Package 'CNAIM'

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Type Package

Title Common Network Asset Indices Methodology (CNAIM)

Version 1.0.1

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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

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Encoding UTF-8

LazyData TRUE

Depends R (>= 3.5.0)

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R topics documented:

`beta_1` *Initial Ageing Rate*

Description

This function calculates the initial ageing rate for an electric network asset. See section 6.1.5 on page 32 in CNAIM (2017).

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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

beta_2 *Forecast Ageing Rate*

Description

This function calculates the forecast Ageing Rate for an electric network asset. See section 6.1.8 on page 34 in CNAIM (2017).

Usage

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

Arguments

current_health_score	Numeric. The output returned by the function current_health().
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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

cof *Consequences of Failure*

Description

This function calculates consequences of failure (cf.section 7, page 71, CNAIM, 2017).

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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

---

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 71, CNAIM, 2017).

Usage

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

Arguments

kva	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 76 in CNAIM (2017). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 162, CNAIM, 2017).

`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 214, page 164, CNAIM, 2017).

`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 218, page 168, CNAIM, 2017). 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 218, page 168, CNAIM, 2017). 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 223, page 172, CNAIM, 2017).

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

`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 86, CNAIM, 2017).

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

current_health *Current Health score*

Description

This function calculates the current health score for a given electric network asset (cf. CNAIM, 2017. Page 21, 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 69 in CNAIM (2017).

Value

Numeric. The Current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 deriviation 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 47 in CNAIM (2017)

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","LV & HV")`. Choose `"EHV"` for cables `>= 33kV` and `"LV & HV"` for cables `< 33kV` .

Value

Numeric. Duty factor for cables.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 deriviation 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 47 in CNAIM (2017)

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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 deriviation 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 47 in CNAIM (2017)

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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

environmental_cof_ehv_cables

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

---

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). 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, bunded)
```

Arguments

ehv_asset_category	String The type of EHV asset category
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 223, page 172, CNAIM, 2017).
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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
environmental_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)",
prox_water = 95, bunded = "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 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_ehv_fittings(ehv_asset_category)
```

Arguments

ehv_asset_category	String The type of EHV asset category

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

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

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

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

Arguments

ehv_asset_category	String The type of EHV asset category
type_env_factor	String The type environment factor of EHV asset category
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 223, page 172, CNAIM, 2017).
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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`environmental_cof_hv_switchgear_distribution` *Environmental cost of Failure for HV switchgear distribution*

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see `cof`().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

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

Arguments

`hv_asset_category`	String The type of HV asset category
`type_env_factor`	String The type environment factor of HV asset category
`prox_water`	Numeric. Specify the proximity to a water course in meters. A setting of `"Default"` will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 223, page 172, CNAIM, 2017).
`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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). 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
`type_env_factor`	String The type environment factor of HV asset category
`prox_water`	Numeric. Specify the proximity to a water course in meters. A setting of `"Default"` will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 223, page 172, CNAIM, 2017).
`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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
environmental_cof_hv_switchgear_primary(
hv_asset_category = "6.6/11kV CB (GM) Secondary",
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 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_lv_switchgear_and_other(lv_asset_category)
```

Arguments

`lv_asset_category`
String The type of LV asset category

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV UGB

Usage

```
environmental_cof_lv_ugb(lv_asset_category)
```

Arguments

`lv_asset_category`
String The type of LV asset category

Value

Numeric. Environmental consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_ohl_cond(ohl_cond_asset_category)
```

Arguments

ohl_cond_asset_category	String The type of Overhead Line Conductors

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

environmental_cof_poles *Environmental cost of Failure for Poles*

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_poles(pole_asset_category)
```

Arguments

pole_asset_category
: String The type of Pole

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

environmental_cof_sub_cables *Environmental cost of Failure for sub cables*

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_sub_cables(sub_cable_asset_category)
```

Arguments

sub_cable_asset_category
: String The type of sub cable asset category

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`environmental_cof_towers` *Environmental cost of Failure for towers*

