

Package ‘CNAIM’

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Type Package

Title Common Network Asset Indices Methodology (CNAIM)

Version 2.1.4

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

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

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

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Forecast ageing rate for an electric network asset.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Consequences of failure.

Source

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

cof_transformer_04_10kv

Consequences of Failure for a 0.4/10 kV transformer

Description

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

Usage

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

Arguments

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

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

Value

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

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

Value

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

Source

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

Examples

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

current_health	<i>Current Health score</i>
----------------	-----------------------------

Description

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

Usage

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

Arguments

- `initial_health_score`
Numeric. The output from the function `initial_health()`.
- `health_score_factor`
Numeric. E.g. output from the function `health_score_excl_ehv_132kv_tf()`.
- `health_score_cap`
Numeric. Specifies the maximum value of current health score. The cap is used in situations where a good result from a condition inspection or measurement implies that the health score should be no more than the specified value. The cap is derived as the minimum of the observed condition cap and the measured condition cap. Measured and observed condition caps are found in lookup tables depending in the asset category, when determine the observed and measured condition factors. A setting of "Default" sets the `health_score_cap` to 10.
- `health_score_collar`
Numeric. Specifies the minimum value of Current Health Score. The collar is used in situations where a poor result from a condition inspection or measurement implies that the health score should be at least the specified value. The collar is derived as the minimum of the observed condition collar and the measured condition collar. Measured and observed condition collars are found in lookup tables depending in the asset category, when determine the observed and measured condition factors. A setting of "Default" sets the `health_score_collar` to 0.5.
- `reliability_factor`
Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).

Value

Numeric. The Current health score.

Source

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

Examples

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

dga_test_modifier *DGA Test Modifier*

Description

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

Usage

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

Arguments

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

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

Value

Data table.

Source

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

Examples

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

duty_factor_cables *Duty Factor for all cables (incl. submarine cables).*

Description

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

Usage

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

Arguments

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

Value

Numeric. Duty factor for cables.

Source

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

Examples

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

```
duty_factor_transformer_11_20kv
```

Duty Factor for 6.6/11kV and 20kV Transformers

Description

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

Usage

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

Arguments

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

Value

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

Source

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

Examples

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

```
duty_factor_transformer_33_66kv
```

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

Description

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

Usage

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

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).

Value

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

Source

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

Examples

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

 environmental_cof_board_04kv

Environmental cost of Failure for 0.4kV Board

Description

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

Usage

```
environmental_cof_board_04kv()
```

Source

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

Examples

```
environmental_cof_board_04kv()
```

environmental_cof_cables_04_10kv

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

Description

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

Usage

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

Arguments

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

Examples

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

```
environmental_cof_cables_60_30kv
```

Environmental cost of Failure for 30-60 kV UG cables

Description

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

Usage

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

Arguments

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

Source

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

Examples

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

environmental_cof_ehv_cables

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

Description

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

Usage

```
environmental_cof_ehv_cables(ehv_asset_category, prox_water, banded)
```

Arguments

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

Source

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

Examples

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

```
environmental_cof_ehv_fittings
```

Environmental cost of Failure for EHV/132kV fittings

Description

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

Usage

```
environmental_cof_ehv_fittings(ehv_asset_category)
```

Arguments

```
ehv_asset_category
```

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

Source

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

Examples

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

```
environmental_cof_ehv_switchgear
```

Environmental cost of Failure for EHV switchgear & 132kV CB

Description

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

Usage

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

Arguments

ehv_asset_category	String The type of EHV switthgear & 132kV CB Options: ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)", "33kV CB (Air Insulated Busbars)(OD)(GM)", "33kV CB (Gas Insulated Busbars)(ID)(GM)", "33kV CB (Gas Insulated Busbars)(OD)(GM)", "33kV RMU", "33kV Switch (GM)", "66kV CB (Air Insulated Busbars)(ID)(GM)", "66kV CB (Air Insulated Busbars)(OD)(GM)", "66kV CB (Gas Insulated Busbars)(ID)(GM)", "66kV CB (Gas Insulated Busbars)(OD)(GM)")
type_env_factor	String The type environment factor of EHV asset category
prox_water	Numeric. Specify the proximity to a water course in meters. A setting of "Default" will result in a proximity factor of 1. Thus assume the proximity to a water course is between 80m and 120m (cf. table 231, page 188, CNAIM, 2021).
bunded	String. Options: bunded = c("Yes", "No", "Default"). A setting of "Default" will result in a bunding factor of 1.

Source

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

Examples

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

```
environmental_cof_hv_switchgear_distribution
```

Environmental cost of Failure for HV switchgear distribution

Description

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

Usage

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

Arguments

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

Source

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

Examples

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

environmental_cof_hv_switchgear_primary

Environmental cost of Failure for HV switchgear primary

Description

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

Usage

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

Arguments

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

Source

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

Examples

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

```
environmental_cof_lv_switchgear_and_other
```

Environmental cost of Failure for LV swicthgear and others

Description

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

Usage

```
environmental_cof_lv_switchgear_and_other(lv_asset_category)
```

Arguments

lv_asset_category	String The type of LV asset category Options: lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")
-------------------	--

Source

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

Examples

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

```
environmental_cof_lv_ugb
```

Environmental cost of Failure for LV UGB

Description

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

Usage

```
environmental_cof_lv_ugb(lv_asset_category)
```

Arguments

```
lv_asset_category
```

String The type of LV asset category Option: `lv_asset_category = "LV UGB"`

Value

Numeric. Environmental consequences of failure for LV UGB

Source

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

Examples

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

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

Description

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

Usage

```
environmental_cof_ohl_cond(ohl_cond_asset_category)
```

Arguments

`ohl_cond_asset_category`

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

Value

Numeric. Financial consequences of failure for LV switchgear

Source

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

Examples

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

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

Description

This function calculates environmental consequences of failure Outputted in DKK

Usage

```
environmental_cof_ohl_cond_50kv()
```

Examples

```
environmental_cof_ohl_cond_50kv()
```

```
environmental_cof_ohl_fittings_50kv
```

Environmental cost of Failure for 50kV Fittings

Description

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

Usage

```
environmental_cof_ohl_fittings_50kv()
```

Value

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

Examples

```
environmental_cof_ohl_fittings_50kv()
```

```
environmental_cof_pillar_04kv
```

Environmental cost of Failure for 0.4kv Pillar

Description

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

Usage

```
environmental_cof_pillar_04kv()
```

Value

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

Source

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

Examples

```
environmental_cof_pillar_04kv()
```

```
environmental_cof_poles
```

Environmental cost of Failure for Poles

Description

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

Usage

```
environmental_cof_poles(pole_asset_category)
```

Arguments

```
pole_asset_category
```

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

Value

Numeric. Financial consequences of failure for Poles

Source

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

Examples

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

```
environmental_cof_poles_ohl_support_50kv
```

Environmental cost of Failure for Poles OHL Support 50kV

Description

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

Usage

```
environmental_cof_poles_ohl_support_50kv()
```

Examples

```
environmental_cof_poles_ohl_support_50kv()
```

```
environmental_cof_relay
```

Environmental cost of Failure for Relays

Description

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

Usage

```
environmental_cof_relay(type_env_factor, prox_water, bunded)
```

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.

Examples

```
environmental_cof_relay(
  type_env_factor = "Oil",
  prox_water = 95,
  bundled = "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, bundled)
```

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

Examples

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

```
environmental_cof_submarine_10kv
```

Environmental cost of Failure for 10kV Submarine Cables

Description

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

Usage

```
environmental_cof_submarine_10kv()
```

Source

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

Examples

```
environmental_cof_submarine_10kv()
```

```
environmental_cof_submarine_30_60kv
```

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

Description

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

Usage

```
environmental_cof_submarine_30_60kv()
```

Source

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

Examples

```
environmental_cof_submarine_30_60kv()
```

```
environmental_cof_sub_cables
```

Environmental cost of Failure for sub cables

Description

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

Usage

```
environmental_cof_sub_cables(sub_cable_asset_category)
```

Arguments

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

Value

Numeric. Financial consequences of failure for sub cables

Source

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

Examples

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

```
environmental_cof_switchgear_30_60kv
```

Environmental cost of Failure for 30kV and 60kV Switchgear

Description

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

Usage

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

Arguments

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

Value

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

Examples

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

environmental_cof_switchgear_primary_10kv

Environmental cost of Failure for 10kV Switchgear Primary

Description

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

Usage

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

Arguments

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

Value

Numeric. Financial consequences of failure for 10kV switchgear

Examples

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

```
environmental_cof_switchgear_secondary_10kv
```

Environmental cost of Failure for 10kV Switchgear Secondary

Description

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

Usage

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

Arguments

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

Examples

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

 environmental_cof_towers

Environmental cost of Failure for towers

Description

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

Usage

```
environmental_cof_towers(tower_asset_category)
```

Arguments

tower_asset_category

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

Value

Numeric. Financial consequences of failure for towers

Source

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

Examples

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

 environmental_cof_tower_ohl_support_50kv

Environmental cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

```
environmental_cof_tower_ohl_support_50kv()
```

Value

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

Examples

```
environmental_cof_tower_ohl_support_50kv()
```

```
environmental_cof_transformers
```

Environmental cost of Failure for Transformers

Description

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

Usage

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

Arguments

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

Source

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

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
)
```

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

Examples

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

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

Description

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

Usage

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

Arguments

normal_expected_life	Numeric. The number of years a new asset is expected to normally last. I.e. technical life time. See page 107, table 20 in CNAIM (2021).
duty_factor	Numeric. E.g. the output returned by the function 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 expected life of 50 years
expected_life(normal_expected_life = 50,
              duty_factor = 1,
              location_factor = 1)
```

e_cof_tf

*Environmental Consequences of Failure for transformers***Description**

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

Usage

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

Arguments

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

Value

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

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

Value

Data table.

