Package: CNAIM (via r-universe)

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Type Package

Title Common Network Asset Indices Methodology (CNAIM)

Version 2.1.4

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

URL https://www.cnaim.io/

BugReports https://github.com/Utiligize/CNAIM/issues

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Encoding UTF-8

LazyData TRUE

Depends R (>= 3.5.0)

Imports plyr, dplyr, jsonlite, magrittr, r2d3, ggplot2, stringr, tibble

RoxygenNote 7.2.1

Suggests knitr, htmltools, readxl, testthat, rmarkdown, widgetframe

VignetteBuilder knitr

Repository https://utiligize.r-universe.dev

RemoteUrl https://github.com/utiligize/cnaim

RemoteRef HEAD

RemoteSha 13a062dfc06fc736404577f6980dbcedb0c37c0b

Contents

`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 36 in CNAIM (2021).

Usage

```
beta_1(expected_life_years)
```

Arguments

`expected_life_years`
: Numeric. The output returned by the function `expected_life`().

Value

Numeric. Initial ageing rate for an electric network asset.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 38 in CNAIM (2021).

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 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

cof *Consequences of Failure*

Description

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

Usage

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

Arguments

financial_cof	Numeric. Financial consequences of failure.
safety_cof	Numeric. Safety consequences of failure.
environmental_cof	Numeric. Environmental consequences of failure.
network_cof	Numeric. Network cost of failure.

Value

Numeric. Consequences of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

---

cof_transformer_04_10kv

Consequences of Failure for a 0.4/10 kV transformer

Description

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

Usage

```
cof_transformer_04_10kv(
  kva,
  type,
  type_risk,
  location_risk,
  prox_water,
  bunded,
  no_customers,
  kva_per_customer,
  gb_ref_given = NULL
)
```

Arguments

kva	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of "Default" will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).

type	String. Relates to the accessibility of the transformer Options: type = c("Type A", "Type B", "Type C", "Default"). A setting of "Type A" - Normal access. A setting of "Type B" - Constrained access or confined working space. A setting of "Type C" - Underground substation. A setting of "Default" - Normal access thus same as "Type A" setting (cf. table 221, page 180, CNAIM, 2021).
type_risk	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: type_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
location_risk	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: location_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
no_customers	Numeric. The 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 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`cof_transformer_11kv` *Consequences of Failure for a 6.6/11 kV transformer*

Description

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

Usage

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

Arguments

`kva`	Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of `"Default"` will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).
`type`	String. Relates to the accessibility of the transformer Options: `type = c("Type A", "Type B", "Type C", "Default")`. A setting of `"Type A"` - Normal access. A setting of `"Type B"` - Constrained access or confined working space. A setting of `"Type C"` - Underground substation. A setting of `"Default"` - Normal access thus same as `"Type A"` setting (cf. table 221, page 180, CNAIM, 2021).
`type_risk`	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: `type_risk = c("Low", "Medium", "High", "Default")` (cf. table 225, page 183, CNAIM, 2021). A setting of `"Default"` equals a setting of `"Medium"`.
`location_risk`	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: `location_risk = c("Low", "Medium", "High", "Default")` (cf. table 225, page 183, CNAIM, 2021). A setting of `"Default"` equals a setting of `"Medium"`.
`prox_water`	Numeric. Specify the proximity to a water course in meters. A setting of `"Default"` will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).

bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
no_customers	Numeric. The 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 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

current_health *Current Health score*

Description

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

Usage

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

Arguments

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

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

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

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

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

Value

Numeric. The Current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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",
  gb_ref_given = NULL
)
```

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.
gb_ref_given	optional parameter to use custom reference values

Value

Data table.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 51 in CNAIM (2021)

Usage

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
voltage_level	String. Specify the voltage level. Options: voltage_level = c("EHV", "HV"). Choose "EHV" for cables >= 33kV and "HV" for cables < 33kV .
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Duty factor for cables.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 51 in CNAIM (2021)

Usage

```
duty_factor_transformer_11_20kv(
  utilisation_pct = "Default",
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

duty_factor_transformer_33_66kv

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

---

Description

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

Usage

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_board_04kv

Environmental cost of Failure for 0.4kV Board

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for 0.4kV board Outputted in DKK

Usage

```
environmental_cof_board_04kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
environmental_cof_board_04kv()
```

environmental_cof_cables_04_10kv

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

Description

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

Usage

```
environmental_cof_cables_04_10kv(
  hv_asset_category,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

hv_asset_category	String The type of HV asset category A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
prox_water	Numeric. Specify the proximity to a water course in meters.
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Examples

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

environmental_cof_cables_60_30kv

Environmental cost of Failure for 30-60 kV UG cables

Description

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

Usage

```
environmental_cof_cables_60_30kv(
  ehv_asset_category,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	Asset category for the analysis
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_ehv_cables

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

---

Description

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

Usage

```
environmental_cof_ehv_cables(
  ehv_asset_category,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV cable distribution asset category Options: ehv_asset_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)","66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)","132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for LV switchgear

Usage

```
environmental_cof_ehv_fittings(ehv_asset_category, gb_ref_given = NULL)
```

Arguments

ehv_asset_category
: String The type of EHV asset category Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")

gb_ref_given
: optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_ehv_switchgear

Environmental cost of Failure for EHV swicthgear & 132kV CB

Description

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

Usage

```
environmental_cof_ehv_switchgear(
  ehv_asset_category,
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category
: String The type of EHV swicthgear & 132kV CB Options: ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)","33kV CB (Air Insulated Busbars)(OD)(GM)","33kV CB (Gas Insulated Busbars)(ID)(GM)","33kV CB (Gas Insulated Busbars)(OD)(GM)","33kV RMU","33kV Switch (GM)","66kV CB (Air Insulated Busbars)(ID)(GM)","66kV CB (Air Insulated Busbars)(OD)(GM)","66kV CB (Gas Insulated Busbars)(ID)(GM)","66kV CB (Gas Insulated Busbars)(OD)(GM)")

type_env_factor
: String The type environment factor of EHV asset category

prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_hv_switchgear_distribution

Environmental cost of Failure for HV switchgear distribution

Description

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

Usage

```
environmental_cof_hv_switchgear_distribution(
  hv_asset_category,
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

hv_asset_category

String The type of HV switchgear distribution asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Secondary","6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)","20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)")

type_env_factor
: String The type environment factor of HV asset category Options: `type_env_factor = c("Oil", "SF6", "Niether", "Default")`.

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

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

gb_ref_given
: optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_hv_switchgear_primary

Environmental cost of Failure for HV switchgear primary

Description

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

Usage

```
environmental_cof_hv_switchgear_primary(
  hv_asset_category,
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

hv_asset_category	String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary","20kV CB (GM) Primary")
type_env_factor	String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_lv_switchgear_and_other

Environmental cost of Failure for LV swicthgear and others

Description

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

Usage

```
environmental_cof_lv_switchgear_and_other(
  lv_asset_category,
  gb_ref_given = NULL
)
```

Arguments

lv_asset_category	String The type of LV asset category Options: lv_asset_category = c("LV Board (WM)","LV Board (X-type Network) (WM)", "LV Circuit Breaker","LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_lv_ugb

Environmental cost of Failure for LV UGB

Description

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

Usage

```
environmental_cof_lv_ugb(lv_asset_category, gb_ref_given = NULL)
```

Arguments

lv_asset_category	String The type of LV asset category Option: lv_asset_category = "LV UGB"
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Environmental consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

Description

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

Usage

```
environmental_cof_ohl_cond(ohl_cond_asset_category, gb_ref_given = NULL)
```

Arguments

`ohl_cond_asset_category`	String The type of Pole asset category Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor","66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

environmental_cof_ohl_cond_50kv

Environmental cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates environmental consequences of failure Outputted in DKK

Usage

```
environmental_cof_ohl_cond_50kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Examples

```
environmental_cof_ohl_cond_50kv()
```

environmental_cof_ohl_fittings_50kv

Environmental cost of Failure for 50kV Fittings

Description

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

Usage

```
environmental_cof_ohl_fittings_50kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

```
environmental_cof_ohl_fittings_50kv()
```

environmental_cof_pillar_04kv

Environmental cost of Failure for 0.4kv Pillar

Description

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

Usage

```
environmental_cof_pillar_04kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
environmental_cof_pillar_04kv()
```

environmental_cof_poles

Environmental cost of Failure for Poles

Description

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

Usage

```
environmental_cof_poles(pole_asset_category, gb_ref_given = NULL)
```

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles","20kV Poles", "33kV Pole", "66kV Pole").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_poles_ohl_support_50kv

Environmental cost of Failure for Poles OHL Support 50kV

Description

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

Usage

```
environmental_cof_poles_ohl_support_50kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Examples

```
environmental_cof_poles_ohl_support_50kv()
```

environmental_cof_relay

Environmental cost of Failure for Relays

Description

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

Usage

```
environmental_cof_relay(
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

type_env_factor	String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Neither", "Default").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Examples

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

environmental_cof_serviceline

Environmental cost of Failure for Service Lines

Description

This function calculates environmental consequences of failure Outputted in DKK

Usage

```
environmental_cof_serviceline(prox_water, bunded, gb_ref_given = NULL)
```

Arguments

prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Examples

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

environmental_cof_submarine_10kv

Environmental cost of Failure for 10kV Submarine Cables

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for 10kV submarine cables Outputted in DKK.

Usage

```
environmental_cof_submarine_10kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
environmental_cof_submarine_10kv()
```

---

environmental_cof_submarine_30_60kv

Environmental cost of Failure for 30kV and 60kV Submarine Cables

---

Description

This function calculates environmental consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see cof().#' @return Numeric. Financial consequences of failure for 30kV and 60kV submarine cables Outputted in DKK.