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_towers(tower_asset_category)
```

Arguments

`tower_asset_category`
: String The type of tower

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`environmental_cof_transformers` *Environmental cost of Failure for Transformers*

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). 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

`tf_asset_category`	String The type of Transformer
`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 223, page 172, CNAIM, 2017).
`bunded`	String. Options: `bunded = 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
`size_conversion`	String The size conversion for the transfromer

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`expected_life` *Expected Life*

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 32 in CNAIM (2017).

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 103, table 20 in CNAIM (2017).
`duty_factor`	Numeric. E.g. the output returned by the function `duty_factor_transformer_11_20kv()`.
`location_factor`	Numeric. The output returned by the function `location_factor()`.

Value

Numeric. Expected life.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# An asset e.g. a transformer with an expcted 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 80, CNAIM, 2017). 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",
  bunded = "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 222, page 171, CNAIM, 2017).
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 223, page 172, CNAIM, 2017).
bunded	String. Options: bunded = 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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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, bunded = "Yes")
```

`ffa_test_modifier` *Oil Test Modifier*

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 67 in CNAIM (2017).

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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

financial_cof_ehv_cables

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

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
financial_cof_ehv_cables(ehv_asset_category)
```

Arguments

ehv_asset_category	String The type of EHV cable distribution asset category

Value

Numeric. Financial consequences of failure for EHV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

`type_financial_factor_criteria`
: String. Type Financial factor criteria for EHV fittings

`access_factor_criteria`
: String. Asses Financial factor criteria for EHV fittings setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for EHV fittings

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear & 132kV CB*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). 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 swicthgear & 132kV CB

`access_factor_criteria`
: String. Asses Financial factor criteria for EHV swicthgear & 132kV CB setting (cf. table 214, page 164, CNAIM, 2017).

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear distribution

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

hv_asset_category	String The type of HV switchgear distribution asset category
access_factor_criteria	String. Asses Financial factor criteria for LV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear primary

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

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

`access_factor_criteria`
: String. Asses Financial factor criteria for HV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for HV switchgear primary

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear and others*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

`lv_asset_category`
: String The type of LV asset category

`type_financial_factor_criteria`
: String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 162, CNAIM, 2017).

`access_factor_criteria`
: String. Asses Financial factor criteria for LV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
financial_cof_lv_ugb(lv_asset_category)
```

Arguments

lv_asset_category	String The type of LV asset category

Value

Numeric. Financial consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ohl_cond_asset_category
: String The type of Pole asset category

access_factor_criteria
: String. Asses Financial factor criteria for Pole setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

financial_cof_poles *Financial cost of Failure for Poles*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

pole_asset_category
: String The type of Pole asset category

type_financial_factor_criteria
: String. Type Financial factor criteria for Pole

access_factor_criteria
: String. Asses Financial factor criteria for Pole setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