Source

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

Examples

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

`financial_cof_board_04kv`*Financial cost of Failure for 0.4kV Board*

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Financial consequences of failure for 0.4kV board

Source

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

Examples

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

 financial_cof_cables_04_10kv

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

Description

This function calculates financial consequences of failure Outputted in DKK

Usage

```
financial_cof_cables_04_10kv(hv_asset_category)
```

Arguments

hv_asset_category

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

Value

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

Examples

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

 financial_cof_cables_60_30kv

Financial cost of Failure for 30-60 kV UG cables

Description

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

Usage

```
financial_cof_cables_60_30kv(ehv_asset_category)
```

Arguments

ehv_asset_category

Asset category for the analysis

Value

Numeric. Financial consequences of failure for EHV switchgear

Source

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

Examples

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

```
financial_cof_ehv_cables
```

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

Description

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

Usage

```
financial_cof_ehv_cables(ehv_asset_category)
```

Arguments

ehv_asset_category

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

Value

Numeric. Financial consequences of failure for EHV switchgear

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

`ehv_asset_category`

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

`type_financial_factor_criteria`

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

`access_factor_criteria`

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

Value

Numeric. Financial consequences of failure for EHV fittings

Source

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

Examples

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

financial_cof_ehv_switchgear

Financial cost of Failure for EHV swithgear & 132kV CB

Description

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

Usage

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

Arguments

ehv_asset_category

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

access_factor_criteria

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

Value

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

Source

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

Examples

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

`financial_cof_hv_switchgear_distribution`*Financial cost of Failure for HV switchgear distribution*

Description

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

Usage

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

Arguments

`hv_asset_category`

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

`access_factor_criteria`

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

Value

Numeric. Financial consequences of failure for LV switchgear

Source

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

Examples

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

`financial_cof_hv_switchgear_primary`*Financial cost of Failure for HV swithgear primary*

Description

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

Usage

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

Arguments

`hv_asset_category`

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

`access_factor_criteria`

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

Value

Numeric. Financial consequences of failure for HV switchgear primary

Source

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

Examples

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

`financial_cof_lv_switchgear_and_other`*Financial cost of Failure for LV swithgear and others*

Description

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

Usage

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

Arguments

`lv_asset_category`

String The type of LV asset category Options: `lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")`

`type_financial_factor_criteria`

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

`access_factor_criteria`

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

Value

Numeric. Financial consequences of failure for LV switchgear

Source

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

Examples

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

financial_cof_lv_ugb *Financial cost of Failure for LV UGB*

Description

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

Usage

```
financial_cof_lv_ugb(lv_asset_category)
```

Arguments

lv_asset_category
String The type of LV asset category Option: lv_asset_category = "LV UGB"

Value

Numeric. Financial consequences of failure for LV UGB

Source

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

Examples

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

financial_cof_ohl_cond
Financial cost of Failure for Overhead Line Conductors

Description

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

Usage

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


Arguments

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

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

Value

Numeric. Financial consequences of failure for Poles

Source

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

Examples

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

`financial_cof_ohl_cond_50kv`

Financial cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates financial consequences of failure Outputted in DKK

Usage

```
financial_cof_ohl_cond_50kv(access_factor_criteria)
```

Arguments

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

Value

Numeric. Financial consequences of failure for Overhead Line Conductors

Examples

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

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

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Financial consequences of failure for EHV fittings

Examples

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

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

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Financial consequences of failure for 0.4kV Pillar

Source

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

Examples

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

financial_cof_poles *Financial cost of Failure for Poles*

Description

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

Usage

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

Arguments

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

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

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

Value

Numeric. Financial consequences of failure for Poles

Source

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

Examples

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

`financial_cof_poles_ohl_support_50kv`*Financial cost of Failure for Poles OHL Support 50kv*

Description

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

Usage

```
financial_cof_poles_ohl_support_50kv(  
    pole_asset_category,  
    type_financial_factor_criteria,  
    access_factor_criteria  
)
```

Arguments

`pole_asset_category`
String. The type of Pole asset category

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

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

Value

Numeric. Financial consequences of failure for Poles

Examples

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

financial_cof_relay *Financial cost of Failure for Relays*

Description

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

Usage

```
financial_cof_relay(access_factor_criteria)
```

Arguments

access_factor_criteria

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

Examples

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

financial_cof_serviceline
Financial cost of Failure for Service Lines

Description

This function calculates financial consequences of failure. Outputted in DKK.

Usage

```
financial_cof_serviceline()
```

Value

Numeric. Financial consequences of failure for service line.

Examples

```
financial_cof_serviceline()
```

`financial_cof_submarine_cables_10kv`*Financial cost of Failure for 10kV Submarine Cables*

Description

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

Usage`financial_cof_submarine_cables_10kv()`**Value**

Numeric. Financial consequences of failure for 10kV submarine cables

Source

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

Examples`financial_cof_submarine_cables_10kv()`

`financial_cof_submarine_cables_30_60kv`*Financial cost of Failure for 30kV and 60kV Submarine Cables*

Description

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

Usage`financial_cof_submarine_cables_30_60kv()`**Value**

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

Source

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

Examples

```
financial_cof_submarine_cables_30_60kv()
```

```
financial_cof_sub_cables
```

Financial cost of Failure for Sub cables

Description

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

Usage

```
financial_cof_sub_cables(sub_cable_asset_category)
```

Arguments

```
sub_cable_asset_category
```

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

Value

Numeric. Financial consequences of failure for Sub cables

Source

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

Examples

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

`financial_cof_switchgear_30_60kv`*Financial cost of Failure for 30kV and 60kV Switchgear*

Description

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

Usage

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

Arguments

`ehv_asset_category`

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

`access_factor_criteria`

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

Value

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

Examples

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

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

Description

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

Usage

```
financial_cof_switchgear_primary_10kv(access_factor_criteria)
```

Arguments

`access_factor_criteria`

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

Value

Numeric. Financial consequences of failure for HV switchgear primary

Examples

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

```
financial_cof_switchgear_secondary_10kv
```

Financial cost of Failure for 10 kV Swicthgear Secondary

Description

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

Usage

```
financial_cof_switchgear_secondary_10kv(access_factor_criteria)
```

Arguments

`access_factor_criteria`

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

Examples

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

financial_cof_towers *Financial cost of Failure for Towers*

Description

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

Usage

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

Arguments

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

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

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

Value

Numeric. Financial consequences of failure for Poles

Source

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

Examples

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

 financial_cof_tower_ohl_support_50kv

Financial cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

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

Arguments

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

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

Value

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

Examples

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

 financial_cof_transformers

Financial cost of Failure for Transformers

Description

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

Usage

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

Arguments

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

type_financial_factor_size
String The type financial factor size for Transformer

type_financial_factor_kva_mva
Numeric The type financial factor kVA MVA for Transformer

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

Value

Numeric. Financial consequences of failure for Transformer

Source

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

Examples

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

financial_cof_transformer_30_60kv

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

Description

This function calculates financial consequences of failure Outputted in DKK.

Usage

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

Arguments

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

type_financial_factor_kva_mva
Numeric The type financial factor kVA MVA for Transformer

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

Value

Numeric. Financial consequences of failure for Transformer

Examples

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

f_cof_transformer_11kv

Financial Consequences of Failure for a 6.6/11 kV Transformer

Description

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

Usage

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

Arguments

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

Value

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

Source

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

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 current age of the asset.

Value

Numeric. Initial health for an electric network asset.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Location factor

Source

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

Examples

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

location_factor_sub *Location Factor (Excl.Submarine Cables)*

Description

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

Usage

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

Arguments

topography	String. Describe the topography around the submarine cable. Options: topography = c("Low Detrimental Topography", "Medium Detrimental Topography", "High Detrimental Topography", "Very High Detrimental Topography", "Default")
situation	String. Describes how the submarine cable af fixed to the sea floor. Options: situation=c("Laid on bed", "Covered", "Buried", "Default")
wind_wave	Numeric. Options: wind_wave=c(1, 2, 3, "Default"). Settings: <ul style="list-style-type: none"> • 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".

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 derivation of the health score factor for all other assets see [health_score_excl_ehv_132kv_tf](#). To derive the health score factor for EHV and 132kV transformers one needs to use `mmi()` to derive the health score factor for the main transformer and for the tapchanger respectively. The constants `factor_divider_1`, `factor_divider_2` and `max_no_combined_factors` are all available in the lookup table 10 and 11 on page 57 and 58 in CNAIM (2021). For an in dept description see also section 6.8 on page 57 in CNAIM (2021). The `mmi()` can also be used in the derivation of observed and measured condition factors for all assets, using measured and observed input factors. The constants `factor_divider_1`, `factor_divider_2` and `max_no_combined_factors` can be found in table 13 on page 63 (observed condition factors) and in table 15 on page 67 (measured condition factors).

Usage

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

Arguments

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

Value

Numeric. Combined factor.

Source

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

Examples

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

network_cof_board_04kv

Network cost of Failure for 0.4kV Board

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

```
network_cof_cables_04_10kv
```

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Examples

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

```
network_cof_cables_60_30kv
```

Network cost of Failure for 30-60 kV UG cables

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

```
network_cof_ehv_cables
```

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

Description

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

Usage

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

Arguments

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


actual_load_mva Numeric. The actual load on the asset

secure Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_ehv_fittings
Network cost of Failure for EHV/132kV Fittings

Description

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

Usage

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

Arguments

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

actual_load_mva
Numeric. The actual load on the asset

secure
Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_ehv_pole *Network cost of Failure for Poles*

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

<code>sub_cable_asset_category</code>	String The type of Submarine cable asset category Options: <code>sub_cable_asset_category = c("EHV Sub Cable", "132kV Sub Cable")</code> .
<code>actual_load_mva</code>	Numeric. The actual load on the asset
<code>secure</code>	Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_ehv_switchgear

Network cost of Failure for EHV switchgear & 132kV CB

Description

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

Usage

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

Arguments

ehv_asset_category

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

actual_load_mva

Numeric. The actual load on the asset

secure

Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_hv_sub_cables

Network cost of Failure for HV Sub cables

Description

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

Usage

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

Arguments

`sub_cable_asset_category` String The type of 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).

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"  
)
```

Arguments

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

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

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_hv_switchgear_primary

Network cost of Failure for HV Switchgear Primary

Description

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

Usage

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

Arguments

hv_asset_category	String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")
no_customers	Numeric. The number of customers fed by an individual asset.
kva_per_customer	Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 (cf. table 18, page 90, CNAIM, 2021).

Value

Numeric. Network cost of failure.

Source

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

Examples

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

 network_cof_lv_switchgear_and_other

Network cost of Failure for LV swicthgear and others

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_ohl_cond *Network cost of Failure for Overhead Line Conductors*

Description

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

Usage

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

Arguments

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

`actual_load_mva`
Numeric. The actual load on the asset

`secure`
Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_ohl_cond_50kv

Network cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates network cost of failure Outputted in DKK

Usage

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

Arguments

actual_load_mva

Numeric. The actual load on the asset

secure

Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Examples

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

network_cof_ohl_fittings_50kv

Network cost of Failure for 50kV Fittings

Description

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

Usage

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

Arguments

actual_load_mva

Numeric. The actual load on the asset

secure

Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Examples

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

```
network_cof_pillar_04kv
```

Network cost of Failure for 0.4kV Pillar

Description

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

Usage

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

Arguments

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

`kva_per_customer`

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_poles_ohl_support_50kv

Network cost of Failure for Poles OHL Support 50kV

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Examples

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

network_cof_relay

Network cost of Failure for Relays

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Network cost of failure.

Examples

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

network_cof_serviceline

Network cost of Failure for Service Lines

Description

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

Usage

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

Arguments

actual_load_mva Numeric. The actual load on the asset

secure Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Examples

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

network_cof_submarine_cables_10kv

Network cost of Failure for 10kV Submarine Cables

Description

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

Usage

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

Arguments

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

`kva_per_customer`

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

`network_cof_submarine_cables_30_60kv`*Network cost of Failure for 30kV and 60kV Submarine Cables*

Description

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

Usage

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

Arguments

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

`kva_per_customer`

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

network_cof_switchgear_30_60kv

Network cost of Failure for 30kV and 60kV Switchgear

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Examples

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

network_cof_switchgear_primary_10kv

Network cost of Failure for 10kV Switchgear Primary

Description

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

Usage

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

Arguments

no_customers Numeric. The number of customers fed by an individual asset.
kva_per_customer Numeric. If the asset have an exceptionally high demand per customer type in kVA per customer. A setting of "Default" results in a multiplication factor of 1 .

Value

Numeric. Network cost of failure.

Examples

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

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Examples

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

network_cof_tower	<i>Network cost of Failure for Towers</i>
-------------------	---

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

 network_cof_tower_ohl_support_50kv

Network cost of Failure for Tower OHL Support 50 kV

Description

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

Usage

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

Arguments

actual_load_mva

Numeric. The actual load on the asset

secure

Boolean If the asset is in a secure network or not

Value

Numeric. Network cost of failure.

Examples

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

 network_cof_transformers

Network cost of Failure for Transformers

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