Usage

```
environmental_cof_submarine_30_60kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
environmental_cof_submarine_30_60kv()
```

environmental_cof_sub_cables

Environmental cost of Failure for sub cables

Description

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

Usage

```
environmental_cof_sub_cables(sub_cable_asset_category, gb_ref_given = NULL)
```

Arguments

sub_cable_asset_category	String The type of Submarine cable asset category Options: sub_cable_asset_category = c("HV Sub Cable","EHV Sub Cable", "132kV Sub Cable").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2017: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

environmental_cof_switchgear_30_60kv

Environmental cost of Failure for 30kV and 60kV Switchgear

Description

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

Usage

```
environmental_cof_switchgear_30_60kv(
  ehv_asset_category,
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV asset category Options: ehv_asset_category = c("30kV", "60kV").
type_env_factor	String The type environment factor of 30kV and 60kV switchgear Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

---

environmental_cof_switchgear_primary_10kv

Environmental cost of Failure for 10kV Switchgear Primary

Description

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

Usage

```
environmental_cof_switchgear_primary_10kv(
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

type_env_factor	String The type environment factor of HV asset category Options: `type_env_factor = c("Oil", "SF6", "Niether", "Default")`.
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of `"Default"` will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
bunded	String. Options: `bunded = c("Yes", "No", "Default")`. A setting of `"Default"` will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 10kV switchgear

Examples

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

---

environmental_cof_switchgear_secondary_10kv

Environmental cost of Failure for 10kV Switchgear Secondary

Description

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

Usage

```
environmental_cof_switchgear_secondary_10kv(
  type_env_factor,
  prox_water,
  bunded,
  gb_ref_given = NULL
)
```

Arguments

type_env_factor	String The type environment factor of HV asset category Options: type_env_factor = c("Oil", "SF6", "Niether", "Default").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Examples

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

---

environmental_cof_towers

Environmental cost of Failure for towers

Description

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

Usage

```
environmental_cof_towers(tower_asset_category, gb_ref_given = NULL)
```

Arguments

tower_asset_category	String The type of tower asset category Options: tower_asset_category = c("33kV Tower", "66kV Tower","132kV Tower").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for towers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`environmental_cof_tower_ohl_support_50kv`
Environmental cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

```
environmental_cof_tower_ohl_support_50kv(gb_ref_given = NULL)
```

Arguments

`gb_ref_given`	optional parameter to use custom reference values

Value

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

Examples

```
environmental_cof_tower_ohl_support_50kv()
```

`environmental_cof_transformers`
Environmental cost of Failure for Transformers

Description

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

Usage

```
environmental_cof_transformers(
  tf_asset_category,
  prox_water,
  bunded,
  size_kva_mva = NULL,
  size_conversion = NULL,
  gb_ref_given = NULL
)
```

Arguments

tf_asset_category	String The type of Transformer asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)","20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) ").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
size_kva_mva	Numeric The MVA KVA rating for the transformer
size_conversion	String The size conversion for the transformer
gb_ref_given	optional parameter to use custom reference values

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 1.1, 2017: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

environmental_cof_transformer_30_60kv

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

---

Description

This function calculates environmental consequences of failure Outputted in DKK.

Usage

```
environmental_cof_transformer_30_60kv(
  tf_asset_category,
  prox_water,
  bunded,
  size_kva_mva = NULL,
  gb_ref_given = NULL
)
```

Arguments

tf_asset_category	String The type of Transformer Options: tf_asset_category = c("30kV Transformer (GM)","60kV Transformer (GM)").
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m
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
gb_ref_given	optional parameter to use custom reference values

Examples

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

---

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 36 in CNAIM (2021).

Usage

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

Arguments

normal_expected_life	Numeric. The number of years a new asset is expected to normally last. I.e. technical life time. See page 107, table 20 in CNAIM (2021).
duty_factor	Numeric. E.g. the output returned by the function 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 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 84, CNAIM, 2021). Environmental consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
e_cof_tf(
  asset_type_tf,
  rated_capacity = "Default",
  prox_water = "Default",
  bunded = "Default",
  gb_ref_given = NULL
)
```

Arguments

asset_type_tf	String. Transformer types. Options: asset_type_tf = c("6.6/11kV Transformer (GM)","20kV Transformer (GM)", "33kV Transformer (GM)","66kV Transformer (GM)", "132kV Transformer (GM)").
rated_capacity	Numeric. The rated capacity for a transformer. For type "6.6/11kV Transformer (GM)" and "20kV Transformer (GM)" use kVA ratings. For "20kV Transformer (GM)", "33kV Transformer (GM)","66kV Transformer (GM)", "132kV Transformer (GM)" use MVA ratings. A setting of "Default" will result in a size environmental factor of 1 (cf. table 230, page 187, CNAIM, 2021).
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).

bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 71 in CNAIM (2021).

Usage

```
ffa_test_modifier(furfuraldehyde = "Default", gb_ref_given = NULL)
```

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.
gb_ref_given	optional parameter to use custom reference values

Value

Data table.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`financial_cof_board_04kv`

Financial cost of Failure for 0.4kV Board

Description

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

Usage

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

Arguments

`type_financial_factor_criteria`	String Type Financial factor criteria for 0.4kV board (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `type_financial_factor_criteria = c("Non Asbestos clad", "Asbestos clad")`.
`access_factor_criteria`	String. Asses Financial factor criteria for 0.4kV board setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 0.4kV board

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

financial_cof_cables_04_10kv

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

Description

This function calculates financial consequences of failure Outputted in DKK

Usage

```
financial_cof_cables_04_10kv(hv_asset_category, gb_ref_given = NULL)
```

Arguments

hv_asset_category	String The type of HV asset category hv_asset_category = c("10kV UG Cable (Oil)","10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)".
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

financial_cof_cables_60_30kv

Financial cost of Failure for 30-60 kV UG cables

Description

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

Usage

```
financial_cof_cables_60_30kv(ehv_asset_category, gb_ref_given = NULL)
```

Arguments

ehv_asset_category	Asset category for the analysis
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_ehv_cables

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

---

Description

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

Usage

```
financial_cof_ehv_cables(ehv_asset_category, gb_ref_given = NULL)
```

Arguments

ehv_asset_category	String The type of EHV cable distribution asset category Options: ehv_asset_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)","66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)","132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_ehv_fittings

Financial cost of Failure for EHV/132kV fittings

Description

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

Usage

```
financial_cof_ehv_fittings(
  ehv_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV asset category Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")
type_financial_factor_criteria	String. Type Financial factor criteria for EHV fittings type_financial_factor_criteria = c("Suspension", "Tension").
access_factor_criteria	String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021). access_factor_criteria = c("Type A", "Type B").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV fittings

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
financial_cof_ehv_switchgear(
  ehv_asset_category,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV swicthgear & 132kV CB Options: ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)","33kV CB (Air Insulated Busbars)(OD)(GM)","33kV CB (Gas Insulated Busbars)(ID)(GM)","33kV CB (Gas Insulated Busbars)(OD)(GM)","33kV RMU","33kV Switch (GM)","66kV CB (Air Insulated Busbars)(ID)(GM)","66kV CB (Air Insulated Busbars)(OD)(GM)","66kV CB (Gas Insulated Busbars)(ID)(GM)","66kV CB (Gas Insulated Busbars)(OD)(GM)")
access_factor_criteria	String. Asses Financial factor criteria for EHV swicthgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021). Options: access_factor_criteria = c("Type A", "Type B", "Type C").
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

```
financial_cof_hv_switchgear_distribution(
  hv_asset_category,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

`hv_asset_category`
: String The type of HV switchgear distribution asset category Options: `hv_asset_category = c("6.6/11kV CB (GM) Secondary","6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)","20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)")`

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

`gb_ref_given`
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof`().

Usage

```
financial_cof_hv_switchgear_primary(
  hv_asset_category,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

`hv_asset_category`	String The type of HV switchgear distribution asset category Options: `hv_asset_category = c("6.6/11kV CB (GM) Primary","20kV CB (GM) Primary")`
`access_factor_criteria`	String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for HV switchgear primary

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Financial consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
financial_cof_lv_switchgear_and_other(
  lv_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

`lv_asset_category`	String The type of LV asset category Options: `lv_asset_category = c("LV Board (WM)","LV Board (X-type Network) (WM)", "LV Circuit Breaker","LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")`
`type_financial_factor_criteria`	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `type_financial_factor_criteria = c("Non Asbestos clad","Asbestos clad")`
`access_factor_criteria`	String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

Description

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

Usage

```
financial_cof_lv_ugb(lv_asset_category, gb_ref_given = NULL)
```

Arguments

`lv_asset_category`	String The type of LV asset category Option: `lv_asset_category = "LV UGB"`
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

financial_cof_ohl_cond *Financial cost of Failure for Overhead Line Conductors*

Description

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

Usage

```
financial_cof_ohl_cond(
  ohl_cond_asset_category,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

ohl_cond_asset_category	String The type of Pole asset category Options: ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor","66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor").
access_factor_criteria	String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021). Options: access_factor_criteria = c("Type A", "Type B").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

financial_cof_ohl_cond_50kv

Financial cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates financial consequences of failure Outputted in DKK

Usage

```
financial_cof_ohl_cond_50kv(access_factor_criteria, gb_ref_given = NULL)
```

Arguments

access_factor_criteria	String. Asses Financial factor criteria for Overhead Line Conductors. Options: `access_factor_criteria = c("Type A", "Type B")`.
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Overhead Line Conductors

Examples

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

financial_cof_ohl_fittings_50kv

Financial cost of Failure for 50kV Fittings

Description

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

Usage

```
financial_cof_ohl_fittings_50kv(
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV fittings

Examples

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

---

financial_cof_pillar_04kv

Financial cost of Failure for 0.4kV Pillar

Description

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

Usage

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

Arguments

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 0.4kV Pillar

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_poles *Financial cost of Failure for Poles*

Description

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

Usage

```
financial_cof_poles(
  pole_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles","20kV Poles", "33kV Pole", "66kV Pole").
type_financial_factor_criteria	String. Type Financial factor criteria for Pole Options: type_financial_factor_criteria = c("Pole (supporting conductor only)","Pole (supporting plant or equipment)", "Small footprint steel masts").
access_factor_criteria	String. Asses Financial factor criteria for Pole setting (cf. table 221, page 180, CNAIM, 2021). Options: access_factor_criteria = c("Type A", "Type B").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_poles_ohl_support_50kv

Financial cost of Failure for Poles OHL Support 50kV

Description

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

Usage

```
financial_cof_poles_ohl_support_50kv(
  pole_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

pole_asset_category	String The type of Pole asset category
type_financial_factor_criteria	String. Type Financial factor criteria for Pole Options: type_financial_factor_criteria = c("Pole (supporting conductor only)","Pole (supporting plant or equipment)", "Small footprint steel masts").
access_factor_criteria	String. Asses Financial factor criteria for Pole setting. Options: access_factor_criteria = c("Type A", "Type B").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Poles

Examples

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

---

financial_cof_relay *Financial cost of Failure for Relays*

Description

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

Usage

```
financial_cof_relay(access_factor_criteria, gb_ref_given = NULL)
```

Arguments

access_factor_criteria	String. Asses Financial factor criteria for relay setting. Options: access_factor_criteria = c("Type A", "Type B", "Type C").
gb_ref_given	optional parameter to use custom reference values

Examples

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

---

financial_cof_serviceline *Financial cost of Failure for Service Lines*

Description

This function calculates financial consequences of failure Outputted in DKK

Usage

```
financial_cof_serviceline(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for service line

Examples

```
financial_cof_serviceline()
```

---

financial_cof_submarine_cables_10kv

Financial cost of Failure for 10kV Submarine Cables

Description

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

Usage

```
financial_cof_submarine_cables_10kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 10kV submarine cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
financial_cof_submarine_cables_10kv()
```

financial_cof_submarine_cables_30_60kv

Financial cost of Failure for 30kV and 60kV Submarine Cables

Description

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

Usage

```
financial_cof_submarine_cables_30_60kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 30kV and 60kV submarine cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
financial_cof_submarine_cables_30_60kv()
```

financial_cof_sub_cables

Financial cost of Failure for Sub cables

Description

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

Usage