financial_cof_sub_cables

Financial cost of Failure for Sub cables

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
financial_cof_sub_cables(sub_cable_asset_category)
```

Arguments

sub_cable_asset_category	String The type of Submarine cable asset category

Value

Numeric. Financial consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`financial_cof_towers` *Financial cost of Failure for Towers*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

`tower_asset_category`
: String The type of Pole asset category

`type_financial_factor_criteria`
: String The type financial factor for Tower

`access_factor_criteria`
: String. Asses Financial factor criteria for Pole setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

financial_cof_transformers *Financial cost of Failure for Transformers*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

tf_asset_category	String The type of Transformer asset category
type_financial_factor_size	String The type financial factor size for Transformer
type_financial_factor_kva_mva	Numeric The type financial factor kVA MVA for Transformer
access_factor_criteria	String. Asses Financial factor criteria for Transformer setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for Transformer

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

f_cof_transformer_11kv *Financial Consequences of Failure for a 6.6/11 kV Transformer*

Description

This function calculates financial consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). 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 76 in CNAIM (2017). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 162, CNAIM, 2017).
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 214, page 164, CNAIM, 2017).

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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, 2017, page 52, 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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 32 in CNAIM (2017).

Usage

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

Arguments

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

Value

Numeric. Initial health for an electric network asset.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 *Location Factor (Excl.Submarine Cables)*

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 42 in CNAIM (2017). 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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). 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 15, table 1 in CNAIM (2017). 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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 44 in CNAIM (2017). For calculating the location factor for all other network assets please see the function location_factor().

Usage

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

Arguments

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")
sitution	String. Descibes how the submarine cable af fixed to the sea floor. Options: sitution=c("Laid on bed","Covered","Buried","Default")
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",
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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
 # Location factor for a non-landlocked submarine cable
location_factor_sub(topography = "Default",
                    sitution = "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, 2017. page 50, section 6.7.2). The function can be used to derive the health score factor for EHV and 132kV transformers. For deriviation 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 53 and 54 in CNAIM (2017). For an in deph desciption see also section 6.8 on page 53 in CNAIM (2017). 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 59 (observed condition factors) and in table 15 on page 63 (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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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_ehv_cables` *Network cost of Failure for EHV UG cabkes & 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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

network_cof_ehv_pole *Network cost of Failure for EHV Pole*

Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear & 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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

network_cof_hv_lv_poles

Network cost of Failure for LV/HV Poles

Description

This function calculates network cost of failure for Poles (cf. section 7.6, page 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

pole_asset_category	String The type of Pole
no_customers	Numeric. The 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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

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

`no_customers`
: Numeric. The 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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). 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 LV asset category
`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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see `cof()`.

Usage

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

Arguments

`hv_asset_category`	String The type of HV asset category
`no_customers`	Numeric. The 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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). 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

`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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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` *Network cost of Failure for LV UGB*

Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

`lv_asset_category`	String The type of LV asset category
`no_customers`	Numeric. The 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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

network_cof_tower *Network cost of Failure for Towers*

Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

network_cof_transformers

Network cost of Failure for Transformers

Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 83, CNAIM, 2017). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

n_cof_excl_ehv_132kv_tf

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

---

Description

This function calculates network cost of failure for all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 83, CNAIM, 2017). 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 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 86, CNAIM, 2017).

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 *Oil Test Modifier*

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 64 in CNAIM (2017).

Usage

```
oil_test_modifier(
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default"
)
```

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.

Value

Data table.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Oil test modifier
oil_test_modifier(moisture = 15,
acidity = 0.15,
bd_strength = 30)
```

---

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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau See page 146-147, table 192 and 194 in CNAIM (2017).
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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for EHV Swicthgear
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_cables_20_10_04kv *Current Probability of Failure for 20/10/0.4kV cables*

Description

This function calculates the current annual probability of failure per kilometer for a 20/10/0.4kV cable. 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 30 in CNAIM (2017).

Usage

```
pof_cables_20_10_04kv(
  hv_lv_cable_type = "10-20kV cable, PEX",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age
)
```

Arguments

`hv_lv_cable_type`
: String. A sting that refers to the specific asset category. Options: `hv_lv_cable_type = c("10-20kV cable,PEX","10-20kV cable,APB","0.4kV cable")`. The default setting is `hv_lv_cable_type = "10-20kV cable,PEX"`.

`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 141, table 168 in CNAIM (2017).

`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 141, table 169 in CNAIM (2017).

`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 141, table 170 in CNAIM (2017).

`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 69 in CNAIM (2017).

`age`
: Numeric. The current age in years of the cable.