```
network_cof_transformer_30_60kv
```

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

Description

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

Usage

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

Arguments

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

Value

Numeric. Network cost of failure.

Examples

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

```
n_cof_excl_ehv_132kv_tf
```

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

Description

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

Usage

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

Arguments

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

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

Value

Numeric. Network cost of failure.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

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

transformer_type_all
String. A sting that refers to the specific transformer type. Options: transformer_type_all = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV Transformer (GM)"). The default setting is transformer_type = "66kV Transformer (GM)"

Value

Data table.

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

pof_function String. Choosing an pof function, Options: pof_function = c(pof_cables_04kv_pex, pof_cables_10kv_pex, pof_cables_10kv_oil, pof_cables_60_30kv, pof_ohl_cond_50kv, pof_submarine_cables_10kv_oil, pof_submarine_cables_10kv_pex, pof_submarine_cables_30kv, pof_transformer_04_10kv, pof_building, pof_serviceline, "Default").

Examples

```
# probability of failure curve
```

pof_132kv_cb

*Current Probability of Failure for 132kV Switchgear***Description**

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

Usage

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

Arguments

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

observed_condition_inputs

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

reliability_factor

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

Value

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

Source

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

Examples

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

pof_board_04kv

Current Probability of Failure for 0.4kV Board

Description

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

Usage

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

Arguments

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

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

Value

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

Examples

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

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

Description

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

Usage

```

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

```

Arguments

substation_type	String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"
material_type	String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the building.
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substant Deterioration", "Default"). in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").

cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default")..
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = "Default" by default. This number is given in a percentage.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life_building	Numeric. normal_expected_life_building = "Default" by default.

Value

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

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

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

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

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

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

k_value Numeric. `k_value = 0.0658` by default.

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

normal_expected_life Numeric. `normal_expected_life = 80` by default.

Value

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

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

partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
k_value	Numeric. k_value = 0.24 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.

Value

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

Examples

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

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

Description

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

Usage

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

Arguments

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

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

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

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

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

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

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

k_value Numeric. `k_value = 0.0658` by default.

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

normal_expected_life Numeric. `normal_expected_life = 80` by default.

Value

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

Examples

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

pof_cables_132kv

Current Probability of Failure for 132kV cables

Description

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

Usage

```
pof_cables_132kv(
  cable_type = "132kV UG Cable (Gas)",
  sub_division = "Aluminium sheath - Aluminium conductor",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  leakage = "Default",
  reliability_factor = "Default",
  age
)
```

Arguments

cable_type String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: `cable_type = c("132kV UG Cable (Gas)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)")`. The default setting is `cable_type = "132kV UG Cable (Gas)"`.

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

Value

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

Source

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

Examples

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

```

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

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

```

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

Description

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

Usage

```

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

```

Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)"). The default setting is cable_type = "60kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.

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

Value

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

Source

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

Examples

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

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

Description

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

Usage

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

Arguments

cable_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: cable_type = c("33kV UG Cable (Gas)", "66kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Non Pressurised)", "33kV UG Cable (Oil)", "66kV UG Cable (Oil)"). The default setting is cable_type = "66kV UG Cable (Gas)".
sub_division	String. Refers to material the sheath and conductor is made of. Options: sub_division = c("Aluminium sheath - Aluminium conductor", "Aluminium sheath - Copper conductor", "Lead sheath - Aluminium conductor", "Lead sheath - Copper conductor")
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).

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

Value

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

Source

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

Examples

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

pof_ehv_fittings

Current Probability of Failure for EHV/132kV Fittings

Description

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

Usage

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

Arguments

ehv_asset_category String The type of EHV asset category

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

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

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

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

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

measured_condition_inputs Named list observed_conditions_input

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

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

Value

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

Source

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

Examples

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

pof_ehv_switchgear *Current Probability of Failure for EHV Switchgear*

Description

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

Usage

```
pof_ehv_switchgear(
  ehv_asset_category = "33kV RMU",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
```

```

corrosion_category_index = "Default",
age,
measured_condition_inputs,
observed_condition_inputs,
reliability_factor = "Default"
)

```

Arguments

ehv_asset_category String The type of EHV asset category

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

number_of_operations The number of operations for duty factor

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

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

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

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

measured_condition_inputs Named list `observed_conditions_input`

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

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

Value

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

Source

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

Examples

```
# Current annual probability of failure for EHV Switchgear
pof_ehv_switchgear(
  ehv_asset_category = "33kV RMU",
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default"),
  "support_structure" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductortest" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
  "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
  reliability_factor = "Default")
```

pof_future_board_04kv *Future Probability of Failure for 0.4kV Board*

Description

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

Usage

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

```

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

```

Arguments

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

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level. `altitude_m` is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of `asset_type`.

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

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

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

measured_condition_inputs Named list `observed_conditions_input`

observed_condition_inputs Named list `observed_conditions_input` `conductor_samp = c("Low", "Medium/Normal", "High", "Default")`

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

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

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

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

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

Value

DataFrame. Future probability of failure along with future health score

Examples

```

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

```

```

corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_cond" =
list("Condition Criteria: Observed Condition" = "Default"),
"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default",
k_value = 0.0069,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)

```

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

Description

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

Usage

```

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

```

Arguments

substation_type	String. A sting that refers to the specific substation type. Options: substation_type = c("Primary", "Secondary"). The default setting is substation_type = "Secondary"
material_type	String. A sting that refers to the specific material_type. Options: material_type = c("Brick", "Steel", "Wood"). The default setting is substation_type = "Wood"
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the building.
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substant Deterioration", "Default"). in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default")..
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = "Default" by default. This number is given in a percentage.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life_building	Numeric. normal_expected_life_building = "Default" by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_cables_04kv_pex

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

Description

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

Usage

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

Arguments

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_cables_10kv_oil

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

Description

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

Usage

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

Arguments

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

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

k_value Numeric. k_value = 0.24 by default.

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

normal_expected_life Numeric. normal_expected_life = 80 by default.

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_cables_10kv_pex

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

Description

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

Usage

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

```

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

```

Arguments

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

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

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

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

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

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

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

k_value Numeric. `k_value = 0.0658` by default.

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

normal_expected_life Numeric. `normal_expected_life = 80` by default.

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

Value

DataFrame. Future probability of failure along with future health score

Examples

```

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

```

```

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

```

pof_future_cables_132kv

Future Probability of Failure for 132kV cables

Description

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

Usage

```

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

```

Arguments

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

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 157, table 184 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 157, table 185 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 157, table 186 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/ moderate", "High", "Very High", "Default"). See page 158, table 187 (oil) and 188 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

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

```
age = 1,
simulation_end_year = 100)
```

pof_future_cables_60_30kv

Future Probability of Failure for 30-60kV cables

Description

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

Usage

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

Arguments

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

sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default"). See page 153, table 168 in CNAIM (2021).
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default"). See page 153, table 169 in CNAIM (2021).
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault. See page 153, table 170 in CNAIM (2021).
leakage	String. Only applied for oil and gas pressurised cables. Options: leakage = c("No (or very low) historic leakage recorded", "Low/moderate", "High", "Very High", "Default"). See page 157, table 182 (oil) and 183 (gas) in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
age	Numeric. The current age in years of the cable.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Source

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

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
)
```

Arguments

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

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

Description

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

Usage

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

Arguments

ohl_conductor	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: ohl_conductor = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor"). The default setting is ohl_conductor = "66kV OHL (Tower Line) Conductor".
sub_division	String. Refers to material the conductor is made of. Options: sub_division = c("ACSR - greased", "ACSR - non-greased", "AAAC", "Cad Cu", "Cu", "Other") . See page 107, table 20 in CNAIM (2021).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM

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

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

```
# Future annual probability of failure for 66kV OHL (Tower Line) Conductor
pof_future_ohl_cond_132_66_33kv(
  ohl_conductor = "66kV OHL (Tower Line) Conductor",
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
```

```

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

```

pof_future_ohl_cond_50kv

Future Probability of Failure for 50kV OHL Conductors

Description

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

Usage

```

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

```

Arguments

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

altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5. corrosion_category_index is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of asset_type.
age	Numeric. The current age in years of the conductor.
conductor_samp	String. Conductor sampling. Options: conductor_samp = c("Low", "Medium/Normal", "High", "Default"). See page 161, table 199 and 201 in CNAIM (2021).
corr_mon_survey	String. Corrosion monitoring survey. Options: corr_mon_survey = c("Low", "Medium/Normal", "High"). See page 161, table 200 and 202 in CNAIM (2021).
visual_cond	String. Visual condition. Options: visual_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 146, table 140 and 142 in CNAIM (2021).
midspan_joints	Integer. Number of midspan joints on the conductor. A span includes all conductors in that span. See page 146, table 141 and 143 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

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

```

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

```

pof_future_ohl_fittings_50kv

Future Probability of Failure for 50 kV Fittings

Description

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

Usage

```

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

```

Arguments

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

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

```

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

```

pof_future_pillar_04kv

Future Probability of Failure for 0.4kV Pillar

Description

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

Usage

```

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

```

Arguments

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

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

```

"compound_leaks" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_cond" = list("Condition Criteria: Observed Condition" = "Default"),
"insulation" = list("Condition Criteria: Observed Condition" = "Default"),
"signs_heating" = list("Condition Criteria: Observed Condition" = "Default"),
"phase_barriers" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("opsal_adequacy" =
list("Condition Criteria: Operational Adequacy" = "Default")),
reliability_factor = "Default",
k_value = 0.0046,
c_value = 1.087,
normal_expected_life = 60,
simulation_end_year = 100)

```

pof_future_poles

Future Probability of Failure for Poles

Description

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

Usage

```

pof_future_poles(
  pole_asset_category = "20kV Poles",
  sub_division = "Wood",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  pole_decay = "default",
  observed_condition_inputs,
  reliability_factor = "Default",
  simulation_end_year = 100
)

```

Arguments

pole_asset_category	String The type of asset category
sub_division	String. Refers to material the pole is made of.
placement	String. Specify if the asset is located outdoor or indoor.

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

Value

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

Source

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

Examples

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

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

pof_future_poles_ohl_support_50kv

Future Probability of Failure for Poles OHL support 50 kV

Description

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

Usage

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

Arguments

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

corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

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

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

pof_future_relay *Future Probability of Failure for Relay*

Description

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

Usage

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

Arguments

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

observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default") See page 161, table 199 and 201 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# future annual probability of failure for relay
pof_future_relay(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 30,
  simulation_end_year = 100)
```

pof_future_rtu *Future Probability of Failure for RTU*

Description

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

Usage

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

Arguments

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

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_serviceline

Future Probability of Failure for Service Line

Description

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

Usage

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

Arguments

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

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

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

Value

DataFrame. Future probability of failure along with future health score

Examples

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

pof_future_submarine_cables

Future Probability of Failure for Submarine Cables

Description

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

Usage

```
pof_future_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
```

```

sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
condition_armour = "Default",
age,
reliability_factor = "Default",
simulation_end_year = 100
)

```

Arguments

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

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

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

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

situation Situation of the cable

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

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

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

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

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

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

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

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

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

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

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

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

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

pof_future_submarine_cables_10kv_oil

Future Probability of Failure for 10kV Oil Submarine Cables

Description

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

Usage

```

pof_future_submarine_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

Arguments

<code>utilisation_pct</code>	Numeric. The max percentage of utilisation under normal operating conditions.
<code>operating_voltage_pct</code>	Numeric. The ratio in percent of operating/design voltage.
<code>topography</code>	String Topography
<code>situation</code>	String Situation
<code>wind_wave</code>	String Wind Wave
<code>intensity</code>	String Intensity
<code>landlocked</code>	String Land Locked
<code>sheath_test</code>	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: <code>sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default")</code> .
<code>partial_discharge</code>	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: <code>partial_discharge = c("Low", "Medium", "High", "Default")</code> .
<code>fault_hist</code>	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
<code>condition_armour</code>	String Condition Armour
<code>age</code>	Numeric. The current age in years of the cable.