```
financial_cof_sub_cables(sub_cable_asset_category, gb_ref_given = NULL)
```

Arguments

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

gb_ref_given
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_switchgear_30_60kv

Financial cost of Failure for 30kV and 60kV Switchgear

Description

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

Usage

```
financial_cof_switchgear_30_60kv(
  ehv_asset_category,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

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

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

Description

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

Usage

```
financial_cof_switchgear_primary_10kv(
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

`access_factor_criteria`	String. Asses Financial factor criteria for 10KV switchgear setting. Options: `access_factor_criteria = c("Type A", "Type B", "Type C")`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for HV switchgear primary

Examples

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

financial_cof_switchgear_secondary_10kv *Financial cost of Failure for 10 kV Swicthgear Secondary*

Description

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

Usage

```
financial_cof_switchgear_secondary_10kv(
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

access_factor_criteria	String. Asses Financial factor criteria for 10 kV Swicthgear Secondary setting. Options: access_factor_criteria = c("Type A", "Type B", "Type C").
gb_ref_given	optional parameter to use custom reference values

Examples

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

financial_cof_towers *Financial cost of Failure for Towers*

Description

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

Usage

```
financial_cof_towers(
  tower_asset_category,
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

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

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

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

`gb_ref_given`
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_tower_ohl_support_50kv

Financial cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

```
financial_cof_tower_ohl_support_50kv(
  type_financial_factor_criteria,
  access_factor_criteria,
  gb_ref_given = NULL
)
```

Arguments

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

```
financial_cof_tower_ohl_support_50kv(
type_financial_factor_criteria = "Suspension",
access_factor_criteria = "Type A")
```

---

financial_cof_transformers

Financial cost of Failure for Transformers

Description

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

Usage

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

Arguments

tf_asset_category
: String The type of Transformer asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)","20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) ").

type_financial_factor_size
: String The type financial factor size for Transformer

type_financial_factor_kva_mva
: Numeric The type financial factor kVA MVA for Transformer

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

gb_ref_given
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Transformer

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

financial_cof_transformer_30_60kv

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

---

Description

This function calculates financial consequences of failure Outputted in DKK.

Usage

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

Arguments

tf_asset_category
: String The type of Transformer asset category Options: `tf_asset_category = c("30kV Transformer (GM)","60kV Transformer (GM)")`.

type_financial_factor_kva_mva
: Numeric The type financial factor kVA MVA for Transformer

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

gb_ref_given
: optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for Transformer

Examples

```
financial_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
type_financial_factor_kva_mva = 20,
access_factor_criteria = "Type A")
```

---

f_cof_transformer_11kv

Financial Consequences of Failure for a 6.6/11 kV Transformer

---

Description

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

Usage

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

Arguments

kva
: Numeric. The rated transformer capacity measured in kVA for a 6.6/11 kV transformer. Rated capacity is used to derive the type financial factor. For a general description of type financial factor see section 7.3.3.1 on page 80 in CNAIM (2021). A setting of `"Default"` will result in a type financial factor equal to 1 (cf. section D1.2.1, page 178, CNAIM, 2021).

type
: String. Relates to the accessibility of the transformer Options: `type = c("Type A", "Type B", "Type C", "Default")`. A setting of `"Type A"` - Normal access. A setting of `"Type B"` - Constrained access or confined working space. A setting of `"Type C"` - Underground substation. A setting of `"Default"` - Normal access thus same as `"Type A"` setting (cf. table 221, page 180, CNAIM, 2021).

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

health_score_excl_ehv_132kv_tf

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

---

Description

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

Usage

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

Arguments

observed_condition_factor	Numeric.
measured_condition_factor	Numeric.

Value

Numeric. Health score factor.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`initial_health` *Initial Health*

Description

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

Usage

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

Arguments

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

Value

Numeric. Initial health for an electric network asset.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Healh & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 46 in CNAIM (2021). For calculating the location factor for submarine cables please see the function `location_factor_sub()`. Note the location factor for all other cables are always equal to 1 hence the function will return a location factor of 1 for other cables than submarine cables.

Usage

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

Arguments

`placement`	String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.
`altitude_m`	Numeric. Specify the altitude location for the asset measured in meters from sea level.`altitude_m` is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of `"Default"` will set the altitude factor to 1 independent of `asset_type`.
`distance_from_coast_km`	Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.
`corrosion_category_index`	Integer. Specify the corrosion index category, 1-5. `corrosion_category_index` is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of `"Default"` will set the corrosion category factor to 1 independent of `asset_type`.

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

sub_division — String. Refers to material the sub division in the asset category

gb_ref_given — optional parameter to use custom reference values

Value

Numeric. Location factor

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

location_factor_sub *Location Factor (Excl.Submarine Cables)*

Description

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

Usage

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

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")`
situation	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", "Default")`.
landlocked	String. Options: `landlocked = c("yes","no")`. Default setting for `landlocked = "no"`.
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Location factor

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`matrix_adjusted_circles` *Adjust circles for matrix visualization*

Description

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

Usage

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

Arguments

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

Value

Long format matrix data. circles for D3 matrix visualization adjusted

matrix_adjusted_intervals

Adjust banding for matrix visualization

Description

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

Usage

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

Arguments

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

Value

Long format matrix data. intervals for matrix D3 visualization adjusted

mmi

Maximum and Multiple Increment (MMI) Technique

Description

This function returns a combined factor using a maximum and multiple increment (MMI) technique (cf. CNAIM, 2021. page 54, section 6.7.2). The function can be used to derive the health score factor for EHV and 132kV transformers. For 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 57 and 58 in CNAIM (2021). For an in dept description see also section 6.8 on page 57 in CNAIM (2021). The mmi() can also be used in the derivation of observed and measured condition factors for all assets, using measured and observed input factors. The constants factor_divider_1, factor_divider_2 and max_no_combined_factors can be found in table 13 on page 63 (observed condition factors) and in table 15 on page 67 (measured condition factors).

Usage

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

Arguments

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

Value

Numeric. Combined factor.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

network_cof_board_04kv

Network cost of Failure for 0.4kV Board

Description

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

Usage

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

Arguments

no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
network_cof_board_04kv(no_customers = 750, kva_per_customer = 51)
```

---

network_cof_cables_04_10kv

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

Description

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

Usage

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

Arguments

hv_asset_category	String The type of HV asset category
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

---

network_cof_cables_60_30kv

Network cost of Failure for 30-60 kV UG cables

Description

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

Usage

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

Arguments

ehv_asset_category	Asset category for the analysis
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

network_cof_ehv_cables

Network cost of Failure for EHV UG 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 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ehv_asset_category	String The type of EHV cable distribution asset category Options: ehv_asset_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)","66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)","132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

network_cof_ehv_fittings

Network cost of Failure for EHV/132kV Fittings

Description

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

Usage

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

Arguments

ehv_asset_category	String The type of EHV asset category Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

network_cof_ehv_pole *Network cost of Failure for Poles*

Description

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

Usage

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

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles","20kV Poles", "33kV Pole", "66kV Pole").
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`network_cof_ehv_sub_cable`

Network cost of Failure for EHV /132 kV sub cables

Description

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

Usage

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

Arguments

`sub_cable_asset_category`	String The type of Submarine cable asset category Options: `sub_cable_asset_category = c( "EHV Sub Cable", "132kV Sub Cable")`.
`actual_load_mva`	Numeric. The actual load on the asset
`secure`	Boolean If the asset is in a secure network or not
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

ehv_asset_category	String The type of EHV swicthgear & 132kV CB Options: ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)","33kV CB (Air Insulated Busbars)(OD)(GM)","33kV CB (Gas Insulated Busbars)(ID)(GM)","33kV CB (Gas Insulated Busbars)(OD)(GM)","33kV RMU","33kV Switch (GM)","66kV CB (Air Insulated Busbars)(ID)(GM)","66kV CB (Air Insulated Busbars)(OD)(GM)","66kV CB (Gas Insulated Busbars)(ID)(GM)","66kV CB (Gas Insulated Busbars)(OD)(GM)")
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_hv_lv_poles *Network cost of Failure for LV,HV,EHV Poles*

Description

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

Usage

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

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles","20kV Poles", "33kV Pole", "66kV Pole").
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_hv_sub_cables *Network cost of Failure for HV Sub cables*

Description

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

Usage

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

Arguments

sub_cable_asset_category	String The type of Submarine cable asset category Option: sub_cable_asset_category = "HV Sub Cable".
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_hv_switchgear_distribution
Network cost of Failure for HV Switchgear distribution

Description

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

Usage

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

Arguments

hv_asset_category	String The type of HV switchgear distribution asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Secondary","6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)","20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)")
no_customers	Numeric. The 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 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_hv_switchgear_primary *Network cost of Failure for HV Switchgear Primary*

Description

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

Usage

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

Arguments

hv_asset_category	String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary","20kV CB (GM) Primary")
no_customers	Numeric. The 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 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_lv_switchgear_and_other
Network cost of Failure for LV swicthgear and others

Description

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

Usage

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

Arguments

lv_asset_category	String The type of LV asset category Options: lv_asset_category = c("LV Board (WM)","LV Board (X-type Network) (WM)", "LV Circuit Breaker","LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")
no_customers	Numeric. The numner of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see cof().

Usage

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

Arguments

lv_asset_category	String The type of LV asset category Option: lv_asset_category = "LV UGB"
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_ohl_cond *Network cost of Failure for Overhead Line Conductors*

Description

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

Usage

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

Arguments

ohl_cond_asset_category	String The type of Pole asset category Options: ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor","66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor").
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

network_cof_ohl_cond_50kv

Network cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates network cost of failure Outputted in DKK

Usage

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

Arguments

actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

network_cof_ohl_fittings_50kv

Network cost of Failure for 50kV Fittings

Description

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

Usage

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

Arguments

actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

`network_cof_pillar_04kv`

Network cost of Failure for 0.4kV Pillar

Description

This function calculates network cost of failure for 0.4kV Pillar all asset categories exclusive the assets EHV and 132kV transformers. (cf. section 7.6, page 87, CNAIM, 2021). Network cost of failure is used in the derivation of consequences of failure see `cof`(). Outputted in DKK.