Value

Numeric. Current probability of failure per annum for 20/10/0.4kV cables.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for 10-20kV cable, APB, 50 years old
pof_cables_10kV_APB <-
pof_cables_20_10_04kv(hv_lv_cable_type = "10-20kV cable, APB",
sub_division = "Lead sheath - Copper conductor",
utilisation_pct = 80,
operating_voltage_pct = 60,
```

```
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
reliability_factor = "Default",
age = 50) * 100

paste0(sprintf("Probability of failure %.4f", pof_cables_10kV_APB),
" percent per annum")
```

`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 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 141, table 168 in CNAIM (2017).

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 141, table 169 in CNAIM (2017).

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 141, table 170 in CNAIM (2017).

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 142, table 171 (oil) and 172 (gas) in CNAIM (2017).

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 69 in CNAIM (2017).

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

Value

Numeric. Current probability of failure per annum per kilometre for 20/10/0.4kV cables.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for
# "66kV UG Cable (Non Pressurised)", 50 years old
pof_cables_66kV_non <-
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) * 100

paste0(sprintf("Probability of failure %.4f", pof_cables_66kV_non),
" percent per annum")
```

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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau See page 146-147, table 192 and 194 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for EHV Swicthgear
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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau See page 146-147, table 192 and 194 in CNAIM (2017).
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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for EHV Swicthgear
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"),
"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_future_cables_20_10_04kv

Future Probability of Failure for 20/10/0.4kV cables

Description

This function calculates the future annual probability of failure per kilometer for a 20/10/0.4kV cable. 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 30 in CNAIM (2017).

Usage

```
pof_future_cables_20_10_04kv(
  hv_lv_cable_type = "10-20kV cable, PEX",
```

```
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  simulation_end_year = 100
)
```

Arguments

`hv_lv_cable_type`
: String. A sting that refers to the specific asset category. Options: `hv_lv_cable_type = c("10-20kV cable,PEX","10-20kV cable,APB","0.4kV cable")`. The default setting is `hv_lv_cable_type = "10-20kV cable,PEX"`.

`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 141, table 168 in CNAIM (2017).

`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 141, table 169 in CNAIM (2017).

`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 141, table 170 in CNAIM (2017).

`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 69 in CNAIM (2017).

`age`
: Numeric. The current age in years of the cable.

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Future probability of failure for 66kV UG Cable (Non Pressurised)
pof_10kV_pex <-
pof_future_cables_20_10_04kv(hv_lv_cable_type = "10-20kV cable, PEX",
sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = "Default",
operating_voltage_pct = "Default",
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
reliability_factor = "Default",
age = 15,
simulation_end_year = 100)
# Plot
plot(pof_10kV_pex$PoF * 100,
type = "line", ylab = "%", xlab = "years",
main = "PoF per kilometre - 10-20kV cable, PEX")
```

---

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 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 141, table 168 in CNAIM (2017).
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 141, table 169 in CNAIM (2017).
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 141, table 170 in CNAIM (2017).
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 142, table 171 (oil) and 172 (gas) in CNAIM (2017).
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 69 in CNAIM (2017).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

pof_future_ohl_cond_04_10kv

Current Probability of Failure for 0.4-10kV OHL Conductors

Description

This function calculates the current annual probability of failure per kilometer 0.4-10kV 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 30 in CNAIM (2017).

Usage

```
pof_future_ohl_cond_04_10kv(
  ohl_conductor = "10kV OHL (Tower Line) Conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  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 15, table 1 in CNAIM (2017). Options: ohl_conductor = c("0.4kV OHL (Tower Line) Conductor","10kV OHL (Tower Line) Conductor"). The default setting is ohl_conductor = "10kV OHL (Tower Line) 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.
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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). 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","Defau See page 146-147, table 192 and 194 in CNAIM (2017).
corr_mon_survey	String. Corrosion monitoring survey. Options: corr_mon_survey = c("Low","Medium/Normal","High' See page 146-147, table 193 and 195 in CNAIM (2017).
visual_cond	String. Visual condition. Options: visual_cond = c("As New","Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 131-132, table 127 and 129 in CNAIM (2017).

`midspan_joints` Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 131-132, table 128 and 130 in CNAIM (2017).

`reliability_factor`
Reliabilty factor

`simulation_end_year`
The year till which simulation has to be run

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current future probability of failure for 10kV OHL (Tower Line) Conductor
pof_future_ohl_cond_04_10kv(
ohl_conductor = "10kV OHL (Tower Line) Conductor",
utilisation_pct = "Default",
operating_voltage_pct = "Default",
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_132_66_33kv

Future Probability of Failure for 33-132kV OHL Conductors

Description

This function calculates the future annual probability of failure per kilometer 3-132kV 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 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 103, table 20 in CNAIM (2017).
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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). 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","Defau`
See page 146-147, table 192 and 194 in CNAIM (2017).