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 1 km 10kV Oil Sub Cable
pof_future_submarine_cables_10kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

pof_future_submarine_cables_10kv_pex

Future Probability of Failure for 10kV Non Pressurised submarine cables

Description

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

Usage

```

pof_future_submarine_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
situation	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 1 km 10kV non pressurised Sub Cable
pof_future_submarine_cables_10kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

pof_future_submarine_cables_30_60kv_oil

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

Description

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

Usage

```

pof_future_submarine_cables_30_60kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  k_value = 2.0944,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
situation	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_submarine_cables_30_60kv_oil(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

pof_future_submarine_cables_30_60kv_pex

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

Description

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

Usage

```

pof_future_submarine_cables_30_60kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100
)

```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
operating_voltage_pct	Numeric. The ratio in percent of operating/design voltage.
topography	String Topography
situation	String Situation
wind_wave	String Wind Wave
intensity	String Intensity
landlocked	String Land Locked
sheath_test	String. Only applied for non pressurised cables. Indicating the state of the sheath. Options: sheath_test = c("Pass", "Failed Minor", "Failed Major", "Default").
partial_discharge	String. Only applied for non pressurised cables. Indicating the level of partial discharge. Options: partial_discharge = c("Low", "Medium", "High", "Default").
fault_hist	Numeric. Only applied for non pressurised cables. The calculated fault rate for the cable in the period per kilometer. A setting of "No historic faults recorded" indicates no fault.
condition_armour	String Condition Armour
age	Numeric. The current age in years of the cable.

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0658 by default.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 80 by default.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_submarine_cables_30_60kv_pex(
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default",
  k_value = 0.0202,
  c_value = 1.087,
  normal_expected_life = 60,
  simulation_end_year = 100)
```

pof_future_switchgear_30_60kv

Future Probability of Failure for 30kV and 60kV Switchgear

Description

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

Usage

```

pof_future_switchgear_30_60kv(
  asset_type = "30kV",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100
)

```

Arguments

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

Value

Numeric. Current probability of failure per annum.

Examples

```
# Future annual probability of failure for 30kV and 60kV Swicthgear
pof_future_switchgear_30_60kv(
  asset_type = "30kV",
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default"),
  "support_structure" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
  "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
  reliability_factor = "Default",
  k_value = "Default",
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

pof_future_switchgear_primary_10kv

Future Probability of Failure for 10kV Switchgear Primary

Description

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

Usage

```

pof_future_switchgear_primary_10kv(
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100
)

```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
number_of_operations	The number of operations for duty factor
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default")
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

normal_expected_life
 Numeric. normal_expected_life = 55 by default. The default value is according to the CNAIM standard on page 107.

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

Value

DataFrame. Future probability of failure along with future health score

Examples

```
# Future annual probability of failure for 10 kV Switchgear (GM) Primary
pof_future_switchgear_primary_10kv(
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
  "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

pof_future_switchgear_secondary_10kv

Future Probability of Failure for 10kV Switchgear Secondary

Description

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

Usage

```

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

```

Arguments

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

simulation_end_year

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

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_switchgear_secondary_10kv(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.0067,
  c_value = 1.087,
  normal_expected_life = 55,
  simulation_end_year = 100)
```

pof_future_transformer_04_10kv

Future Probability of Failure for 0.4/10kV Transformers

Description

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

Usage

```
pof_future_transformer_04_10kv(
  utilisation_pct = "Default",
  placement = "Default",
```

```

altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age,
partial_discharge = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100
)

```

Arguments

utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 153, table 172 in CNAIM (2021).
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration",

"Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 130, table 81 in CNAIM (2021).

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	String Acidity
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
k_value	Numeric. k_value = 0.0069 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 60 by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```
pof_future_transformer_04_10kv(utilisation_pct = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 20,
partial_discharge = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55,
simulation_end_year = 100)
```

pof_future_transformer_11_20kv

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

Description

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

Usage

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

Arguments

hv_transformer_type	String. Refers to the high voltage transformer type the calculation is done for. Options: hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)"). The default setting is hv_transformer_type = 6.6/11kV Transformer (GM).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.

altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 153, table 172 in CNAIM (2021).
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 130, table 81 in CNAIM (2021).
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
oil_acidity	Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

```
# Future probability of a 6.6/11 kV transformer
future_pof_transformer <-
pof_future_transformer_11_20kv(hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 20,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default",
  simulation_end_year = 100)
```

pof_future_transformer_132kv

Future Probability of Failure for 132kV Transformers

Description

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

Usage

```
pof_future_transformer_132kv(
  transformer_type = "132kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
```

```

bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
simulation_end_year = 100
)

```

Arguments

transformer_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("132kV Transformer (GM)")
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 155, table 177 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration",

"Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).

diverter_contacts

String. Indicating the observed condition of the selector and diverter contacts.
Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).

diverter_braids

String. Indicating the observed condition of the selector and diverter braids.
Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

reliability_factor

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

simulation_end_year

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

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

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



```

methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
simulation_end_year = 100)

```

pof_future_transformer_30_60kv

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

Description

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

Usage

```

pof_future_transformer_30_60kv(
  transformer_type = "60kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",

```

```

hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default",
simulation_end_year = 100
)

```

Arguments

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

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

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

no_taps
Numeric. Average number of daily taps (tapchanger).

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

altitude_m
Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

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

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

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

age_tc
Numeric. The current age in years of the tapchanger

partial_discharge_tf
String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").

partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).

hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = "0.0454" by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life_tf	Numeric. normal_expected_life_tf = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.
normal_expected_life_tc	Numeric. normal_expected_life_tc = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.
simulation_end_year	Numeric. The last year of simulating probability of failure. Default is 100.

Value

DataFrame. Future probability of failure along with future health score

Examples

```

# Future probability of failure for a 60/10kV transformer
pof_future_transformer_30_60kv(transformer_type = "60kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default",
simulation_end_year = 100)

```

pof_future_transformer_33_66kv

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

Description

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

Usage

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

)

Arguments

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

main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.

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

Value

DataFrame. Future probability of failure along with future health score

Source

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

Examples

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

```

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

```

pof_hv_switchgear_distribution

Current Probability of Failure for HV Switchgear Distribution

Description

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

Usage

```
pof_hv_switchgear_distribution(
```

```

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

```

Arguments

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

Value

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

Source

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

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"
  )

```

Arguments

hv_asset_category String The type of HV asset category

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

number_of_operations The number of operations for duty factor

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

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

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

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

measured_condition_inputs Named list observed_conditions_input

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

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

Value

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

Source

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

Examples

```

# Current annual probability of failure for HV Switthgear Primary
pof_hv_switchgear_primary(
  hv_asset_category = "6.6/11kV CB (GM) Primary",
  placement = "Default",

```

```

number_of_operations = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs = list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs = list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ducter_test" = list("Condition Criteria: Ducter Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
"ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
reliability_factor = "Default")

```

pof_lv_switchgear_and_other

Current Probability of Failure for LV switchgear and others

Description

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

Usage

```

pof_lv_switchgear_and_other(
  lv_asset_category = "LV Circuit Breaker",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default"
)

```

Arguments

lv_asset_category
String The type of LV asset category

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

Value

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

Source

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

Examples

```
# Current annual probability of failure for LV Switchgear and other
pof_lv_switchgear_and_other(
  lv_asset_category = "LV Circuit Breaker",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("operational_adequacy" =
  list("Condition Criteria: Operational Adequacy" = "Default")),
  reliability_factor = "Default")
```

pof_lv_ugb

*Current Probability of Failure for LV UGB***Description**

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

Usage

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

Arguments

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

reliability_factor

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

Value

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

pof_meter

Current Probability of Failure for Meters

Description

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

Usage

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

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default")
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.128 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 50 by default. The default value is accordingly to the CNAIM standard on page 107.

Value

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

Examples

```
# Current annual probability of failure for meter
pof_meter(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
  reliability_factor = "Default",
  k_value = 0.128,
  c_value = 1.087,
  normal_expected_life = 25)
```

pof_ohl_cond_132_66_33kv

Current Probability of Failure for 33-132kV OHL Conductors

Description

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

Usage

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

```

conductor_samp = "Default",
corr_mon_survey = "Default",
visual_cond = "Default",
midspan_joints = "Default",
reliability_factor = "Default"
)

```

Arguments

- ohl_conductor** String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: `ohl_conductor = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`. The default setting is `ohl_conductor = "66kV OHL (Tower Line) Conductor"`.
- sub_division** String. Refers to material the conductor is made of. Options: `sub_division = c("ACSR - greased", "ACSR - non-greased", "AAAC", "Cad Cu", "Cu", "Other")`. See page 107, table 20 in CNAIM (2021).
- placement** String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of `asset_type`. See page 110-113, table 26 in CNAIM (2021) for default environments.
- altitude_m** Numeric. Specify the altitude location for the asset measured in meters from sea level. `altitude_m` is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of `asset_type`.
- distance_from_coast_km** Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of `asset_type`.
- corrosion_category_index** Integer. Specify the corrosion index category, 1-5. `corrosion_category_index` is used to derive the corrosion category factor. See page 111, table 24 in CNAIM (2021). A setting of "Default" will set the corrosion category factor to 1 independent of `asset_type`.
- age** Numeric. The current age in years of the conductor.
- conductor_samp** String. Conductor sampling. Options: `conductor_samp = c("Low", "Medium/Normal", "High", "Default")`. See page 161, table 199 and 201 in CNAIM (2021).
- corr_mon_survey** String. Corrosion monitoring survey. Options: `corr_mon_survey = c("Low", "Medium/Normal", "High")`. See page 161, table 200 and 202 in CNAIM (2021).
- visual_cond** String. Visual condition. Options: `visual_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default")`. See page 146, table 140 and 142 in CNAIM (2021).