Usage

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

Arguments

`no_customers`	Numeric. The number of customers fed by an individual asset.
`kva_per_customer`	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of `"Default"` results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
network_cof_pillar_04kv(no_customers = 750, kva_per_customer = 51)
```

`network_cof_poles_ohl_support_50kv` *Network cost of Failure for Poles OHL Support 50kV*

Description

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

Usage

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

Arguments

`pole_asset_category`	String The type of Pole asset category
`actual_load_mva`	Numeric. The actual load on the asset
`secure`	Boolean If the asset is in a secure network or not
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

network_cof_relay *Network cost of Failure for Relays*

Description

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

Usage

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

Arguments

no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

network_cof_serviceline *Network cost of Failure for Service Lines*

Description

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

Usage

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

Arguments

actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

---

network_cof_submarine_cables_10kv

Network cost of Failure for 10kV Submarine Cables

Description

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

Usage

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

Arguments

no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
network_cof_submarine_cables_10kv(
no_customers = 250, kva_per_customer = 51)
```

---

network_cof_submarine_cables_30_60kv

Network cost of Failure for 30kV and 60kV Submarine Cables

Description

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

Usage

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

Arguments

`no_customers`	Numeric. The number of customers fed by an individual asset.
`kva_per_customer`	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of `"Default"` results in a multiplication factor of 1 (cf. table 18, page 89, CNAIM, 2021).
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
network_cof_submarine_cables_30_60kv(
no_customers = 250, kva_per_customer = 51)
```

`network_cof_switchgear_30_60kv`
Network cost of Failure for 30kV and 60kV Switchgear

Description

This function calculates network cost of failure for 30kV and 60kV switchgear. Network cost of failureis used in the derivation of consequences of failure see `cof`(). Outputted in DKK.

Usage

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

Arguments

`ehv_asset_category`	String The type of 30kV and 60kV switchgear category Options: `ehv_asset_category = c("30kV", "60kV")`.
`actual_load_mva`	Numeric. The actual load on the asset
`secure`	Boolean If the asset is in a secure network or not
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

network_cof_switchgear_primary_10kv
Network cost of Failure for 10kV Switchgear Primary

Description

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

Usage

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

Arguments

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 .
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

network_cof_switchgear_secondary_10kv
Network cost of Failure for 10kV Switchgear Secondary

Description

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

Usage

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

Arguments

no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

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

---

network_cof_tower *Network cost of Failure for Towers*

Description

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

Usage

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

Arguments

tower_asset_category	String The type of tower asset category Options: tower_asset_category = c("33kV Tower", "66kV Tower","132kV Tower").
actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

network_cof_tower_ohl_support_50kv

Network cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

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

Arguments

actual_load_mva	Numeric. The actual load on the asset
secure	Boolean If the asset is in a secure network or not
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

```
network_cof_tower_ohl_support_50kv(
actual_load_mva = 15)
```

`network_cof_transformers`

Network cost of Failure for Transformers

Description

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

Usage

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

Arguments

`tf_asset_category`	String The type of Transformer asset category Options: `tf_asset_category = c("6.6/11kV Transformer (GM)","20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) ")`.
`actual_load_mva`	Numeric. The actual load on the asset
`secure`	Boolean If the asset is in a secure network or not
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`network_cof_transformer_30_60kv`
Network cost of Failure for 30/10kV and 60/10kV Transformers

Description

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

Usage

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

Arguments

`tf_asset_category`	String The type of Tower Options: `tf_asset_category = c("30kV Transformer (GM)","60kV Transformer (GM)")`.
`actual_load_mva`	Numeric. The actual load on the asset
`secure`	Boolean If the asset is in a secure network or not
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Examples

```
network_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
actual_load_mva = 15)
```

`n_cof_excl_ehv_132kv_tf` *Network cost of Failure for all Assets Categories excl. EHV and 132kV Transformers*

Description

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

Usage

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

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 90, CNAIM, 2021).
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Network cost of failure.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 68 in CNAIM (2021).

Usage

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

Arguments

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

gb_ref_given optional parameter to use custom reference values

Value

Data table.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

plot_pof *Plot of probability of failure*

Description

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

Usage

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

Arguments

pof_function String. Choosing an pof function, Options: pof_function = c(pof_cables_04kv_pex, pof_cables_10kv_pex, pof_cables_10kv_oil,pof_cables_60_30kv, pof_ohl_cond_50kv, pof_submarine_cables_10kv_oil,pof_submarine_cables_10kv_pex, pof_submarine_cables_30 pof_transformer_04_10kv, pof_building,pof_serviceline, "Default").

Examples

```
# probability of failure curve
```

pof_132kv_cb *Current Probability of Failure for 132kV Switchgear*

Description

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

Usage

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

Arguments

cb_asset_category	String The type of 132kV asset category
placement	String. Specify if the asset is located outdoor or indoor.
number_of_operations	The number of operations for duty factor
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.

measured_condition_inputs
: Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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_board_04kv *Current Probability of Failure for 0.4kV Board*

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

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

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

normal_expected_life
: Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

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

---

pof_building *Current Probability of Failure for Primary Substation Building and Secondary Substation Building.*

Description

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

Usage

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

Arguments

substation_type	String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"
material_type	String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the building.

temperature_reading
: String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default").

coolers_radiator
: String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). in CNAIM (2021).

kiosk
: String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

cable_boxes
: String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default")..

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

k_value
: Numeric. k_value = "Default" by default. This number is given in a percentage.

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

normal_expected_life_building
: Numeric. normal_expected_life_building = "Default" by default.

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

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

pof_cables_04kv_pex *Current Probability of Failure for 0.4kV UG PEX Non Pressurised Cables*

Description

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

Usage

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.

k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

---

pof_cables_10kv_oil *Current Probability of Failure for 10kV UG Oil Non Preesurised Cables (Armed Paper Lead)*

Description

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

Usage

```
pof_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.24,
```

```
  c_value = 1.087,
  normal_expected_life = 80,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
k_value	Numeric. k_value = 0.24 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

```
k_value = 0.24,
c_value = 1.087,
normal_expected_life = 80)
```

`pof_cables_10kv_pex` *Current Probability of Failure for 10kV UG PEX Non Pressurised Cables*

Description

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

Usage

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

Arguments

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

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

`sheath_test`
: String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: `sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default")`.

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

`fault_hist`
: Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of `"No historic faults recorded"` indicates no fault.

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

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

k_value
: Numeric. k_value = 0.0658 by default.

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

normal_expected_life
: Numeric. normal_expected_life = 80 by default.

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

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

---

pof_cables_132kv *Current Probability of Failure for 132kV cables*

Description

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

Usage

```
pof_cables_132kv(
  cable_type = "132kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
```

```
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age,
  gb_ref_given = NULL
)
```

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for
# "132kV UG Cable (Non Pressurised)", 50 years old
pof_cables_132kV_non <-
pof_cables_132kv(cable_type = "132kV UG Cable (Non Pressurised)",
sub_division = "Lead sheath - Copper conductor",
utilisation_pct = 80,
operating_voltage_pct = 60,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 50) * 100

paste0(sprintf("Probability of failure %.4f", pof_cables_132kV_non),
" percent per annum")
```

---

pof_cables_60_30kv *Current Probability of Failure for 30-60kV cables*

Description

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

Usage

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

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

pof_cables_66_33kv *Current Probability of Failure for 33-66kV cables*

Description

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

Usage

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

Arguments

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

sub_division — String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor","Aluminium sheath - Copper conductor","Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")

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

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

sheath_test — String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default"). See page 153, table 168 in CNAIM (2021).

partial_discharge — String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).

fault_hist — Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).

leakage — String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded","Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).

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

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

gb_ref_given — optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for
# "66kV UG Cable (Non Pressurised)", 50 years old
pof_cables_66_33kv(cable_type = "66kV UG Cable (Non Pressurised)",
sub_division = "Lead sheath - Copper conductor",
utilisation_pct = 80,
operating_voltage_pct = 60,
```

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

---

pof_ehv_fittings *Current Probability of Failure for EHV/132kV Fittings*

Description

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

Usage

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

Arguments

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

corrosion_category_index
: Integer. Specify the corrosion index category, 1-5.

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

measured_condition_inputs
: Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 34 in CNAIM (2021).

Usage

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

Arguments

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

measured_condition_inputs
: Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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_board_04kv *Future Probability of Failure for 0.4kV Board*

Description

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

Usage

```
pof_future_board_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0069,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

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

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

`normal_expected_life`
: Numeric. `normal_expected_life = 60` by default. The default value is accordingly to the CNAIM standard on page 107.

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

`gb_ref_given`
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 0.4kV board
pof_future_board_04kv(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default",
k_value = 0.0069,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)
```

pof_future_building *Future Probability of Failure for Primary Substation Building and Secondary Substation Building.*

Description

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

Usage

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

Arguments

substation_type	String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"
material_type	String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km
: Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
: Integer. Specify the corrosion index category, 1-5.

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

temperature_reading
: String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default").

coolers_radiator
: String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). in CNAIM (2021).

kiosk
: String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

cable_boxes
: String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default")..

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

k_value
: Numeric. k_value = "Default" by default. This number is given in a percentage.

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

normal_expected_life_building
: Numeric. normal_expected_life_building = "Default" by default.

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future probability of failure for a Secondary substation Building
pof_future_building(substation_type = "Secondary",
material_type = "Wood",
placement = "Outdoor",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 1,
```

```
  temperature_reading = "Default",
  coolers_radiator = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life_building = "Default",
  simulation_end_year = 100)
```

`pof_future_cables_04kv_pex` *Future Probability of Failure for 0.4kV UG PEX Non Pressurised Cables*

Description

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

Usage

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

Arguments

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

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

`sheath_test`
: String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: `sheath_test = c("Pass", "Failed Minor", "Failed Major","Default")`.

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

fault_hist
: Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.

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

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

k_value
: Numeric. k_value = 0.0658 by default.

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

normal_expected_life
: Numeric. normal_expected_life = 80 by default.

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

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

---

pof_future_cables_10kv_oil

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

Description

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

Usage

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
k_value	Numeric. k_value = 0.24 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

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

---

pof_future_cables_10kv_pex

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

---

Description

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

Usage

```
pof_future_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  reliability_factor = "Default",
  age,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80,
```

```
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# future annual probability of failure for 10kV cable pex, 50 years old
pof_future_cables_10kv_pex(
utilisation_pct = 80,
operating_voltage_pct = 60,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
reliability_factor = "Default",
```

```
  age = 50,
  k_value = 0.0658,
  c_value = 1.087,
  normal_expected_life = 80,
  simulation_end_year = 100)
```

`pof_future_cables_132kv`

Future Probability of Failure for 132kV cables

Description

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

Usage

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

Arguments

`cable_type`	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: `cable_type = c("132kV UG Cable (Gas)", "132kV UG Cable (Gas)","132kV UG Cable (Non Pressurised)")`. The default setting is `cable_type = "132kV UG Cable (Gas)"`.
`sub_division`	String. Refers to material the sheath and conductor is made of. Options: `sub_division = c("Aluminium sheath - Aluminium conductor","Aluminium sheath - Copper conductor","Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")`
`utilisation_pct`	Numeric. The max percentage of utilisation under normal operating conditions.

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

sheath_test
: String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default"). See page 157, table 184 in CNAIM (2021).

partial_discharge
: String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 157, table 185 in CNAIM (2021).

fault_hist
: Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 157, table 186 in CNAIM (2021).

leakage
: String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded","Low/ moderate", "High", "Very High", "Default"). See page 158, table 187 (oil) and 188 (gas) in CNAIM (2021).

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

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

pof_future_cables_60_30kv *Future Probability of Failure for 30-60kV cables*

Description

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

Usage

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

Arguments

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

partial_discharge
: String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).

fault_hist
: Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).

leakage
: String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded","Low/ moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).

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

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Future probability of failure for 60kV UG Cable (Non Pressurised)
pof_future_cables_60_30kv(cable_type = "60kV UG Cable (Non Pressurised)",
sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = 75,
operating_voltage_pct = 50,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 1,
simulation_end_year = 100)
```

pof_future_cables_66_33kv

Future Probability of Failure for 33-66kV cables

Description

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

Usage

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

Arguments

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

partial_discharge
: String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: `partial_discharge = c("Low", "Medium", "High", "Default")`. See page 153, table 169 in CNAIM (2021).

fault_hist
: Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).

leakage
: String. Only applied for oil and gas pressurised cables. Options: `leakage = c("No (or very low) historic leakage recorded","Low/ moderate", "High", "Very High", "Default")`. See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).