`corr_mon_survey`
String. Corrosion monitoring survey. Options: `corr_mon_survey = c("Low","Medium/Normal","High"`
See page 146-147, table 193 and 195 in CNAIM (2017).

`visual_cond` String. Visual condition. Options: `visual_cond = c("As New","Normal Wear","Some Deterioration","Substantial Deterioration","Default")`. See page 131-132, table 127 and 129 in CNAIM (2017).

`midspan_joints` Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 131-132, table 128 and 130 in CNAIM (2017).

`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 69 in CNAIM (2017).

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

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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_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 30 in CNAIM (2017).

Usage

```
pof_future_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  sitution = "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 15, table 1 in CNAIM (2017). 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` String. Descibes 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:

- `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",`

`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 143, table 182 in CNAIM (2017).

`partial_discharge` String. Indicating the level of partial discharge. Options: `partial_discharge = c("Low","Medium","High","Default")`. See page 144, table 183 in CNAIM (2017).

`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 144, table 184 in CNAIM (2017).

`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 69 in CNAIM (2017).

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

Value

Numeric. Current probability of failure per annum per kilometre.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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",
  sitution = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default",
  simulation_end_year = 100)
```

`pof_future_transformer_11_20kv` *Future Probability of Failure for 6.6/11kV and 20kV Transformers*

Description

This function calculates the future annual probability of failure for 6.6/11kV and 20kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 30 in CNAIM (2017).

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",
  oil_acidity = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.

age
: Numeric. The current age in years.

partial_discharge
: String. Indicating the level of partial discharge. Options for partial_discharge: partial_discharge = c("Low","Medium","High (Not Confirmed)","High (Confirmed)","Defaul See page 138, table 159 in CNAIM (2017).

oil_acidity
: Numeric. Measured in mg KOH/g. See page 138, table 160 in CNAIM (2017).

temperature_reading
: String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal","Moderately High","Very High","Default"). See page 139, table 161 in CNAIM (2017).

observed_condition
: String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("As New","Good","Slight Deterioration","Poor","Very Poor","Default"). See page 120, table 73 in CNAIM (2017).

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 69 in CNAIM (2017).

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

Value

Numeric array. Future probability of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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",
oil_acidity = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
simulation_end_year = 100)
plot(future_pof_transformer$PoF * 100,
type = "line", ylab = "%", xlab = "years",
main = "PoF")
```

---

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 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 103 table 20 in CNAIM (2017).

`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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.

age_tf Numeric. The current age in years of the transformer.

age_tc Numeric. The current age in years of the tapchanger

partial_discharge_tf
String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low","Medium","High (Not Confirmed)","High (Confirmed)","Default"). See page 139, table 162 in CNAIM (2017).

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 140, table 164 in CNAIM (2017).

temperature_reading
String. Indicating the criticality. Options: temperature_reading = c("Normal","Moderately High","Very High","Default"). See page 139, table 163 in CNAIM (2017).

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 74 in CNAIM (2017).

coolers_radiator
String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 75 in CNAIM (2017).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 76 in CNAIM (2017).

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 121, table 77 in CNAIM (2017).

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 121, table 78 in CNAIM (2017).

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defau See page 121, table 79 in CNAIM (2017).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defau See page 121, table 80 in CNAIM (2017).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defa See page 121, table 81 in CNAIM (2017).

diverter_contacts String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 122, table 82 in CNAIM (2017).

diverter_braids String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 122, table 83 in CNAIM (2017)

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

acidity Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.

bd_strength Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.

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

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

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

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

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

hydrogen_pre Numeric. Previous results. A setting of "Default" will result in the best possible result.

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

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

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

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

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

`reliability_factor`
Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of `"Default"` sets the `reliability_factor` to 1. See section 6.14 on page 69 in CNAIM (2017).

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

Value

Numeric. Current probability of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau`
See page 146-147, table 192 and 194 in CNAIM (2017).

`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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for HV Swicthgear 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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau
See page 146-147, table 192 and 194 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for HV Swicthgear Primary
pof_hv_switchgear_primary(
hv_asset_category = "6.6/11kV CB (GM) Secondary",
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")
```