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

`reliability_factor`

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

Value

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

Source

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

Examples

```
# Current annual probability of failure for 66kV OHL (Tower Line) Conductor
pof_ohl_cond_132_66_33kv(
  ohl_conductor = "66kV OHL (Tower Line) Conductor",
  sub_division = "Cu",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  conductor_samp = "Default",
  corr_mon_survey = "Default",
  visual_cond = "Default",
  midspan_joints = "Default",
  reliability_factor = "Default")
```

pof_poles

Current Probability of Failure for Poles

Description

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

Usage

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

Arguments

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

Value

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

Source

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

Examples

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

pof_submarine_cables *Current Probability of Failure for Submarine Cables*

Description

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

Usage

```
pof_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
```

```

landlocked = "no",
sheath_test = "Default",
partial_discharge = "Default",
fault_hist = "Default",
condition_armour = "Default",
age,
reliability_factor = "Default"
)

```

Arguments

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

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

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

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

situation Situation of the cable

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

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

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

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

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

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

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

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

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

reliability_factor Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for 1 km EHV Sub Cable
pof_submarine_cables(
  sub_cable_type = "EHV Sub Cable",
  utilisation_pct = "Default",
  operating_voltage_pct = "Default",
  topography = "Default",
  situation = "Default",
  wind_wave = "Default",
  intensity = "Default",
  landlocked = "no",
  sheath_test = "Default",
  partial_discharge = "Default",
  fault_hist = "Default",
  condition_armour = "Default",
  age = 10,
  reliability_factor = "Default"
)
```

pof_switchgear_primary_10kv

Current Probability of Failure for 10 kV Switchgear (GM) Primary

Description

This function calculates the current annual probability of failure 10 kV Switchgear (GM) Primary. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

Usage

```

pof_switchgear_primary_10kv(
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  measured_condition_inputs,
  observed_condition_inputs,
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55
)

```

Arguments

placement	String. Specify if the asset is located outdoor or indoor.
number_of_operations	The number of operations for duty factor
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years of the conductor.
measured_condition_inputs	Named list observed_conditions_input
observed_condition_inputs	Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default")
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = 0.0052 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life	Numeric. normal_expected_life = 55 by default. The default value is accordingly to the CNAIM standard on page 107.

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Examples

```
# Current annual probability of failure for 10 kV Switchgear (GM) Primary
pof_switchgear_primary_10kv(
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  observed_condition_inputs =
  list("external_condition" =
  list("Condition Criteria: Observed Condition" = "Default"),
  "oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
  "thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
  "internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
  "indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
  measured_condition_inputs =
  list("partial_discharge" =
  list("Condition Criteria: Partial Discharge Test Results" = "Default"),
  "ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
  "oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
  "temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
  "trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default"),
  "ir_test" = list("Condition Criteria: IR Test Results" = "Default" )),
  reliability_factor = "Default",
  k_value = 0.0052,
  c_value = 1.087,
  normal_expected_life = 55)
```

pof_switchgear_secondary_10kV

Current Probability of Failure for 10kV Switchgear secondary

Description

This function calculates the current annual probability of failure 10kV Switchgear secondary The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

Usage

```
pof_switchgear_secondary_10kV(
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
```

```

corrosion_category_index = "Default",
age,
measured_condition_inputs,
observed_condition_inputs,
reliability_factor = "Default",
k_value = 0.0067,
c_value = 1.087,
normal_expected_life = 55
)

```

Arguments

placement String. Specify if the asset is located outdoor or indoor.

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level. `altitude_m` is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of `asset_type`.

distance_from_coast_km Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of `asset_type`.

corrosion_category_index Integer. Specify the corrosion index category, 1-5.

age Numeric. The current age in years of the conductor.

measured_condition_inputs Named list `observed_conditions_input`

observed_condition_inputs Named list `observed_conditions_input` `conductor_samp = c("Low", "Medium/Normal", "High", "Default")`

reliability_factor Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).

k_value Numeric. `k_value = 0.0067` by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

c_value Numeric. `c_value = 1.087` by default. The default value is accordingly to the CNAIM standard see page 110

normal_expected_life Numeric. `normal_expected_life = 55` by default. The default value is accordingly to the CNAIM standard on page 107.

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Examples

```

# Current annual probability of failure for 10kV Switchgear secondary
pof_switchgear_secondary_10kV(

```

```

placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age = 10,
observed_condition_inputs =
list("external_condition" =
list("Condition Criteria: Observed Condition" = "Default"),
"oil_gas" = list("Condition Criteria: Observed Condition" = "Default"),
"thermo_assment" = list("Condition Criteria: Observed Condition" = "Default"),
"internal_condition" = list("Condition Criteria: Observed Condition" = "Default"),
"indoor_env" = list("Condition Criteria: Observed Condition" = "Default")),
measured_condition_inputs =
list("partial_discharge" =
list("Condition Criteria: Partial Discharge Test Results" = "Default"),
"ductor_test" = list("Condition Criteria: Ductor Test Results" = "Default"),
"oil_test" = list("Condition Criteria: Oil Test Results" = "Default"),
"temp_reading" = list("Condition Criteria: Temperature Readings" = "Default"),
"trip_test" = list("Condition Criteria: Trip Timing Test Result" = "Default")),
reliability_factor = "Default",
k_value = 0.0067,
c_value = 1.087,
normal_expected_life = 55)

```

pof_towers

Current Probability of Failure for Towers

Description

This function calculates the current annual probability of failure per kilometer EHV Switchgear The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

Usage

```

pof_towers(
  tower_asset_category = "33kV Tower",
  foundation_type = "Foundation - Fully Encased Concrete",
  paint_type = "Paint System - Paint",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  observed_condition_inputs_steelwork,
  observed_condition_inputs_paint,
  observed_condition_inputs_foundation,

```

```

    reliability_factor = "Default"
)

```

Arguments

tower_asset_category
String The type of Tower asset category

foundation_type
String Foundation type of the tower

paint_type
String Paint type of the tower

placement
String. Specify if the asset is located outdoor or indoor.

number_of_operations
Numeric Number of operations for the tower

altitude_m
Numeric. Specify the altitude location for the asset measured in meters from sea level. `altitude_m` is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of `asset_type`.

distance_from_coast_km
Numeric. Specify the distance from the coast measured in kilometers. `distance_from_coast_km` is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of `asset_type`.

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

age
Numeric. The current age in years of the conductor.

observed_condition_inputs_steelwork
Named list `observed_conditions_input`

observed_condition_inputs_paint
Named list `observed_conditions_input`

observed_condition_inputs_foundation
Named list `observed_conditions_input` `conductor_samp = c("Low", "Medium/Normal", "High", "Default")`
See page 161, table 199 and 201 in CNAIM (2021).

reliability_factor
Numeric. `reliability_factor` shall have a value between 0.6 and 1.5. A setting of "Default" sets the `reliability_factor` to 1. See section 6.14 on page 73 in CNAIM (2021).

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current annual probability of failure for Towers
pof_towers(
  tower_asset_category = "33kV Tower",
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  paint_type = "Paint System - Galvanising",
  foundation_type = "Foundation - Earth Grillage",
  observed_condition_inputs_steelwork =
  list("tower_legs" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_bracings" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_crossarms" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_peak" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_paint =
  list("paintwork_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_foundation =
  list("foundation_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  reliability_factor = "Default")
```

pof_tower_ohl_support_50kv

Current Probability of Failure for Towers OHL support 50kV

Description

This function calculates the current annual probability of failure per kilometer EHV for Towers OHL support 50kV. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

Usage

```
pof_tower_ohl_support_50kv(
  foundation_type = "Foundation - Fully Encased Concrete",
  paint_type = "Paint System - Paint",
  placement = "Default",
  number_of_operations = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  observed_condition_inputs_steelwork,
  observed_condition_inputs_paint,
  observed_condition_inputs_foundation,
  reliability_factor = "Default",
```

```

k_value = 0.0545,
c_value = 1.087,
normal_expected_life = "Default"
)

```

Arguments

foundation_type String. Foundation type of the tower foundation_type = c("Foundation - Fully Encased Concrete", "Foundation - Earth Grillage")

paint_type String. Paint type of the tower foundation_type = c(Paint System - Galvanising, Paint System - Paint)

placement String. Specify if the asset is located outdoor or indoor.

number_of_operations Numeric Number of operations for the tower

altitude_m Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index Integer. Specify the corrosion index category, 1-5.

age Numeric. The current age in years of the conductor.

observed_condition_inputs_steelwork Named list observed_conditions_input

observed_condition_inputs_paint Named list observed_conditions_input

observed_condition_inputs_foundation Named list observed_conditions_input conductor_samp = c("Low", "Medium/Normal", "High", "Default")

reliability_factor Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

k_value Numeric. k_value = 0.0545 by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.

c_value Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

normal_expected_life Numeric. normal_expected_life = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Examples

```
# Current annual probability of failure for Towers
pof_tower_ohl_support_50kv(
  number_of_operations = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  paint_type = "Paint System - Galvanising",
  foundation_type = "Foundation - Earth Grillage",
  observed_condition_inputs_steelwork =
  list("tower_legs" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_bracings" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_crossarms" = list("Condition Criteria: Observed Condition" = "Default"),
    "tower_peak" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_paint =
  list("paintwork_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  observed_condition_inputs_foundation =
  list("foundation_cond" = list("Condition Criteria: Observed Condition" = "Default")),
  reliability_factor = "Default",
  k_value = 0.0545,
  c_value = 1.087,
  normal_expected_life = "Default")
```

pof_transformer_04_10kv

Current Probability of Failure for 0.4/10kV Transformers

Description

This function calculates the current annual probability of failure for 0.4/10kV Transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

Usage

```
pof_transformer_04_10kv(
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
```

```

moisture = "Default",
acidity = "Default",
bd_strength = "Default",
k_value = 0.0077,
c_value = 1.087,
normal_expected_life = 55
)

```

Arguments

utilisation_pct	Numeric Utilisation percentage
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level. altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age	Numeric. The current age in years.
partial_discharge	String. Indicating the level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").
temperature_reading	String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").
observed_condition	String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration", "Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm)
acidity	Oil Acidity
bd_strength	Numeric. the amount of breakdown strength given in (kV)
k_value	Numeric. k_value = 0.0077 by default. This number is given in a percentage. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 34.

c_value Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110

normal_expected_life Numeric. normal_expected_life = 55 by default. The default value is accordingly to the standard "DE-10kV apb kabler CNAIM" on p. 33.

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Examples

```
# Current probability of failure for 0.4/10kV Transformers
pof_transformer_04_10kv(utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  k_value = 0.0077,
  c_value = 1.087,
  normal_expected_life = 55)
```

pof_transformer_11_20kv

Current Probability of Failure for 6.6/11kV and 20kV Transformers

Description

This function calculates the current annual probability of failure for 6.6/11kV and 20kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

Usage

```
pof_transformer_11_20kv(
  hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
```

```

distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age,
partial_discharge = "Default",
temperature_reading = "Default",
observed_condition = "Default",
reliability_factor = "Default",
moisture = "Default",
oil_acidity = "Default",
bd_strength = "Default"
)

```

Arguments

hv_transformer_type
String. Refers to the high voltage transformer type the calculation is done for. Options: hv_transformer_type = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)"). The default setting is hv_transformer_type = 6.6/11kV Transformer (GM).

utilisation_pct
Numeric. The max percentage of utilisation under normal operating conditions.

placement
String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.

altitude_m
Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km
Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index
Integer. Specify the corrosion index category, 1-5.

age
Numeric. The current age in years.

partial_discharge
String. Indicating the

temperature_reading
String. Indicating the criticality. Options for temperature_reading: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 153, table 172 in CNAIM (2021).

observed_condition
String. Indicating the observed condition of the transformer. Options for observed_condition: observed_condition = c("No deterioration", "Superficial/minor deterioration",

"Slight deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 130, table 81 in CNAIM (2021).