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

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

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Future probability of failure for 66kV UG Cable (Non Pressurised)
pof_future_cables_66_33kv(cable_type = "66kV UG Cable (Non Pressurised)",
sub_division = "Aluminium sheath - Aluminium conductor",
utilisation_pct = 75,
operating_voltage_pct = 50,
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
leakage = "Default",
reliability_factor = "Default",
age = 1,
simulation_end_year = 100)
```

pof_future_meter *Future Probability of Failure for Meters*

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

`k_value`
: Numeric. `k_value = 0.128` by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

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

`normal_expected_life`
: Numeric. `normal_expected_life = 50` by default. The default value is accordingly to the CNAIM standard on page 107.

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

`gb_ref_given`
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

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

`pof_future_ohl_cond_132_66_33kv`

Future Probability of Failure for 33-132kV OHL Conductors

Description

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

Usage

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

Arguments

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

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

`distance_from_coast_km`
Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

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

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

`conductor_samp` String. Conductor sampling. Options: `conductor_samp = c("Low","Medium/Normal","High","Defau`
See page 161, table 199 and 201 in CNAIM (2021).

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

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

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

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

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

`gb_ref_given` optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Future annual probability of failure for 66kV OHL (Tower Line) Conductor
pof_future_ohl_cond_132_66_33kv(
```

```
ohl_conductor = "66kV OHL (Tower Line) Conductor",
sub_division = "Cu",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
conductor_samp = "Default",
corr_mon_survey = "Default",
visual_cond = "Default",
midspan_joints = "Default",
reliability_factor = "Default",
simulation_end_year = 100)
```

`pof_future_ohl_cond_50kv` *Future Probability of Failure for 50kV OHL Conductors*

Description

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

Usage

```
pof_future_ohl_cond_50kv(
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default",
  k_value = 0.008,
  c_value = 1.087,
  normal_expected_life = "Default",
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

sub_division	String. Refers to material the conductor is made of. Options: sub_division = c("ACSR - greased","ACSR - non-greased","AAAC","Cad Cu","Cu","Other") . See page 107, table 20 in CNAIM (2021).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age	Numeric. The current age in years of the conductor.
conductor_samp	String. Conductor sampling. Options: conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
corr_mon_survey	String. Corrosion monitoring survey. Options: corr_mon_survey = c("Low","Medium/Normal","High' See page 161, table 200 and 202 in CNAIM (2021).
visual_cond	String. Visual condition. Options: visual_cond = c("No deterioration","Superficial/minor deterioration","Some Deterioration","Substantial Deterioration", "Default"). See page 146, table 140 and 142 in CNAIM (2021).
midspan_joints	Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 146, table 141 and 143 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 50kV OHL (Tower Line) Conductor
pof_future_ohl_cond_50kv(
sub_division = "Cu",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
conductor_samp = "Default",
corr_mon_survey = "Default",
visual_cond = "Default",
midspan_joints = "Default",
reliability_factor = "Default",
k_value = 0.0080,
c_value = 1.087,
normal_expected_life = "Default",
simulation_end_year = 100)
```

---

pof_future_ohl_fittings_50kv

Future Probability of Failure for 50 kV Fittings

Description

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

Usage

```
pof_future_ohl_fittings_50kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
```

```
  k_value = 0.0096,
  c_value = 1.087,
  normal_expected_life = 40,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.code
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 50kV fittings
pof_future_ohl_fittings_50kv(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("insulator_elec_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"insulator_mech_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"conductor_fitting_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"tower_fitting_cond" =
list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("thermal_imaging" =
list("Condition Criteria: Thermal Imaging Result" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.0096,
c_value = 1.087,
normal_expected_life = 40,
simulation_end_year = 100)
```

---

pof_future_pillar_04kv

Future Probability of Failure for 0.4kV Pillar

Description

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

Usage

```
pof_future_pillar_04kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
```

```
  k_value = 0.0046,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 0.4kV Pillar
pof_future_pillar_04kv(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default",
k_value = 0.0046,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)
```

---

pof_future_poles *Future Probability of Failure for Poles*

Description

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

Usage

```
pof_future_poles(
  pole_asset_category = "20kV Poles",
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  pole_decay = "default",
  observed_condition_inputs,
  reliability_factor = "Default",
```

```
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

pole_asset_category	String The type of asset category
sub_division	String. Refers to material the pole is made of.
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
pole_decay	Numeric Pole Decay
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

Numeric array. Future probability of failure per annum per kilometre for poles.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Future annual probability of failure for HV Poles
pof_future_poles(
pole_asset_category = "20kV Poles",
sub_division = "Wood",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("visual_pole_cond" =
list("Condition Criteria: Pole Top Rot Present?" = "Default"),
"pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
"bird_animal_damage" =
list("Condition Criteria: Bird/Animal Damage?" = "Default"),
"top_rot"  = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
pole_decay = "Default",
reliability_factor = "Default",
simulation_end_year = 100)
```

---

pof_future_poles_ohl_support_50kv

Future Probability of Failure for Poles OHL support 50 kV

Description

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

Usage

```
pof_future_poles_ohl_support_50kv(
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0285,
  c_value = 1.087,
  normal_expected_life = "Default",
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

sub_division	String Sub Division
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for Poles OHL support 50 kV
pof_future_poles_ohl_support_50kv(
sub_division = "Wood",
placement = "Default",
```

```
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("visual_pole_cond" =
list("Condition Criteria: Pole Top Rot Present?" = "Default"),
"pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
"bird_animal_damage" =
list("Condition Criteria: Bird/Animal Damage?" = "Default"),
"top_rot"  = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
measured_condition_inputs =
list("pole_decay" =
list("Condition Criteria: Degree of Decay/Deterioration" = "Default")),
reliability_factor = "Default",
k_value = 0.0285,
c_value = 1.087,
normal_expected_life = "Default",
simulation_end_year = 100)
```

`pof_future_relay` *Future Probability of Failure for Relay*

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
 # future annual probability of failure for relay
pof_future_relay(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
```

```
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.128,
c_value = 1.087,
normal_expected_life = 30,
simulation_end_year = 100)
```

`pof_future_rtu` *Future Probability of Failure for RTU*

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
 # future annual probability of failure for RTU
pof_future_rtu(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
```

```
age = 1,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.128,
c_value = 1.087,
normal_expected_life = 20,
simulation_end_year = 100)
```

`pof_future_serviceline`

Future Probability of Failure for Service Line

Description

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

Usage

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

Arguments

utilisation_pct	Numeric Utilisation Percentage
operating_voltage_pct	Numeric Operating Voltage Percentage
sheath_test	String Sheath Test
partial_discharge	String Partial Discharge
fault_hist	String Fault Histogram
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the conductor.
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_submarine_cables
Future Probability of Failure for Submarine Cables

Description

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

Usage

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

Arguments

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

`situation` Situation of the cable

`wind_wave` Numeric. Options: `wind_wave=c(1, 2, 3, "Default")`. Settings:

- `wind_wave = 1`: Sheltered sea loch, Wind <200 W/m2
- `wind_wave = 2`: Wave <15kW/m, Wind 200-800 W/m2
- `wind_wave = 3`: Wave <15kW/m, Wind 200-800 W/m2
- `wind_wave = "Default"`: No data available

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

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

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

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

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

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

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

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

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

`gb_ref_given` optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for 1 km EHV Sub Cable
pof_future_submarine_cables(
 sub_cable_type = "EHV Sub Cable",
 utilisation_pct = "Default",
 operating_voltage_pct = "Default",
 topography = "Default",
 situation = "Default",
 wind_wave = "Default",
 intensity = "Default",
 landlocked = "no",
 sheath_test = "Default",
 partial_discharge = "Default",
 fault_hist = "Default",
 condition_armour = "Default",
 age = 10,
 reliability_factor = "Default",
 simulation_end_year = 100)
```

---

pof_future_submarine_cables_10kv_oil

Future Probability of Failure for 10kV Oil Submarine Cables

Description

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

Usage

```
pof_future_submarine_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situtation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
```

```
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
situtation	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: `sheath_test = c("Pass", "Failed Minor", "Failed Major","Default")`.
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: `partial_discharge = c("Low", "Medium", "High", "Default")`.
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.
reliability_factor	Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. `k_value = 0.0658` by default.
c_value	Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. `normal_expected_life = 80` by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

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

---

pof_future_submarine_cables_10kv_pex

Future Probability of Failure for 10kV Non Pressurised submarine cables

---

Description

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

Usage

```
pof_future_submarine_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  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",
```

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
situtation	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

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

---

pof_future_submarine_cables_30_60kv_oil

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

---

Description

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

Usage

```
pof_future_submarine_cables_30_60kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  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",
```

```
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
sitution	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_submarine_cables_30_60kv_oil(
utilisation_pct = "Default",
operating_voltage_pct = "Default",
topography = "Default",
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",
k_value = 0.0202,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)
```

---

pof_future_submarine_cables_30_60kv_pex

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

---

Description

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

Usage

```
pof_future_submarine_cables_30_60kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  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",
  k_value = 0.0202,
```

```
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
sitution	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major","Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_submarine_cables_30_60kv_pex(
utilisation_pct = "Default",
operating_voltage_pct = "Default",
topography = "Default",
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",
k_value = 0.0202,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)
```

---

pof_future_switchgear_30_60kv

Future Probability of Failure for 30kV and 60kV Switchgear

Description

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

Usage

```
pof_future_switchgear_30_60kv(
  asset_type = "30kV",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

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

Value

Numeric. Current probability of failure per annum.

Examples

```
# Future annual probability of failure for 30kV and 60kV Swicthgear
pof_future_switchgear_30_60kv(
asset_type = "30kV",
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
```

```
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default"),
"support_structure" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
"ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
reliability_factor = "Default",
k_value = "Default",
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100)
```

`pof_future_switchgear_primary_10kv`
Future Probability of Failure for 10kV Switchgear Primary

Description

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

Usage

```
pof_future_switchgear_primary_10kv(
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
number_of_operations	The number of operations for duty factor
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 55 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference value

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 10 kV Switchgear (GM) Primary
pof_future_switchgear_primary_10kv(
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
```

```
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
"ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
reliability_factor = "Default",
k_value = 0.0052,
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100)
```

`pof_future_switchgear_secondary_10kv`
Future Probability of Failure for 10kV Switchgear Secondary

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.
gb_ref_given	optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_switchgear_secondary_10kv(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
```

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

`pof_future_transformer_04_10kv`

Future Probability of Failure for 0.4/10kV Transformers

Description

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

Usage

```
pof_future_transformer_04_10kv(
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  k_value = 0.0077,
  c_value = 1.087,
```

```
  normal_expected_life = 55,
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

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

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

`partial_discharge`
: String. Indicating the

`temperature_reading`
: String. Indicating the criticality. Options for `temperature_reading`: `temperature_reading = c("Normal", "Moderately High","Very High", "Default")`. See page 153, table 172 in CNAIM (2021).

`observed_condition`
: String. Indicating the observed condition of the transformer. Options for `observed_condition`: `observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default")`. See page 130, table 81 in CNAIM (2021).

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

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

`acidity`
: String Acidity

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

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

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

normal_expected_life — Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.

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

gb_ref_given — optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_transformer_04_10kv(utilisation_pct = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 20,
partial_discharge = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100)
```

---

pof_future_transformer_11_20kv

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

---

Description

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

Usage

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

Arguments

`hv_transformer_type`
: String. Refers to the high voltage transformer type the calculation is done for. Options: `hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)")`. The default setting is `hv_transformer_type = 6.6/11kV Transformer (GM)`.