`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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau
See page 146-147, table 192 and 194 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau See page 146-147, table 192 and 194 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

pof_ohl_cond_04_10kv *Current Probability of Failure for 0.4-10kV OHL Conductors*

Description

This function calculates the current annual probability of failure per kilometer 0.4-10kV 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 30 in CNAIM (2017).

Usage

```
pof_ohl_cond_04_10kv(
  ohl_conductor = "10kV OHL (Tower Line) Conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  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 15, table 1 in CNAIM (2017). Options: ohl_conductor = c("0.4kV OHL (Tower Line) Conductor","10kV OHL (Tower Line) Conductor"). The default setting is ohl_conductor = "10kV OHL (Tower Line) 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.
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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). 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","Defau`
See page 146-147, table 192 and 194 in CNAIM (2017).

`corr_mon_survey`
String. Corrosion monitoring survey. Options: `corr_mon_survey = c("Low","Medium/Normal","High"`
See page 146-147, table 193 and 195 in CNAIM (2017).

`visual_cond` String. Visual condition. Options: `visual_cond = c("As New","Normal Wear","Some Deterioration","Substantial Deterioration","Default")`. See page 131-132, table 127 and 129 in CNAIM (2017).

`midspan_joints` Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 131-132, table 128 and 130 in CNAIM (2017).

`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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for 10kV OHL (Tower Line) Conductor
pof_ohl_cond_04_10kv(
ohl_conductor = "10kV OHL (Tower Line) Conductor",
utilisation_pct = "Default",
operating_voltage_pct = "Default",
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_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 3-132kV 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 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 103, table 20 in CNAIM (2017).
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 107-108, table 25A in CNAIM (2017) 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 107, table

23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). 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","Defau
See page 146-147, table 192 and 194 in CNAIM (2017).

corr_mon_survey
: String. Corrosion monitoring survey. Options: corr_mon_survey = c("Low","Medium/Normal","High'
See page 146-147, table 193 and 195 in CNAIM (2017).

visual_cond
: String. Visual condition. Options: visual_cond = c("As New","Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 131-132, table 127 and 129 in CNAIM (2017).

midspan_joints
: Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 131-132, table 128 and 130 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau`
See page 146-147, table 192 and 194 in CNAIM (2017).

`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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 30 in CNAIM (2017).

Usage

```
pof_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  sitution = "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 15, table 1 in CNAIM (2017). 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")
sitution	String. Descibes how the submarine cable af fixed to the sea floor. Options: sitution=c("Laid on bed","Covered","Buried","Default")
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",

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 143, table 182 in CNAIM (2017).

partial_discharge — String. Indicating the level of partial discharge. Options: partial_discharge = c("Low","Medium","High","Default"). See page 144, table 183 in CNAIM (2017).

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 144, table 184 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometre.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for 1 km EHV Sub Cable
pof_subcables <- pof_submarine_cables(
 sub_cable_type = "EHV Sub Cable",
 utilisation_pct = "Default",
 operating_voltage_pct = "Default",
 topography = "Default",
 sitution = "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"
)
paste0(sprintf("Probability of failure %.4f", pof_subcables),
" percent per annum")
```

`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 30 in CNAIM (2017).

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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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","Defau
See page 146-147, table 192 and 194 in CNAIM (2017).

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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure per annum per kilometer.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