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
oil_acidity	Oil Acidity level of partial discharge. Options for partial_discharge: partial_discharge = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 153, table 171 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current probability of failure for a 6.6/11 kV transformer
pof_transformer_11_20kv(hv_transformer_type = "6.6/11kV Transformer (GM)",
  utilisation_pct = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age = 10,
  partial_discharge = "Default",
  temperature_reading = "Default",
  observed_condition = "Default",
  reliability_factor = "Default",
  moisture = "Default",
  oil_acidity = "Default",
  bd_strength = "Default")
```

Description

This function calculates the current annual probability of failure for 132kv transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

Usage

```
pof_transformer_132kv(
  transformer_type = "132kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",
  mechnism_cond = "Default",
  diverter_contacts = "Default",
  diverter_braids = "Default",
  moisture = "Default",
  acidity = "Default",
  bd_strength = "Default",
  hydrogen = "Default",
  methane = "Default",
  ethylene = "Default",
  ethane = "Default",
  acetylene = "Default",
  hydrogen_pre = "Default",
  methane_pre = "Default",
  ethylene_pre = "Default",
  ethane_pre = "Default",
  acetylene_pre = "Default",
  furfuraldehyde = "Default",
  reliability_factor = "Default"
)
```

Arguments

transformer_type	String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("132kV Transformer (GM)")
year_of_manufacture	Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).
utilisation_pct	Numeric. The max percentage of utilisation under normal operating conditions.
no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 176 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 156, table 178 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 155, table 177 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 93 in CNAIM (2021).

coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 94 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 95 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 96 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 135, table 97 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 98 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 99 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 100 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 101 in CNAIM (2021).
diverter_brands	String. Indicating the observed condition of the selector and diverter brands. Options: diverter_brands = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 136, table 102 in CNAIM (2021).
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.

ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Current probability of failure for a 132kV transformer
pof_transformer_132kv(transformer_type = "132kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
```

```

age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default")

```

pof_transformer_30_60kv

Current Probability of Failure for 30/10kV and 60/10kV Transformers

Description

This function calculates the current annual probability of failure for 30/10kV and 60/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function.

Usage

```

pof_transformer_30_60kv(
  transformer_type = "60kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",

```

```

distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf,
age_tc,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default"
)

```

Arguments

transformer_type

String. A sting that refers to the specific asset category. Options: transformer_type = c("30kV Transformer (GM)", "60kV Transformer (GM)"). The default setting is transformer_type = "60kV Transformer (GM)"

year_of_manufacture

Numeric. Normal expected life depends on the year for manufacture.

utilisation_pct

Numeric. The max percentage of utilisation under normal operating conditions.

no_taps	Numeric. Average number of daily taps (tapchanger).
placement	String. Specify if the asset is located outdoor or indoor.
altitude_m	Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. A setting of "Default" will set the altitude factor to 1 independent of asset_type.
distance_from_coast_km	Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor. A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.
corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default").
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default").
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).

mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default").
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.

reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).
k_value	Numeric. k_value = "0.0454" by default. This number is given in a percentage. The default value is accordingly to the CNAIM standard on p. 110.
c_value	Numeric. c_value = 1.087 by default. The default value is accordingly to the CNAIM standard see page 110
normal_expected_life_tf	Numeric. normal_expected_life_tf = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.
normal_expected_life_tc	Numeric. normal_expected_life_tc = "Default" by default. The default value is accordingly to the CNAIM standard on page 107.

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Examples

```
# Current probability of failure for a 60/10kV transformer
pof_transformer_30_60kv(transformer_type = "60kV Transformer (GM)",
year_of_manufacture = 1980,
utilisation_pct = "Default",
no_taps = "Default",
placement = "Default",
altitude_m = "Default",
distance_from_coast_km = "Default",
corrosion_category_index = "Default",
age_tf = 43,
age_tc = 43,
partial_discharge_tf = "Default",
partial_discharge_tc = "Default",
temperature_reading = "Default",
main_tank = "Default",
coolers_radiator = "Default",
bushings = "Default",
kiosk = "Default",
cable_boxes = "Default",
external_tap = "Default",
internal_tap = "Default",
mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
```

```

ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default",
k_value = 0.454,
c_value = 1.087,
normal_expected_life_tf = "Default",
normal_expected_life_tc = "Default")

```

pof_transformer_33_66kv

Current Probability of Failure for 33/10kV and 66/10kV Transformers

Description

This function calculates the current annual probability of failure for 33/10kV and 66/10kV transformers. The function is a cubic curve that is based on the first three terms of the Taylor series for an exponential function. For more information about the probability of failure function see section 6 on page 34 in CNAIM (2021).

Usage

```

pof_transformer_33_66kv(
  transformer_type = "66kV Transformer (GM)",
  year_of_manufacture,
  utilisation_pct = "Default",
  no_taps = "Default",
  placement = "Default",
  altitude_m = "Default",
  distance_from_coast_km = "Default",
  corrosion_category_index = "Default",
  age_tf,
  age_tc,
  partial_discharge_tf = "Default",
  partial_discharge_tc = "Default",
  temperature_reading = "Default",
  main_tank = "Default",
  coolers_radiator = "Default",
  bushings = "Default",
  kiosk = "Default",
  cable_boxes = "Default",
  external_tap = "Default",
  internal_tap = "Default",

```

```

mechnism_cond = "Default",
diverter_contacts = "Default",
diverter_braids = "Default",
moisture = "Default",
acidity = "Default",
bd_strength = "Default",
hydrogen = "Default",
methane = "Default",
ethylene = "Default",
ethane = "Default",
acetylene = "Default",
hydrogen_pre = "Default",
methane_pre = "Default",
ethylene_pre = "Default",
ethane_pre = "Default",
acetylene_pre = "Default",
furfuraldehyde = "Default",
reliability_factor = "Default"
)

```

Arguments

transformer_type

String. A sting that refers to the specific asset category. See See page 17, table 1 in CNAIM (2021). Options: transformer_type = c("33kV Transformer (GM)", "66kV Transformer (GM)"). The default setting is transformer_type = "66kV Transformer (GM)"

year_of_manufacture

Numeric. Normal expected life depends on the year for manufacture, see page 107 table 20 in CNAIM (2021).

utilisation_pct

Numeric. The max percentage of utilisation under normal operating conditions.

no_taps

Numeric. Average number of daily taps (tapchanger).

placement

String. Specify if the asset is located outdoor or indoor. A setting of "Outdoor" means the asset is located in an outside environment, and a setting of "Indoor" means the asset is located in an indoor environment. A setting of "Default" will result in either an indoor or an outdoor environment setting that depends on the specification of asset_type. See page 110-113, table 26 in CNAIM (2021) for default environments.

altitude_m

Numeric. Specify the altitude location for the asset measured in meters from sea level.altitude_m is used to derive the altitude factor. See page 111, table 23 in CNAIM (2021). A setting of "Default" will set the altitude factor to 1 independent of asset_type.

distance_from_coast_km

Numeric. Specify the distance from the coast measured in kilometers. distance_from_coast_km is used to derive the distance from coast factor See page 110, table 22 in CNAIM (2021). A setting of "Default" will set the distance from coast factor to 1 independent of asset_type.

corrosion_category_index	Integer. Specify the corrosion index category, 1-5.
age_tf	Numeric. The current age in years of the transformer.
age_tc	Numeric. The current age in years of the tapchanger
partial_discharge_tf	String. Indicating the level of partial discharge in the transformer. Options: partial_discharge_tf = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 154, table 173 in CNAIM (2021).
partial_discharge_tc	String. Indicating the level of partial discharge in the tapchanger Options: partial_discharge_tc = c("Low", "Medium", "High (Not Confirmed)", "High (Confirmed)", "Default"). See page 155, table 175 in CNAIM (2021).
temperature_reading	String. Indicating the criticality. Options: temperature_reading = c("Normal", "Moderately High", "Very High", "Default"). See page 154, table 174 in CNAIM (2021).
main_tank	String. Indicating the observed condition of the main tank. Options: main_tank = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 83 in CNAIM (2021).
coolers_radiator	String. Indicating the observed condition of the coolers/radiators. Options: coolers_radiator = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 84 in CNAIM (2021).
bushings	String. Indicating the observed condition of the bushings. Options: bushings = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 131, table 85 in CNAIM (2021).
kiosk	String. Indicating the observed condition of the kiosk. Options: kiosk = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 86 in CNAIM (2021).
cable_boxes	String. Indicating the observed condition of the cable boxes. Options: cable_boxes = c("No Deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 132, table 87 in CNAIM (2021).
external_tap	String. Indicating the observed external condition of the tapchanger. Options: external_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 88 in CNAIM (2021).
internal_tap	String. Indicating the observed internal condition of the tapchanger. Options: internal_tap = c("Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 89 in CNAIM (2021).
mechnism_cond	String. Indicating the observed condition of the drive mechnism. Options: mechnism_cond = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 90 in CNAIM (2021).
diverter_contacts	String. Indicating the observed condition of the selector and diverter contacts. Options: diverter_contacts = c("No deterioration", "Superficial/minor

	deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 133, table 91 in CNAIM (2021).
diverter_braids	String. Indicating the observed condition of the selector and diverter braids. Options: diverter_braids = c("No deterioration", "Superficial/minor deterioration", "Some Deterioration", "Substantial Deterioration", "Default"). See page 134, table 92 in CNAIM (2021)
moisture	Numeric. the amount of moisture given in (ppm) See page 162, table 203 in CNAIM (2021).
acidity	Numeric. the amount of acidity given in (mg KOH/g) See page 162, table 204 in CNAIM (2021).
bd_strength	Numeric. the amount of breakdown strength given in (kV) See page 162, table 205 in CNAIM (2021).
hydrogen	Numeric. Refers to the hydrogen level in the transformer oil. Hydrogen levels are measured in ppm. A setting of "Default" will result in the best possible result.
methane	Numeric. Refers to the methane level in the transformer oil. Methane levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethylene	Numeric. Refers to the ethylene level in the transformer oil. Ethylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
ethane	Numeric. Refers to the ethane level in the transformer oil. Ethane levels are measured in ppm. A setting of "Default" will result in the best possible result.
acetylene	Numeric. Refers to the acetylene level in the transformer oil. Acetylene levels are measured in ppm. A setting of "Default" will result in the best possible result.
hydrogen_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
methane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
ethane_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
acetylene_pre	Numeric. Previous results. A setting of "Default" will result in the best possible result.
furfuraldehyde	Numeric. Refers to the furfuraldehyde level in the transformer oil. furfuraldehyde levels are measured in ppm. A setting of "Default" will result in the best possible result.
reliability_factor	Numeric. reliability_factor shall have a value between 0.6 and 1.5. A setting of "Default" sets the reliability_factor to 1. See section 6.14 on page 73 in CNAIM (2021).

Value

DataFrame Current probability of failure per annum per kilometer along with current health score.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

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	<i>Calculates risk and converts to matrix coordinates</i>
------------------	---

Description

This function calculates risk matrix coordinates dimensions.