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

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

partial_discharge
: String. Indicating the

temperature_reading
: String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High","Very High", "Default"). See page 153, table 172 in CNAIM (2021).

observed_condition
: String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 130, table 81 in CNAIM (2021).

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

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

oil_acidity
: Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Future probability of a 6.6/11 kV transformer
future_pof_transformer <-
pof_future_transformer_11_20kv(hv_transformer_type = "6.6/11kV Transformer (GM)",
utilisation_pct = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 20,
partial_discharge = "Default",
```

```
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default",
  simulation_end_year = 100)
```

`pof_future_transformer_132kv`
Future Probability of Failure for 132kV Transformers

Description

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

Usage

```
pof_future_transformer_132kv(
  transformer_type = "132kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
```

```
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default",
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

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

`year_of_manufacture`
: Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).

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

`no_taps`
: Numeric. Average number of daily taps (tapchanger).

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

age_tc Numeric. The current age in years of the tapchanger

partial_discharge_tf
String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).

partial_discharge_tc
String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).

temperature_reading
String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default"). See page 155, table 177 in CNAIM (2021).

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).

coolers_radiator
String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).

diverter_contacts
String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).

diverter_braids
: String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`pof_future_transformer_30_60kv`
Future Probability of Failure for 30/10kV and 60/10kV Transformers

Description

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

Usage

```
pof_future_transformer_30_60kv(
  transformer_type = "60kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
```

```
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default",
  k_value = 0.454,
  c_value = 1.087,
  normal_expected_life_tf = "Default",
  normal_expected_life_tc = "Default",
  simulation_end_year = 100,
  gb_ref_given = NULL
)
```

Arguments

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

`year_of_manufacture`
: Numeric. Normal expected life depends on the year for manufacture.

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

`no_taps`
: Numeric. Average number of daily taps (tapchanger).

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

`altitude_m`
: Numeric. Specify the altitude location for the asset measured in meters from sea level.`altitude_m` is used to derive the altitude factor. A setting of `"Default"` will set the altitude factor to 1 independent of `asset_type`.

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor. A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

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

`partial_discharge_tf`
: String. Indicating the level of partial discharge in the transformer. Options: `partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default")`.

`partial_discharge_tc`
: String. Indicating the level of partial discharge in the tapchanger Options: `partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default")`.

`temperature_reading`
: String. Indicating the criticality. Options: `temperature_reading = c("Normal", "Moderately High","Very High", "Default")`.

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

coolers_radiator String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default").

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

diverter_contacts String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

diverter_braids String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

`k_value` Numeric. `k_value` = `"0.0454"` by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

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

`normal_expected_life_tf`
Numeric. `normal_expected_life_tf` = `"Default"` by default. The default value is accordingly to the CNAIM standard on page 107.

`normal_expected_life_tc`
Numeric. `normal_expected_life_tc` = `"Default"` by default. The default value is accordingly to the CNAIM standard on page 107.

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

`gb_ref_given` optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future probability of failure for a 60/10kV transformer
pof_future_transformer_30_60kv(transformer_type = "60kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default",
simulation_end_year = 100)
```

---

pof_future_transformer_33_66kv

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

---

Description

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

Usage

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

```
  gb_ref_given = NULL
)
```

Arguments

`transformer_type`
: String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: `transformer_type = c("33kV Transformer (GM)", "66kV Transformer (GM)")`. The default setting is `transformer_type = "66kV Transformer (GM)"`

`year_of_manufacture`
: Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).

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

`no_taps`
: Numeric. Average number of daily taps (tapchanger).

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

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

`partial_discharge_tf`
: String. Indicating the level of partial discharge in the transformer. Options: `partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default")`. See page 154, table 173 in CNAIM (2021).

`partial_discharge_tc`
: String. Indicating the level of partial discharge in the tapchanger Options: `partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default")`. See page 155, table 175 in CNAIM (2021).

`temperature_reading`
: String. Indicating the criticality. Options: `temperature_reading = c("Normal", "Moderately High","Very High", "Default")`. See page 154, table 174 in CNAIM (2021).

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).

coolers_radiator String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).

diverter_contacts String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).

diverter_braids String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

`gb_ref_given` optional parameter to use custom reference values

Value

DataFrame. Future probability of failure along with future health score

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

`pof_hv_switchgear_distribution`

Current Probability of Failure for HV Switchgear Distribution

---

Description

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

Usage

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

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 34 in CNAIM (2021).

Usage

```
pof_hv_switchgear_primary(
  hv_asset_category = "6.6/11kV CB (GM) Primary",
  placement = "Default",
  number_of_operations = "Default",
```

```
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  gb_ref_given = NULL
)
```

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for HV Swicthgear Primary
pof_hv_switchgear_primary(
hv_asset_category = "6.6/11kV CB (GM) Primary",
placement = "Default",
number_of_operations = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
 measured_condition_inputs = list("partial_discharge" =
 list("Condition Criteria: Partial Discharge Test Results" = "Default"),
 "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
 "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
 "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
 "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
 "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
 reliability_factor = "Default")
```

---

pof_lv_switchgear_and_other

Current Probability of Failure for LV switchgear and others

Description

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

Usage

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

```
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  gb_ref_given = NULL
)
```

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
pof_lv_switchgear_and_other(
lv_asset_category = "LV Circuit Breaker",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("operational_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default")
```

---

pof_lv_ugb *Current Probability of Failure for LV UGB*

Description

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

Usage

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

Arguments

lv_asset_category	String The type of LV asset category
placement	String. Specify if the asset is located outdoor or indoor.

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

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

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

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

measured_condition_inputs
Named list observed_conditions_input

observed_condition_inputs
Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
pof_lv_ugb(
lv_asset_category = "LV UGB",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("steel_cover_and_pit_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"water_moisture" = list("Condition Criteria: Observed Condition" = "Default"),
"bell_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
```

```
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default")
```

`pof_meter` *Current Probability of Failure for Meters*

Description

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

Usage

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

Arguments

`placement`	String. Specify if the asset is located outdoor or indoor.
`altitude_m`	Numeric. Specify the altitude location for the asset measured in meters from sea level.`altitude_m` is used to derive the altitude factor. A setting of `"Default"` will set the altitude factor to 1 independent of `asset_type`.
`distance_from_coast_km`	Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor. A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.
`corrosion_category_index`	Integer. Specify the corrosion index category, 1-5.
`age`	Numeric. The current age in years of the conductor.
`measured_condition_inputs`	Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

k_value
: Numeric. k_value = 0.128 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

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

normal_expected_life
: Numeric. normal_expected_life = 50 by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

```
# Current annual probability of failure for meter
pof_meter(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.128,
c_value = 1.087,
normal_expected_life = 25)
```

pof_ohl_cond_132_66_33kv

Current Probability of Failure for 33-132kV OHL Conductors

Description

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

Usage

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

Arguments

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

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

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

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

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

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

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

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

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

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

gb_ref_given optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for 66kV OHL (Tower Line) Conductor
pof_ohl_cond_132_66_33kv(
ohl_conductor = "66kV OHL (Tower Line) Conductor",
sub_division = "Cu",
```

```
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
conductor_samp = "Default",
corr_mon_survey = "Default",
visual_cond = "Default",
midspan_joints = "Default",
reliability_factor = "Default")
```

`pof_poles` *Current Probability of Failure for Poles*

Description

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

Usage

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

Arguments

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

distance_from_coast_km
: Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
: Integer. Specify the corrosion index category, 1-5.

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

measured_condition_inputs
: Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for HV Poles
pof_poles(
pole_asset_category = "20kV Poles",
sub_division = "Wood",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("visual_pole_cond" =
list("Condition Criteria: Pole Top Rot Present?" = "Default"),
"pole_leaning" = list("Condition Criteria: Pole Leaning?" = "Default"),
"bird_animal_damage" =
list("Condition Criteria: Bird/Animal Damage?" = "Default"),
"top_rot"  = list("Condition Criteria: Pole Top Rot Present?" = "Default")),
measured_condition_inputs =
list("pole_decay" =
```

```
list("Condition Criteria: Degree of Decay/Deterioration" = "Default")),
reliability_factor = "Default")
```

`pof_submarine_cables` *Current Probability of Failure for Submarine Cables*

Description

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

Usage

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

Arguments

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

`situation` Situation of the cable

`wind_wave` Numeric. Options: `wind_wave=c(1, 2, 3, "Default")`. Settings:

- `wind_wave = 1`: Sheltered sea loch, Wind <200 W/m2
- `wind_wave = 2`: Wave <15kW/m, Wind 200-800 W/m2
- `wind_wave = 3`: Wave <15kW/m, Wind 200-800 W/m2
- `wind_wave = "Default"`: No data available

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

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

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

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

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

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

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

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

`gb_ref_given` optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

`pof_switchgear_primary_10kv` *Current Probability of Failure for 10 kV Switchgear (GM) Primary*

Description

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

Usage

```
pof_switchgear_primary_10kv(
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  gb_ref_given = NULL
)
```

Arguments

`placement`	String. Specify if the asset is located outdoor or indoor.
`number_of_operations`	The number of operations for duty factor

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km
Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

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

measured_condition_inputs
Named list observed_conditions_input

observed_condition_inputs
Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

k_value Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

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

normal_expected_life
Numeric. normal_expected_life = 55 by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given optional parameter to use custom reference values

Value

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

Examples

```
# Current annual probability of failure for 10 kV Switchgear (GM) Primary
pof_switchgear_primary_10kv(
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
```

```
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
"ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
reliability_factor = "Default",
k_value = 0.0052,
c_value = 1.087,
normal_expected_life = 55)
```

`pof_switchgear_secondary_10kV` *Current Probability of Failure for 10kV Switchgear secondary*

Description

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

Usage

```
pof_switchgear_secondary_10kV(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0067,
  c_value = 1.087,
  normal_expected_life = 55,
  gb_ref_given = NULL
)
```

Arguments

`placement`	String. Specify if the asset is located outdoor or indoor.
`altitude_m`	Numeric. Specify the altitude location for the asset measured in meters from sea level.`altitude_m` is used to derive the altitude factor. A setting of `"Default"` will set the altitude factor to 1 independent of `asset_type`.

distance_from_coast_km
: Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
: Integer. Specify the corrosion index category, 1-5.