```
# Current annual probability of failure for Towers
pof_towers(
tower_asset_category = "33kV Tower",
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
```

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

`pof_transformer_11_20kv`

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

---

Description

This function calculates the current annual probability of failure for 6.6/11kV and 20kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 30 in CNAIM (2017).

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",
  oil_acidity = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "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 107-108, table 25A in CNAIM (2017) 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 107, table 23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). A setting of `"Default"` will set the corrosion category factor to 1 independent of `asset_type`.

`age`
: Numeric. The current age in years.

`partial_discharge`
: String. Indicating the level of partial discharge. Options for `partial_discharge`: `partial_discharge = c("Low","Medium","High (Not Confirmed)","High (Confirmed)","Defaul` See page 138, table 159 in CNAIM (2017).

`oil_acidity`
: Numeric. Measured in mg KOH/g. See page 138, table 160 in CNAIM (2017).

`temperature_reading`
: String. Indicating the criticality. Options for `temperature_reading`: `temperature_reading = c("Normal","Moderately High","Very High","Default")`. See page 139, table 161 in CNAIM (2017).

`observed_condition`
: String. Indicating the observed condition of the transformer. Options for `observed_condition`: `observed_condition = c("As New","Good","Slight Deterioration","Poor","Very Poor","Default")`. See page 120, table 73 in CNAIM (2017).

`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 69 in CNAIM (2017).

Value

Numeric. Current probability of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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",
oil_acidity = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default")
```

---

pof_transformer_33_66kv

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

---

Description

This function calculates the current annual probability of failure for 33/10kV and 66/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 30 in CNAIM (2017).

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 15, table 1 in CNAIM (2017). 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 103 table 20 in CNAIM (2017).

`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 107-108, table 25A in CNAIM (2017) 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 107, table

23 in CNAIM (2017). 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 106, table 22 in CNAIM (2017). 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 107, table 24 in CNAIM (2017). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.

age_tf
: Numeric. The current age in years of the transformer.

age_tc
: Numeric. The current age in years of the tapchanger

partial_discharge_tf
: String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low","Medium","High (Not Confirmed)","High (Confirmed)","Default"). See page 139, table 162 in CNAIM (2017).

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 140, table 164 in CNAIM (2017).

temperature_reading
: String. Indicating the criticality. Options: temperature_reading = c("Normal","Moderately High","Very High","Default"). See page 139, table 163 in CNAIM (2017).

main_tank
: String. Indicating the observed condition of the main tank. Options: main_tank = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 74 in CNAIM (2017).

coolers_radiator
: String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 75 in CNAIM (2017).

bushings
: String. Indicating the observed condition of the bushings. Options: bushings = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 120, table 76 in CNAIM (2017).

kiosk
: String. Indicating the observed condition of the kiosk. Options: kiosk = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 121, table 77 in CNAIM (2017).

cable_boxes
: String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 121, table 78 in CNAIM (2017).

external_tap
: String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defau
See page 121, table 79 in CNAIM (2017).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defau See page 121, table 80 in CNAIM (2017).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("Normal Wear","Some Deterioration","Substantial Deterioration","Defa See page 121, table 81 in CNAIM (2017).

diverter_contacts
String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 122, table 82 in CNAIM (2017).

diverter_braids
String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("Normal Wear","Some Deterioration","Substantial Deterioration","Default"). See page 122, table 83 in CNAIM (2017)

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

acidity Numeric. Refers to the acidity level in the transformer oil. Acidity levels are measured in (mgKOH/g). A setting of "Default" will result in the best possible result.

bd_strength Numeric. Refers to the breakdown strength. Breakdown strength is measured in kV. A setting of "Default" will result in the best possible result.

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

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

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

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

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

hydrogen_pre Numeric. Previous results. A setting of "Default" will result in the best possible result.

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

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

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

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

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

`reliability_factor` Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of `"Default"` sets the `reliability_factor` to 1. See section 6.14 on page 69 in CNAIM (2017).

