchgear

**Examples**

```
safety_cof_switchgear_primary_10kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

```
safety_cof_switchgear_secondary_10kv
```

*Safety cost of Failure for 10 kV Switchgear Secondary*

---

**Description**

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

**Usage**

```
safety_cof_switchgear_secondary_10kv(location_risk, type_risk)
```

**Arguments**

**location\_risk** String Type Financial factor criteria for 10kV switchgear secondary (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

**type\_risk** String. Asses Financial factor criteria for 10kV switchgear secondary setting. Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

**Value**

Numeric. Financial consequences of failure for 10kV switchgear secondary

**Examples**

```
safety_cof_switchgear_secondary_10kv(
  location_risk = "Default",
  type_risk = "Default")
```

---

|                   |   |
|-------------------|---|
| 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 Options: tower_asset_category = c("33kV Tower", "66kV Tower", "132kV Tower").  |
| location_risk        | String Type Financial factor criteria for tower (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk            | String. Asses Financial factor criteria for tower setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

**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\_tower\_ohl\_support\_50kv

*Safety cost of Failure for Tower OHL Support 50 kV*

---

### Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

### Usage

```
safety_cof_tower_ohl_support_50kv(location_risk, type_risk)
```

### Arguments

|               |   |
|---------------|---|
| location_risk | String Type Financial factor criteria for tower Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk     | String. Asses Financial factor criteria for tower Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".       |

### Value

Numeric. Safety consequences of failure for tower ohl support 50 kV

### Examples

```
safety_cof_tower_ohl_support_50kv(
  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 asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) "). |
| location_risk     | String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".         |
| type_risk         | String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".            |

**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")
```

---

safety\_cof\_transformer\_30\_60kv

*Safety cost of Failure for 30/10kv and 60/10kv Transformer*

---

**Description**

This function calculates safety consequences of failure Outputted in DKK.

**Usage**

```
safety_cof_transformer_30_60kv(tf_asset_category, location_risk, type_risk)
```

**Arguments**

|                   |  |
|-------------------|--|
| tf_asset_category | String The type of Transformer Options: tf_asset_category = c("30kV Transformer (GM)", "60kV Transformer (GM)"). |
|-------------------|--|

|               |  |
|---------------|--|
| location_risk | String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium". |
| type_risk     | String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".    |

### Value

Numeric. Safety consequences of failure for Transformers

### Examples

```
safety_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
location_risk = "Default",
type_risk = "Default")
```

---

|                  |  |
|------------------|--|
| s_cof_swg_tf_ohl | <i>Safety Consequences of Failure for Switchgears, Transformers &amp; Overhead Lines</i> |
|------------------|--|

---

### 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    *Training function for Weibull model*

---

### 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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