Usage

```
risk_calculation(  
  matrix_dimensions,  
  id,  
  chs,  
  cof,  
  asset_type,  
  hi_bands = NULL,  
  ci_bands = NULL  
)
```

Arguments

matrix_dimensions	
id	A data frame with the dimensions of the desired risk matrix.
chs	An integer that identifies the asset
cof	The Current Health Score (CHS) of the asset
asset_type	The Consequence of Failure of the asset
hi_bands	The asset type to be calculated for class
ci_bands	Specific Health Index (HI) bands for risk matrix. Default values are the same as defined in the CNAIM v2.1 standard
	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)
```

Arguments

location_risk	String Type Financial factor criteria for 0.4kV board (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 0.4kV board setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for 0.4kV board

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_board_04kv(
  location_risk = "Default",
  type_risk = "Default")
```

```
safety_cof_cables_04_10kv
```

Safety cost of Failure for 0.4kV and 10kV UG Cables

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_cables_04_10kv(hv_asset_category)
```

Arguments

```
hv_asset_category
```

String The type of HV asset category hv_asset_category = c("10kV UG Cable (Oil)", "10kV UG Cable (Non Pressurised)", "0.4kV UG Cable (Non Pressurised)").

Value

Numeric. Financial consequences of failure for 0.4kV and 10kV UG cables

Examples

```
safety_cof_cables_04_10kv(hv_asset_category = "10kV UG Cable (Oil)")
```

safety_cof_cables_60_30kv

Safety cost of Failure for 30-60 kV UG cables

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.
`#' ehv_asset_category = c("30kV UG Cable (Gas)", "60kV UG Cable (Gas)", "30kV UG Cable (Non Pressurised)", "60kV UG Cable (Non Pressurised)", "30kV UG Cable (Oil)", "60kV UG Cable (Oil)")`. The default setting is `ehv_asset_category = "60kV UG Cable (Gas)"`.

Usage

```
safety_cof_cables_60_30kv(ehv_asset_category)
```

Arguments

```
ehv_asset_category
    Asset category for analysis
```

Value

Numeric. Financial consequences of failure for 30-60 kV UG cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_cables_60_30kv(ehv_asset_category = "30kV UG Cable (Oil)")
```

safety_cof_ehv_cables *Safety cost of Failure for EHV UG cables & 132 kV UG cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_ehv_cables(ehv_asset_category)
```

Arguments

ehv_asset_category

String The type of EHV cable distribution asset category Options: ehv_asset_category = c("33kV UG Cable (Oil)", "33kV UG Cable (Gas)", "33kV UG Cable (Non Pressurised)", "66kV UG Cable (Oil)", "66kV UG Cable (Gas)", "66kV UG Cable (Non Pressurised)", "132kV UG Cable (Oil)", "132kV UG Cable (Gas)", "132kV UG Cable (Non Pressurised)").

Value

Numeric. Financial consequences of failure for EEHV UG cables & 132 kV UG cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_ehv_cables(ehv_asset_category = "33kV UG Cable (Oil)")
```

```
safety_cof_ehv_fittings
```

Safety cost of Failure for EHV/132kV Fittings

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_ehv_fittings(ehv_asset_category, location_risk, type_risk)
```

Arguments

ehv_asset_category

String The type of EHV asset category Options: ehv_asset_category = c("33kV Fittings", "66kV Fittings", "132kV Fittings")

location_risk

String Type Financial factor criteria for EHV fittings (cf. section D1.2.1, page 178, CNAIM, 2021). location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".

type_risk

String. Asses Financial factor criteria for EHV fittings setting (cf. table 221, page 180, CNAIM, 2021). type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for EHV fittings

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_ehv_fittings(ehv_asset_category = "33kV Fittings",
location_risk = "Default",
type_risk = "Default")
```

```
safety_cof_ehv_switchgear
```

Safety cost of Failure for EHV swithgear & 132kV CB

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_ehv_switchgear(ehv_asset_category, location_risk, type_risk)
```

Arguments

`ehv_asset_category`

String The type of EHV swithgear & 132kV CB Options: `ehv_asset_category = c("33kV CB (Air Insulated Busbars)(ID)(GM)", "33kV CB (Air Insulated Busbars)(OD)(GM)", "33kV CB (Gas Insulated Busbars)(ID)(GM)", "33kV CB (Gas Insulated Busbars)(OD)(GM)", "33kV RMU", "33kV Switch (GM)", "66kV CB (Air Insulated Busbars)(ID)(GM)", "66kV CB (Air Insulated Busbars)(OD)(GM)", "66kV CB (Gas Insulated Busbars)(ID)(GM)", "66kV CB (Gas Insulated Busbars)(OD)(GM)")`

`location_risk`

String Type Financial factor criteria for EHV swithgear & 132kV CB (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

`type_risk`

String. Asses Financial factor criteria for EHV swithgear & 132kV CB setting (cf. table 221, page 180, CNAIM, 2021). Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

Value

Numeric. Financial consequences of failure for EHV swithgear & 132kV CB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_ehv_switchgear(ehv_asset_category = "33kV RMU",
location_risk = "Default",
type_risk = "Default")
```

safety_cof_hv_switchgear_distribution

Safety cost of Failure for HV Switchgear Distribution

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safetyr consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

Usage

```
safety_cof_hv_switchgear_distribution(
  hv_asset_category,
  location_risk,
  type_risk
)
```

Arguments

hv_asset_category	String The type of HV switchgear distribution asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Secondary", "6.6/11kV RMU", "6.6/11kV X-type RMU", "6.6/11kV Switch (GM)", "20kV CB (GM) Secondary", "20kV RMU", "20kV Switch (GM)")
location_risk	String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for HV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_hv_switchgear_distribution(  
hv_asset_category = "6.6/11kV CB (GM) Secondary",  
location_risk = "Default",  
type_risk = "Default")
```

safety_cof_hv_switchgear_primary

Safety cost of Failure for HV Switchgear Primary

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

Usage

```
safety_cof_hv_switchgear_primary(hv_asset_category, location_risk, type_risk)
```

Arguments

hv_asset_category	String The type of HV asset category Options: hv_asset_category = c("6.6/11kV CB (GM) Primary", "20kV CB (GM) Primary")
location_risk	String Type Financial factor criteria for HV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for HV switchgear setting (cf. table 218, page 176, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for HV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_lv_switchgear_primary(
  hv_asset_category = "6.6/11kV CB (GM) Primary",
  location_risk = "Default",
  type_risk = "Default")
```

```
safety_cof_lv_switchgear_and_other
```

Safety cost of Failure for LV switchgear and others

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_lv_switchgear_and_other(lv_asset_category, location_risk, type_risk)
```

Arguments

<code>lv_asset_category</code>	String The type of LV asset category Options: <code>lv_asset_category = c("LV Board (WM)", "LV Board (X-type Network) (WM)", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)")</code>
<code>location_risk</code>	String Type Financial factor criteria for LV switchgear (cf. section D1.2.1, page 178, CNAIM, 2021). Options: <code>location_risk = c("Low", "Medium", "High")</code> . The default setting is <code>location_risk = "Medium"</code> .
<code>type_risk</code>	String. Asses Financial factor criteria for LV switchgear setting (cf. table 221, page 180, CNAIM, 2021). Options: <code>type_risk = c("Low", "Medium", "High")</code> . The default setting is <code>type_risk = "Medium"</code> .

Value

Numeric. Financial consequences of failure for LV switchgear

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_lv_switchgear_and_other(lv_asset_category = "LV Board (WM)",
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_lv_ugb	<i>Safety cost of Failure for LV UGB</i>
-------------------	--

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_lv_ugb(lv_asset_category, location_risk, type_risk)
```

Arguments

lv_asset_category	String The type of LV asset category Option: lv_asset_category = "LV UGB"
location_risk	String Type Financial factor criteria for LV UGB (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for LV UGB setting (cf. table 221, page 178, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for LV UGB

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_lv_ugb(lv_asset_category = "LV UGB", location_risk = "Default", type_risk = "Default")
```

safety_cof_ohl_cond *Safety cost of Failure for Overhead Line Conductors*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

Usage

```
safety_cof_ohl_cond(ohl_cond_asset_category, location_risk, type_risk)
```

Arguments

ohl_cond_asset_category String The type of Pole asset category Options: `ohl_cond_asset_category = c("33kV OHL (Tower Line) Conductor", "66kV OHL (Tower Line) Conductor", "132kV OHL (Tower Line) Conductor")`.

location_risk String Type Financial factor criteria for Overhead Line Conductors (cf. section D1.2.1, page 178, CNAIM, 2021). `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

type_risk String. Asses Financial factor criteria for Overhead Line Conductors setting (cf. table 221, page 180, CNAIM, 2021). `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

Value

Numeric. Safety consequences of failure for Overhead Line Conductors

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_ohl_cond(  
  ohl_cond_asset_category = "33kV OHL (Tower Line) Conductor",  
  location_risk = "Default",  
  type_risk = "Default")
```

safety_cof_ohl_cond_50kv

Safety cost of Failure for 50kV Overhead Line Conductors

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_ohl_cond_50kv(location_risk, type_risk)
```

Arguments

location_risk String Type Financial factor criteria for Overhead Line Conductors Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".

type_risk String. Asses Financial factor criteria for Overhead Line Conductors Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for Overhead Line Conductors

Examples

```
safety_cof_ohl_cond_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_ohl_fittings_50kv

Safety cost of Failure for 50kV Fittings

Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

Usage

```
safety_cof_ohl_fittings_50kv(location_risk, type_risk)
```

Arguments

location_risk	String Type Financial factor criteria for 50kV fittings Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 50kV fittings setting Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for EHV fittings

Examples

```
safety_cof_ohl_fittings_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_pillar_04kv

Safety cost of Failure for 0.4kV Pillar

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Out-putted in DKK

Usage

```
safety_cof_pillar_04kv(location_risk, type_risk)
```

Arguments

location_risk	String Type Financial factor criteria for 0.4kV Pillar (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for 0.4kV Pillar setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for 0.4kV Pillar

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_pillar_04kv(
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_poles	<i>Safety cost of Failure for Pole</i>
------------------	--

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_poles(pole_asset_category, location_risk, type_risk)
```

Arguments

pole_asset_category	String The type of pole asset category Options: pole_asset_category = c("LV Poles", "6.6/11kV Poles", "20kV Poles", "33kV Pole", "66kV Pole").
location_risk	String Type Financial factor criteria for Pole (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for pole setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for poles

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_poles(pole_asset_category = "33kV Pole",
  location_risk = "Default",
  type_risk = "Default")
```

 safety_cof_poles_ohl_support_50kv

Safety cost of Failure for Poles OHL Support 50kV

Description

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage

```
safety_cof_poles_ohl_support_50kv(
  pole_asset_category,
  location_risk,
  type_risk
)
```

Arguments

pole_asset_category	String The type of Pole asset category
location_risk	String Type Financial factor criteria for Pole Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for pole setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for poles

Examples

```
safety_cof_poles_ohl_support_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

 safety_cof_relay

Safety cost of Failure for Relays

Description

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage

```
safety_cof_relay(location_risk, type_risk)
```

Arguments

`location_risk` String Type Financial factor criteria for 50kV fittings Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

`type_risk` String. Asses Financial factor criteria for 50kV fittings setting Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

Value

Numeric. Financial consequences of failure for relay

Examples

```
safety_cof_relay(  
  location_risk = "Default",  
  type_risk = "Default")
```

`safety_cof_serviceline`

Safety cost of Failure for Service Lines

Description

This function calculates safety consequences of failure Outputted in DKK

Usage

```
safety_cof_serviceline()
```

Value

Numeric. Financial consequences of failure for service line

Examples

```
safety_cof_serviceline()
```

`safety_cof_submarine_cables_10kv`*Safety cost of Failure for 10kV Submarine Cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage`safety_cof_submarine_cables_10kv()`**Value**