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

measured_condition_inputs
: Named list observed_conditions_input

observed_condition_inputs
: Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

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

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

normal_expected_life
: Numeric. normal_expected_life = 55 by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given
: optional parameter to use custom reference values

Value

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

Examples

```
# Current annual probability of failure for 10kV Swicthgear secondary
pof_switchgear_secondary_10kV(
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
```

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

`pof_towers` *Current Probability of Failure for Towers*

Description

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

Usage

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

Arguments

`tower_asset_category`	String The type of Tower asset category
`foundation_type`	String Foundation type of the tower
`paint_type`	String Paint type of the tower
`placement`	String. Specify if the asset is located outdoor or indoor.
`number_of_operations`	Numeric Number of operations for the tower

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

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

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

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

observed_condition_inputs_steelwork
Named list observed_conditions_input

observed_condition_inputs_paint
Named list observed_conditions_input

observed_condition_inputs_foundation
Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau
See page 161, table 199 and 201 in CNAIM (2021).

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

gb_ref_given optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for Towers
pof_towers(
tower_asset_category = "33kV Tower",
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
paint_type = "Paint System - Galvanising",
foundation_type = "Foundation - Earth Grillage",
```

```
observed_condition_inputs_steelwork =
list("tower_legs" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_bracings" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_crossarms" = list("Condition Criteria: Observed Condition" = "Default"),
"tower_peak" = list("Condition Criteria: Observed Condition" = "Default")),
observed_condition_inputs_paint =
list("paintwork_cond" = list("Condition Criteria: Observed Condition" = "Default")),
observed_condition_inputs_foundation =
list("foundation_cond" = list("Condition Criteria: Observed Condition" = "Default")),
reliability_factor = "Default")
```

`pof_tower_ohl_support_50kv`
Current Probability of Failure for Towers OHL support 50kV

Description

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

Usage

```
pof_tower_ohl_support_50kv(
  foundation_type = "Foundation - Fully Encased Concrete",
  paint_type = "Paint System - Paint",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  observed_condition_inputs_steelwork,
  observed_condition_inputs_paint,
  observed_condition_inputs_foundation,
  reliability_factor = "Default",
  k_value = 0.0545,
  c_value = 1.087,
  normal_expected_life = "Default",
  gb_ref_given = NULL
)
```

Arguments

`foundation_type`
: String. Foundation type of the tower `foundation_type = c("Foundation - Fully Encased Concrete", "Foundation - Earth Grillage")`

paint_type String. Paint type of the tower foundation_type = c(Paint System - Galvanising, Paint System - Paint)

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

number_of_operations
Numeric Number of operations for the tower

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km
Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

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

observed_condition_inputs_steelwork
Named list observed_conditions_input

observed_condition_inputs_paint
Named list observed_conditions_input

observed_condition_inputs_foundation
Named list observed_conditions_input conductor_samp = c("Low","Medium/Normal","High","Defau

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

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

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

normal_expected_life
Numeric. normal_expected_life = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given optional parameter to use custom reference values

Value

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

Examples

```
# Current annual probability of failure for Towers
pof_tower_ohl_support_50kv(
number_of_operations = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
```

```
  corrosion_category_index = "Default",
  age = 10,
  paint_type = "Paint System - Galvanising",
  foundation_type = "Foundation - Earth Grillage",
  observed_condition_inputs_steelwork =
  list("tower_legs" = list("Condition Criteria: Observed Condition" = "Default"),
  "tower_bracings" = list("Condition Criteria: Observed Condition" = "Default"),
  "tower_crossarms" = list("Condition Criteria: Observed Condition" = "Default"),
  "tower_peak" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_paint =
  list("paintwork_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_foundation =
  list("foundation_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  reliability_factor = "Default",
  k_value = 0.0545,
  c_value = 1.087,
  normal_expected_life = "Default")
```

`pof_transformer_04_10kv`

Current Probability of Failure for 0.4/10kV Transformers

Description

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

Usage

```
pof_transformer_04_10kv(
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  k_value = 0.0077,
  c_value = 1.087,
  normal_expected_life = 55,
  gb_ref_given = NULL
)
```

Arguments

utilisation_pct	Numeric Utilisation percentage
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High","Very High", "Default").
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm)
acidity	Oil Acidity
bd_strength	Numeric. the amount of breakdown strength given in (kV)
k_value	Numeric. k_value = 0.0077 by default. This number is given in a percentage. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 34.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 55 by default. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 33.
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

```
# Current probability of failure for 0.4/10kV Transformers
pof_transformer_04_10kv(utilisation_pct = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
partial_discharge = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55)
```

---

pof_transformer_11_20kv

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

---

Description

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

Usage

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

```
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default",
  gb_ref_given = NULL
)
```

Arguments

`hv_transformer_type`
: String. Refers to the high voltage transformer type the calculation is done for. Options: `hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)")`. The default setting is `hv_transformer_type = 6.6/11kV Transformer (GM)`.

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

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

`partial_discharge`
: String. Indicating the

`temperature_reading`
: String. Indicating the criticality. Options for `temperature_reading`: `temperature_reading = c("Normal", "Moderately High","Very High", "Default")`. See page 153, table 172 in CNAIM (2021).

`observed_condition`
: String. Indicating the observed condition of the transformer. Options for `observed_condition`: `observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default")`. See page 130, table 81 in CNAIM (2021).

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

moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
oil_acidity	Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

pof_transformer_132kv *Current Probability of Failure for 132kv Transformers*

Description

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

Usage

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

Arguments

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

(GM)"

year_of_manufacture
: Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).

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

no_taps
: Numeric. Average number of daily taps (tapchanger).

placement
: String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

distance_from_coast_km
: Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
: Integer. Specify the corrosion index category, 1-5.

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

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

partial_discharge_tf
: String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).

partial_discharge_tc
: String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).

temperature_reading
: String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default"). See page 155, table 177 in CNAIM (2021).

main_tank
: String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).

coolers_radiator
: String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).

diverter_contacts
String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).

diverter_braids
String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021)

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

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

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

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

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

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

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

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

`pof_transformer_30_60kv` *Current Probability of Failure for 30/10kV and 60/10kV Transformers*

Description

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

Usage

```
pof_transformer_30_60kv(
  transformer_type = "60kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
```

```
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default",
  k_value = 0.454,
  c_value = 1.087,
  normal_expected_life_tf = "Default",
  normal_expected_life_tc = "Default",
  gb_ref_given = NULL
)
```

Arguments

transformer_type	String. A sting that refers to the specific asset category. Options: transformer_type = c("30kV Transformer (GM)", "60kV Transformer (GM)"). The default setting is transformer_type = "60kV Transformer (GM)"
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture.
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor.

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km
Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

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

age_tc Numeric. The current age in years of the tapchanger

partial_discharge_tf
String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").

partial_discharge_tc
String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").

temperature_reading
String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default").

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

coolers_radiator
String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default").

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

diverter_contacts
: String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). in CNAIM (2021).

diverter_braids
: String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default").

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

k_value — Numeric. k_value = "0.0454" by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

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

normal_expected_life_tf — Numeric. normal_expected_life_tf = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

normal_expected_life_tc — Numeric. normal_expected_life_tc = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

gb_ref_given — optional parameter to use custom reference values

Value

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

Examples

```
# Current probability of failure for a 60/10kV transformer
pof_transformer_30_60kv(transformer_type = "60kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
```

```
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default",
  k_value = 0.454,
  c_value = 1.087,
  normal_expected_life_tf = "Default",
  normal_expected_life_tc = "Default")
```

`pof_transformer_33_66kv` *Current Probability of Failure for 33/10kV and 66/10kV Transformers*

Description

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

Usage

```
pof_transformer_33_66kv(
  transformer_type = "66kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
```

```
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default",
  gb_ref_given = NULL
)
```

Arguments

`transformer_type`
: String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: `transformer_type = c("33kV Transformer (GM)", "66kV Transformer (GM)")`. The default setting is `transformer_type = "66kV Transformer (GM)"`

`year_of_manufacture`
: Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).

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

`no_taps`
: Numeric. Average number of daily taps (tapchanger).

`placement`
: String. Specify if the asset is located outdoor or indoor. A setting of `"Outdoor"` means the asset is located in an outside environment, and a setting of `"Indoor"` means the asset is located in an indoor environment. A setting of `"Default"` will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.

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

`distance_from_coast_km`
: Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of `"Default"` will set the distance from coast factor to 1 independent of `asset_type`.

`corrosion_category_index`
: Integer. Specify the corrosion index category, 1-5.

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

age_tc Numeric. The current age in years of the tapchanger

partial_discharge_tf
String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 154, table 173 in CNAIM (2021).

partial_discharge_tc
String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 175 in CNAIM (2021).

temperature_reading
String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High","Very High", "Default"). See page 154, table 174 in CNAIM (2021).

main_tank String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).

coolers_radiator
String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration","Substant Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).

bushings String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).

kiosk String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).

cable_boxes String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration","Superficial/minor deterioration", "Some Deterioration","Substa Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).

external_tap String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).

internal_tap String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).

mechnism_cond String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).

diverter_contacts
String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).

diverter_braids
: String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration","Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

gb_ref_given
: optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

predict_weibull_model *Prediction function for Weibull model*

Description

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

Usage

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

Arguments

age	Numeric. Age of transformer which should be used in the prediction.
environmental_factors	Data frame. Must contain the following fields: utilisation_pct: Numeric or "Default", placement: "Indoor", "Outdoor" or "Default", altitude_m: Numeric or "Default", distance_from_coast_km: Numeric or "Default", corrosion_category_index: Numeric or "Default", partial_discharge: "Low", "Medium", "High (Not Confirmed)", "High (Confirmed)" or "Default", oil_acidity: Numeric or "Default", temperature_reading: "Normal", "Moderately High", "Very High" or "Default", observed_condition: "No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration" or "Default" Default value if environmental_factors is not provided: data frame with value "Default" for all fields
weibull_model_parameters	Data frame. The output returned by the function train_weibull_model(). Default value if weibull_parameters is not provided: data frame with parameters trained on data set transformer_11kv_faults.rda

Value

Numeric. Probability of failure at the given age.

Source

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

Examples

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

`present_value_future_risk` *Present Value of Future Risk*

Description

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

Usage

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

Arguments

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`risk_calculation` *Calculates risk and converts to matrix coordinates*

Description

This function calculates risk matrix coordinates dimensions.

Usage

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

Arguments

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

# 2. Calculate risk matrix coordinates
risk_calculation(matrix_dimensions = matrix_structure,
```

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

`risk_matrix_points_plot` *Make a risk matrix with individual asset points*

Description

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

Usage

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

Arguments

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

`risk_matrix_structure` *Makes a default risk matrix structure*

Description

This function makes a simple matrix structure that can be used as an input to the risk_matrix_points and risk_matrix_summary functions