Value

Numeric. Current probability of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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: "As New", "Good", "Slight Deterioration", "Poor", "Very Poor" 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)
```

---

risk_calculation *Calculates risk and converts to matrix coordinates*

Description

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

Usage

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

Arguments

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

risk_matrix_points_plot *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_ehv_cables *Safety cost of Failure for EHV UG cabkes & 132 kV UG cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
safety_cof_ehv_cables(ehv_asset_category)
```

Arguments

ehv_asset_category	String The type of EHV asset category

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ehv_asset_category	String The type of EHV asset category
location_risk	String Type Financial factor criteria for EHV fittings (cf. section D1.2.1, page 162, CNAIM, 2017).
type_risk	String. Asses Financial factor criteria for EHV fittings setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for EHV fittings

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 swicthgear & 132kV CB*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ehv_asset_category	String The type of EHV asset category
location_risk	String Type Financial factor criteria for EHV swicthgear & 132kV CB (cf. section D1.2.1, page 162, CNAIM, 2017).
type_risk	String. Asses Financial factor criteria for EHV swicthgear & 132kV CB setting (cf. table 214, page 164, CNAIM, 2017).

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). 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 LV asset category
`location_risk`	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 162, CNAIM, 2017).
`type_risk`	String. Asses Financial factor criteria for LV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Safetyr consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

hv_asset_category	String The type of HV asset category
location_risk	String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 162, CNAIM, 2017).
type_risk	String. Asses Financial factor criteria for HV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for HV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`safety_cof_lv_switchgear_and_other` *Safety cost of Failure for LV swicthgear and others*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safetyr consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

`lv_asset_category`	String The type of LV asset category
`location_risk`	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 162, CNAIM, 2017).
`type_risk`	String. Asses Financial factor criteria for LV switchgear setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

safety_cof_lv_ugb *Safety cost of Failure for LV UGB*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

lv_asset_category	String The type of LV asset category
location_risk	String Type Financial factor criteria for LV UGB (cf. section D1.2.1, page 162, CNAIM, 2017).
type_risk	String. Asses Financial factor criteria for LV UGB setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Financial consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ohl_cond_asset_category
: String The type of overhead line conductor asset category

location_risk
: String Type Financial factor criteria for Overhead Line Conductors (cf. section D1.2.1, page 162, CNAIM, 2017).

type_risk
: String. Asses Financial factor criteria for Overhead Line Conductors setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Safety consequences of failure for Overhead Line Conductors

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

safety_cof_poles *Safety cost of Failure for Pole*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

pole_asset_category
: String The type of pole asset category

location_risk
: String Type Financial factor criteria for Pole (cf. section D1.2.1, page 162, CNAIM, 2017).

type_risk
: String. Asses Financial factor criteria for pole setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Safety consequences of failure for poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

---

safety_cof_sub_cables *Safety cost of Failure for Sub cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
safety_cof_sub_cables(sub_cable_asset_category)
```

Arguments

sub_cable_asset_category	String The type of sub cable asset category

Value

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

`safety_cof_towers` *Safety cost of Failure for tower*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

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

Arguments

`tower_asset_category`	String The type of tower asset category
`location_risk`	String Type Financial factor criteria for tower (cf. section D1.2.1, page 162, CNAIM, 2017).
`type_risk`	String. Asses Financial factor criteria for tower setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Safety consequences of failure for towers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

safety_cof_transformers *Safety cost of Failure for Transformer*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 75, CNAIM, 2017). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

tf_asset_category	String The type of Transformer
location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 162, CNAIM, 2017).
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 214, page 164, CNAIM, 2017).

Value

Numeric. Safety consequences of failure for Transformers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.pdf

Examples

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

s_cof_swg_tf_ohl *Safety Consequences of Failure for Switchgears, Transformers & Overhead Lines*

Description

This function calculates safety consequences of failure for switchgear, transformers and overhead lines (cf. section 7.4, page 75, CNAIM, 2017). 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 218, page 168, CNAIM, 2017). 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 218, page 168, CNAIM, 2017). 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 1.1, 2017: https://www.ofgem.gov.uk/system/files/docs/2017/05/dno_common_network_asset_indices_methodology_v1.1.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: "As New", "Good", "Slight Deterioration", "Poor", "Very Poor" 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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