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples`safety_cof_submarine_cables_10kv()`

`safety_cof_submarine_cables_30_60kv`*Safety cost of Failure for 30kV and 60kV Submarine Cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage`safety_cof_submarine_cables_30_60kv()`**Value**

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_submarine_cables_30_60kv()
```

safety_cof_sub_cables *Safety cost of Failure for Sub cables*

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_sub_cables(sub_cable_asset_category)
```

Arguments

```
sub_cable_asset_category  
String The type of Submarine cable asset category Options: sub_cable_asset_category  
= c("HV Sub Cable", "EHV Sub Cable", "132kV Sub Cable").
```

Value

Numeric. Safety consequences of failure for Sub cables

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_sub_cables(sub_cable_asset_category = "HV Sub Cable")
```

 safety_cof_switchgear_30_60kv

Safety cost of Failure for 30kV and 60kV Switchgear

Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

Usage

```
safety_cof_switchgear_30_60kv(ehv_asset_category, location_risk, type_risk)
```

Arguments

ehv_asset_category

String The type of 30kV and 60kV switchgear Options: ehv_asset_category = c("30kV", "60kV").

location_risk

String Type Financial factor criteria for 30kV and 60kV switchgear Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".

type_risk

String. Asses Financial factor criteria for 30kV and 60kV switchgear setting. Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Financial consequences of failure for 30kV and 60kV switchgear

Examples

```
safety_cof_switchgear_30_60kv(ehv_asset_category = "30kV",
location_risk = "Default",
type_risk = "Default")
```

 safety_cof_switchgear_primary_10kv

Safety cost of Failure for 10kV Switchgear Primary

Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#). Outputted in DKK.

Usage

```
safety_cof_switchgear_primary_10kv(location_risk, type_risk)
```

Arguments

location_risk String Type Financial factor criteria for 10kV switchgear Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

type_risk String. Asses Financial factor criteria for 10kV switchgear setting. Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

Value

Numeric. Financial consequences of failure for HV switchgear

Examples

```
safety_cof_switchgear_primary_10kv(
  location_risk = "Default",
  type_risk = "Default")
```

```
safety_cof_switchgear_secondary_10kv
```

Safety cost of Failure for 10 kV Switchgear Secondary

Description

This function calculates safety consequences of failure. Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage

```
safety_cof_switchgear_secondary_10kv(location_risk, type_risk)
```

Arguments

location_risk String Type Financial factor criteria for 10kV switchgear secondary (cf. section D1.2.1, page 178, CNAIM, 2021). Options: `location_risk = c("Low", "Medium", "High")`. The default setting is `location_risk = "Medium"`.

type_risk String. Asses Financial factor criteria for 10kV switchgear secondary setting. Options: `type_risk = c("Low", "Medium", "High")`. The default setting is `type_risk = "Medium"`.

Value

Numeric. Financial consequences of failure for 10kV switchgear secondary

Examples

```
safety_cof_switchgear_secondary_10kv(
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_towers	<i>Safety cost of Failure for tower</i>
-------------------	---

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_towers(tower_asset_category, location_risk, type_risk)
```

Arguments

tower_asset_category	String The type of tower asset category Options: tower_asset_category = c("33kV Tower", "66kV Tower", "132kV Tower").
location_risk	String Type Financial factor criteria for tower (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for tower setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for towers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_towers(tower_asset_category = "33kV Tower",
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_tower_ohl_support_50kv

Safety cost of Failure for Tower OHL Support 50 kV

Description

This function calculates safety consequences of failure Safety consequences of failure is used in the derivation of consequences of failure see `cof()`. Outputted in DKK.

Usage

```
safety_cof_tower_ohl_support_50kv(location_risk, type_risk)
```

Arguments

location_risk	String Type Financial factor criteria for tower Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for tower Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for tower ohl support 50 kV

Examples

```
safety_cof_tower_ohl_support_50kv(
  location_risk = "Default",
  type_risk = "Default")
```

safety_cof_transformers

Safety cost of Failure for Transformer

Description

This function calculates safety consequences of failure (cf. section 7.3, page 79, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see `cof()`.

Usage

```
safety_cof_transformers(tf_asset_category, location_risk, type_risk)
```

Arguments

tf_asset_category	String The type of Transformer asset category Options: tf_asset_category = c("6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Transformer (GM)", "66kV Transformer (GM) " "132kV Transformer (GM) ").
location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for Transformers

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
safety_cof_transformers(tf_asset_category = "33kV Transformer (GM)",
location_risk = "Default",
type_risk = "Default")
```

safety_cof_transformer_30_60kv

Safety cost of Failure for 30/10kv and 60/10kv Transformer

Description

This function calculates safety consequences of failure Outputted in DKK.

Usage

```
safety_cof_transformer_30_60kv(tf_asset_category, location_risk, type_risk)
```

Arguments

tf_asset_category	String The type of Transformer Options: tf_asset_category = c("30kV Transformer (GM)", "60kV Transformer (GM)").
-------------------	--

location_risk	String Type Financial factor criteria for Transformer (cf. section D1.2.1, page 178, CNAIM, 2021). Options: location_risk = c("Low", "Medium", "High"). The default setting is location_risk = "Medium".
type_risk	String. Asses Financial factor criteria for Transformer setting (cf. table 221, page 180, CNAIM, 2021). Options: type_risk = c("Low", "Medium", "High"). The default setting is type_risk = "Medium".

Value

Numeric. Safety consequences of failure for Transformers

Examples

```
safety_cof_transformer_30_60kv(tf_asset_category = "30kV Transformer (GM)",
location_risk = "Default",
type_risk = "Default")
```

s_cof_swg_tf_ohl	<i>Safety Consequences of Failure for Switchgears, Transformers & Overhead Lines</i>
------------------	--

Description

This function calculates safety consequences of failure for switchgear, transformers and overhead lines (cf. section 7.4, page 80, CNAIM, 2021). Safety consequences of failure is used in the derivation of consequences of failure see [cof\(\)](#).

Usage

```
s_cof_swg_tf_ohl(
  type_risk = "Default",
  location_risk = "Default",
  asset_type_scf
)
```

Arguments

type_risk	String. Risk that the asset presents to the public by its characteristics and particular situation. Options: type_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".
location_risk	String. Proximity to areas that may affect its likelihood of trespass or interference. Options: location_risk = c("Low", "Medium", "High", "Default") (cf. table 225, page 183, CNAIM, 2021). A setting of "Default" equals a setting of "Medium".

asset_type_scf String. Options: asset_type_scf = c("LV Poles", "LV Circuit Breaker", "LV Pillar (ID)", "LV Pillar (OD at Substation)", "LV Pillar (OD not at a Substation)", "LV Board (WM)", "LV UGB", "LV Board (X-type Network) (WM)", "6.6/11kV Poles", "20kV Poles", "6.6/11kV CB (GM) Primary", "6.6/11kV CB (GM) Secondary", "6.6/11kV Switch (GM)", "6.6/11kV RMU", "6.6/11kV X-type RMU", "20kV CB (GM) Primary", "20kV CB (GM) Secondary", "20kV Switch (GM)", "20kV RMU", "6.6/11kV Transformer (GM)", "20kV Transformer (GM)", "33kV Pole", "66kV Pole", "33kV OHL (Tower Line) Conductor", "33kV Tower", "33kV Fittings", "66kV OHL (Tower Line) Conductor", "66kV Tower", "66kV Fittings", "33kV CB (Air Insulated Busbars)(ID) (GM)", "33kV CB (Air Insulated Busbars)(OD) (GM)", "33kV CB (Gas Insulated Busbars)(ID) (GM)", "33kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Switch (GM)", "33kV RMU", "66kV CB (Air Insulated Busbars)(ID) (GM)", "66kV CB (Air Insulated Busbars)(OD) (GM)", "66kV CB (Gas Insulated Busbars)(ID) (GM)", "66kV CB (Gas Insulated Busbars)(OD) (GM)", "33kV Transformer (GM)", "66kV Transformer (GM)", "132kV OHL (Tower Line) Conductor", "132kV Tower", "132kV Fittings", "132kV CB (Air Insulated Busbars)(ID) (GM)", "132kV CB (Air Insulated Busbars)(OD) (GM)", "132kV CB (Gas Insulated Busbars)(ID) (GM)", "132kV CB (Gas Insulated Busbars)(OD) (GM)", "132kV Transformer (GM)")

Value

Numeric. Safety consequences of failure for switchgear, transformers and overhead lines.

Source

DNO Common Network Asset Indices Methodology (CNAIM), Health & Criticality - Version 2.1, 2021: https://www.ofgem.gov.uk/sites/default/files/docs/2021/04/dno_common_network_asset_indices_methodology_v2.1_final_01-04-2021.pdf

Examples

```
# Safety consequences failure for a 6.6/11 kV transformer
s_cof_swg_tf_ohl(type_risk = "Default", location_risk = "Default",
  asset_type_scf = "6.6/11kV Transformer (GM)")
```

train_weibull_model *Training function for Weibull model*

Description

This function uses transformer fault statistics data to train a Weibull model: Based on the environmental factors determining a transformer's expected lifetime, the set of all data points is first partitioned into five parts. Then a multilinear estimate for the expected lifetime of a transformer is trained for each part separately, and the corresponding Weibull shape and scale parameters for the five parts are estimated. The function returns the shape and scale parameters needed for the function `predict_weibull_model()`.

Usage

```
train_weibull_model(transformer_faults_data)
```

Arguments

transformer_faults_data

Data frame. Contains past data on transformer faults, together with environmental factors. Must contain the following fields: utilisation_pct: Numeric or "Default", placement: "Indoor", "Outdoor" or "Default", altitude_m: Numeric or "Default", distance_from_coast_km: Numeric or "Default", corrosion_category_index: Numeric or "Default", partial_discharge: "Low", "Medium", "High (Not Confirmed)", "High (Confirmed)" or "Default", oil_acidity: Numeric or "Default", temperature_reading: "Normal", "Moderately High", "Very High" or "Default", observed_condition: "No deterioration", "Superficial/minor deterioration", "Slight Deterioration", "Some deterioration", "Substantial deterioration" or "Default" age: Numeric

Value

Data frame. All shape and scale parameters needed for the function `predict_weibull_model()`.

Source

<https://www.cnaim.io/docs/fault-analysis/>

Examples

```
train_weibull_model(transformer_faults_data = transformer_11kv_faults)
```

transformer_11kv_faults

Failure statistics dataset for 10,000 6.6/11kV transformers

Description

A dataset containing failure statistics for 10,000 6.6/11kV transformers from the CNAIM standard, simulated over 100 years. The variables are as follows:

Usage

```
transformer_11kv_faults
```


Format

A data frame with 103,848 rows and 13 variables:

- utilisation_pct** Utilization of a transformer in %
- placement** Is the transformer placed indoors or outdoors?
- altitude_m** Altitude above sea level (m)
- distance_from_coast_km** Distance from salt water (km)
- corrosion_category_index** Corrosion zone the asset exists in
- partial_discharge** Condition converted from TEV %-measurement
- oil_acidity** Oil acidity (mg KOH/g)
- temperature_reading** Temperature condition band
- observed_condition** Observed condition band
- age** Age of transformer (years)
- pof** Probability of failure (current and future) when the transformer failed
- transformer_id** Id of transformer that died
- dead** Monte carlo result showing if the transformer has died (TRUE)

Source

<https://www.cnaim.io/>

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