Usage

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

Arguments

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

risk_matrix_summary_plot

Make a risk matrix with non-linear spacing

Description

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

Usage

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

Arguments

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

safety_cof_board_04kv *Safety cost of Failure for 0.4kV Board*

Description

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

Usage

```
safety_cof_board_04kv(location_risk, type_risk, gb_ref_given = NULL)
```

Arguments

location_risk	String Type Financial factor criteria for 0.4kV board (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 0.4kV board setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 0.4kV board

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_board_04kv(
location_risk = "Default",
type_risk = "Default")
```

---

safety_cof_cables_04_10kv

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

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_cables_04_10kv(hv_asset_category, gb_ref_given = NULL)
```

Arguments

hv_asset_category	String The type of HV asset category hv_asset_category = c("10kV UG Cable (Oil)","10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)".
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

safety_cof_cables_60_30kv *Safety cost of Failure for 30-60 kV UG cables*

Description

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

Usage

```
safety_cof_cables_60_30kv(ehv_asset_category, gb_ref_given = NULL)
```

Arguments

ehv_asset_category	Asset category for analysis
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

safety_cof_ehv_cables *Safety cost of Failure for EHV UG cables & 132 kV UG cables*

Description

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

Usage

```
safety_cof_ehv_cables(ehv_asset_category, gb_ref_given = NULL)
```

Arguments

ehv_asset_category	String The type of EHV cable distribution asset category Options: ehv_asset_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)","66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)","132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_ehv_fittings

Safety cost of Failure for EHV/132kV Fittings

Description

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

Usage

```
safety_cof_ehv_fittings(
  ehv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV asset category Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")
location_risk	String Type Financial factor criteria for EHV fittings (cf. section D1.2.1, page 178, CNAIM, 2021). location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021). type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV fittings

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
safety_cof_ehv_switchgear(
  ehv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

ehv_asset_category	String The type of EHV swicthgear & 132kV CB Options: ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)","33kV CB (Air Insulated Busbars)(OD)(GM)","33kV CB (Gas Insulated Busbars)(ID)(GM)","33kV CB (Gas Insulated Busbars)(OD)(GM)","33kV RMU","33kV Switch (GM)","66kV CB (Air Insulated Busbars)(ID)(GM)","66kV CB (Air Insulated Busbars)(OD)(GM)","66kV CB (Gas Insulated Busbars)(ID)(GM)","66kV CB (Gas Insulated Busbars)(OD)(GM)")
location_risk	String Type Financial factor criteria for EHV swicthgear & 132kV CB (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for EHV swicthgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_hv_switchgear_distribution

Safety cost of Failure for HV Switchgear Distribution

Description

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

Usage

```
safety_cof_hv_switchgear_distribution(
  hv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

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

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_hv_switchgear_primary

Safety cost of Failure for HV Switchgear Primary

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). 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,
  gb_ref_given = NULL
)
```

Arguments

hv_asset_category	String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary","20kV CB (GM) Primary")
location_risk	String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for HV switchgear setting (cf. table 218, page 176, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for HV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

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

Description

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

Usage

```
safety_cof_lv_switchgear_and_other(
  lv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

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

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

safety_cof_lv_ugb *Safety cost of Failure for LV UGB*

Description

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

Usage

```
safety_cof_lv_ugb(
  lv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

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

Value

Numeric. Financial consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

safety_cof_ohl_cond *Safety cost of Failure for Overhead Line Conductors*

Description

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

Usage

```
safety_cof_ohl_cond(
  ohl_cond_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

ohl_cond_asset_category	String The type of Pole asset category Options: ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor","66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor").
location_risk	String Type Financial factor criteria for Overhead Line Conductors (cf. section D1.2.1, page 178, CNAIM, 2021). location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Overhead Line Conductors setting (cf. table 221, page 180, CNAIM, 2021). type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Overhead Line Conductors

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

safety_cof_ohl_cond_50kv

Safety cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_ohl_cond_50kv(location_risk, type_risk, gb_ref_given = NULL)
```

Arguments

location_risk	String Type Financial factor criteria for Overhead Line Conductors Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Overhead Line Conductors Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Overhead Line Conductors

Examples

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

safety_cof_ohl_fittings_50kv

Safety cost of Failure for 50kV Fittings

Description

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

Usage

```
safety_cof_ohl_fittings_50kv(location_risk, type_risk, gb_ref_given = NULL)
```

Arguments

location_risk	String Type Financial factor criteria for 50kV fittings Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 50kV fittings setting Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for EHV fittings

Examples

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

---

safety_cof_pillar_04kv

Safety cost of Failure for 0.4kV Pillar

Description

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

Usage

```
safety_cof_pillar_04kv(location_risk, type_risk, gb_ref_given = NULL)
```

Arguments

location_risk	String Type Financial factor criteria for 0.4kV Pillar (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 0.4kV Pillar setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 0.4kV Pillar

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_pillar_04kv(
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 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see cof().

Usage

```
safety_cof_poles(
  pole_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles","20kV Poles", "33kV Pole", "66kV Pole").
location_risk	String Type Financial factor criteria for Pole (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for pole setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_poles_ohl_support_50kv

Safety cost of Failure for Poles OHL Support 50kV

Description

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

Usage

```
safety_cof_poles_ohl_support_50kv(
  pole_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

pole_asset_category	String The type of Pole asset category
location_risk	String Type Financial factor criteria for Pole Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for pole setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for poles

Examples

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

safety_cof_relay *Safety cost of Failure for Relays*

Description

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

Usage

```
safety_cof_relay(location_risk, type_risk, gb_ref_given = NULL)
```

Arguments

location_risk	String Type Financial factor criteria for 50kV fittings Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 50kV fittings setting Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for relay

Examples

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

safety_cof_serviceline *Safety cost of Failure for Service Lines*

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_serviceline(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for service line

Examples

```
safety_cof_serviceline()
```

`safety_cof_submarine_cables_10kv`
Safety cost of Failure for 10kV Submarine Cables

Description

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

Usage

```
safety_cof_submarine_cables_10kv(gb_ref_given = NULL)
```

Arguments

`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_submarine_cables_10kv()
```

safety_cof_submarine_cables_30_60kv *Safety cost of Failure for 30kV and 60kV Submarine Cables*

Description

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

Usage

```
safety_cof_submarine_cables_30_60kv(gb_ref_given = NULL)
```

Arguments

gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_submarine_cables_30_60kv()
```

safety_cof_sub_cables *Safety cost of Failure for Sub cables*

Description

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

Usage

```
safety_cof_sub_cables(sub_cable_asset_category, gb_ref_given = NULL)
```

Arguments

sub_cable_asset_category	String The type of Submarine cable asset category Options: sub_cable_asset_category = c("HV Sub Cable","EHV Sub Cable", "132kV Sub Cable").
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_switchgear_30_60kv

Safety cost of Failure for 30kV and 60kV Switchgear

Description

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

Usage

```
safety_cof_switchgear_30_60kv(
  ehv_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

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

type_risk	String. Asses Financial factor criteria for 30kV and 60kV switchgear setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

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

---

safety_cof_switchgear_primary_10kv

Safety cost of Failure for 10kV Switchgear Primary

Description

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

Usage

```
safety_cof_switchgear_primary_10kv(
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

location_risk	String Type Financial factor criteria for 10kV switchgear Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 10kV switchgear setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for HV switchgear

Examples

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

`safety_cof_switchgear_secondary_10kv`
Safety cost of Failure for 10 kV Switchgear Secondary

Description

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

Usage

```
safety_cof_switchgear_secondary_10kv(
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

`location_risk`	String Type Financial factor criteria for 10kV switchgear secondary (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.
`type_risk`	String. Asses Financial factor criteria for 10kV switchgear secondary setting. Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.
`gb_ref_given`	optional parameter to use custom reference values

Value

Numeric. Financial consequences of failure for 10kV switchgear secondary

Examples

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

safety_cof_towers *Safety cost of Failure for tower*

Description

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

Usage

```
safety_cof_towers(
  tower_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

tower_asset_category	String The type of tower asset category Options: tower_asset_category = c("33kV Tower", "66kV Tower","132kV Tower").
location_risk	String Type Financial factor criteria for tower (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for tower setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for towers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

safety_cof_tower_ohl_support_50kv

Safety cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

```
safety_cof_tower_ohl_support_50kv(
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

location_risk	String Type Financial factor criteria for tower Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for tower Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

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

Examples

```
safety_cof_tower_ohl_support_50kv(
location_risk = "Default",
type_risk = "Default")
```

safety_cof_transformers

Safety cost of Failure for Transformer

Description

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

Usage

```
safety_cof_transformers(
  tf_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

tf_asset_category	String The type of Transformer asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)","20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) ").
location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Transformers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

---

safety_cof_transformer_30_60kv

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

Description

This function calculates safety consequences of failure Outputted in DKK.

Usage

```
safety_cof_transformer_30_60kv(
  tf_asset_category,
  location_risk,
  type_risk,
  gb_ref_given = NULL
)
```

Arguments

tf_asset_category	String The type of Transformer Options: tf_asset_category = c("30kV Transformer (GM)","60kV Transformer (GM)").
location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".
gb_ref_given	optional parameter to use custom reference values

Value

Numeric. Safety consequences of failure for Transformers

Examples

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

---

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

Description

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

Usage

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

Arguments

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

Value

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

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

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

`train_weibull_model` *Training function for Weibull model*

Description

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

Usage

```
train_weibull_model(transformer_faults_data)
```

Arguments

`transformer_faults_data`
: Data frame. Contains past data on transformer faults, together with environmental factors. Must contain the following fields: utilisation_pct: Numeric or "Default", placement: "Indoor", "Outdoor" or "Default", altitude_m: Numeric or "Default", distance_from_coast_km: Numeric or "Default", corrosion_category_index: Numeric or "Default", partial_discharge: "Low", "Medium", "High (Not Confirmed)", "High (Confirmed)" or "Default", oil_acidity: Numeric or "Default", temperature_reading: "Normal", "Moderately High", "Very High" or "Default", observed_condition: "No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration" or "Default" age: Numeric

Value

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

Source

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

Examples

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

`transformer_11kv_faults` *Failure statistics dataset for 10,000 6.6/11kV transformers*

Description

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

Usage

```
transformer_11kv_faults
```

Format

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

utilisation_pct Utilization of a transformer in %

placement Is the transformer placed indoors or outdoors?

altitude_m Altitude above sea level (m)

distance_from_coast_km Distance from salt water (km)

corrosion_category_index Corrosion zone the asset exists in

partial_discharge Condition converted from TEV %-measurement

oil_acidity Oil acidity (mg KOH/g)

temperature_reading Temperature condition band

observed_condition Observed condition band

age Age of transformer (years)

pof Probability of failure (current and future) when the transformer failed

transformer_id Id of transformer that died

dead Monte carlo result showing if the transformer has died (TRUE)

Source

https://www.cnaim.io/

Index