SA Technical Service

for

ABCD Corporation

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Company Profile & Task Force

Key Operations

UniteTek will corporate with System Assurance Operation Plan of ABCD Corporation to provide the following operation services:

- System assurance plan of power supply system

Excerpt: Target Value of Safety, Reliability, Availability, and Maintainability of power supply system, coordination, negotiation…..

- Hazard analysis of power supply system

Excerpt: Hazard Control, Hazard and Operability study, HAZOP, Hazard Analysis Reports, Hazard Log……..

- Safety analysis of power supply system

Excerpt: Data of Hazard Analyses, Quantified Risk Assessment, Safety Target…..

- Reliability analysis of power supply system

Excerpt: Reliability Analyses of Third Rail and 22kV/380V Transformer, Reliability Analysis Modeling, Single Line Diagram, MTTF (Mean Time To Failure)…..

- Availability analysis of power supply system

Excerpt: Availability Analyses of Third Rail and 22kV/380V Transformer, MTBF (Mean Time Between Failure)…..

- Mmaintainability analysis of power supply system)

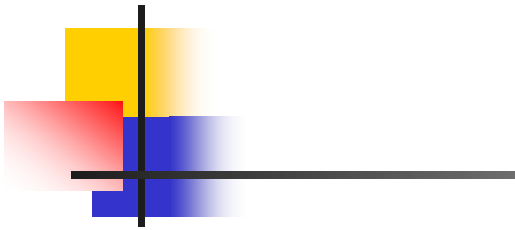
Excerpt: lognormal distribution, tmedian, and Error Factor of GIS, Gas Insulated Switch, 161kV/22kV Transformer, Rectifier, Ring Main Unit, 22kV/380V Transformer, Rectifier-Transformer, Diesel emergency Generator, Breaker…….

- FMECA of power supply system

Excerpt: Failure Modes, Effects, and Criticality Analysis, Failure rate information……

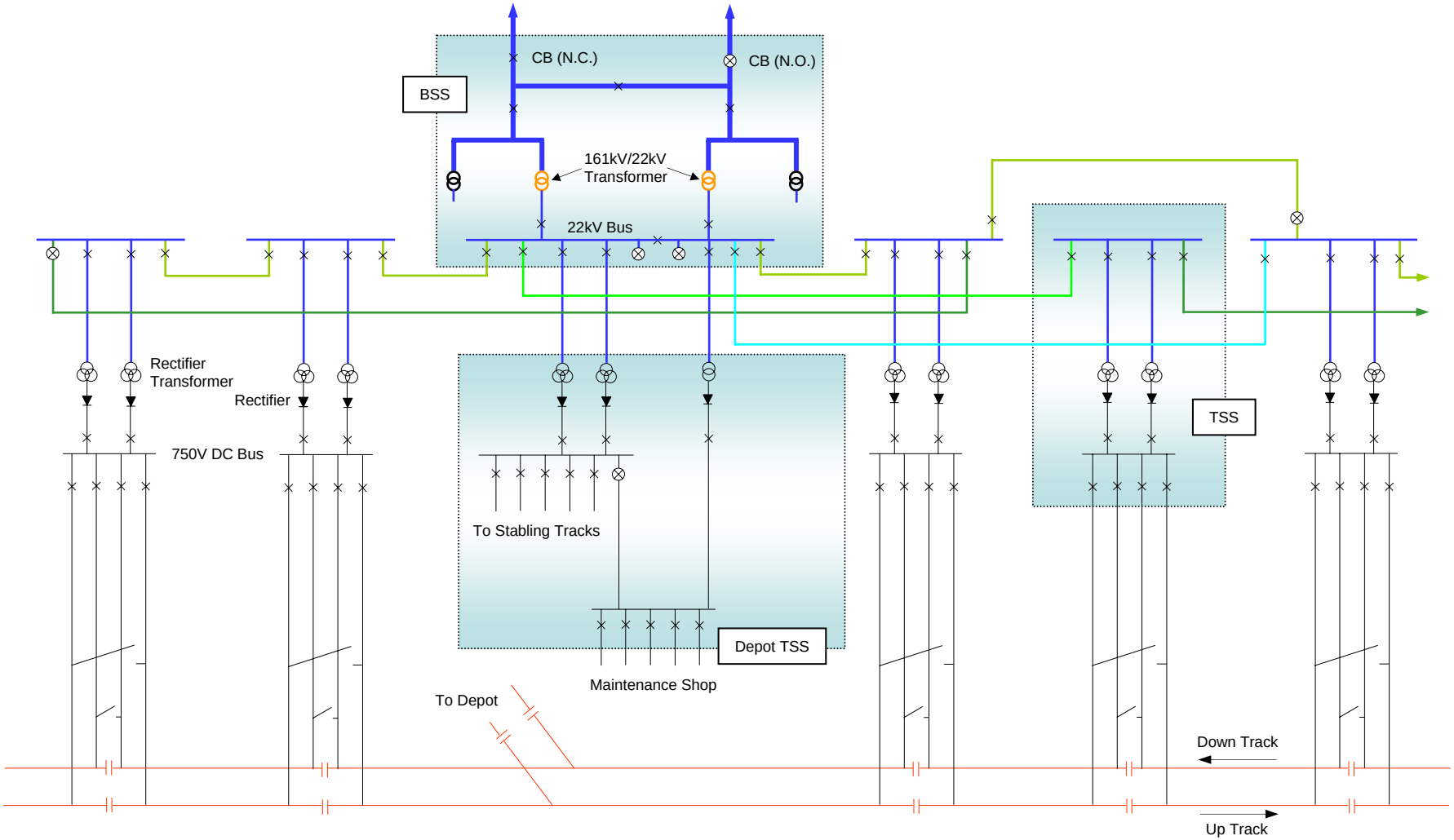
Deliverables

(Total 16 reports, wherein title, issuing date, and detail description are all reserved.)

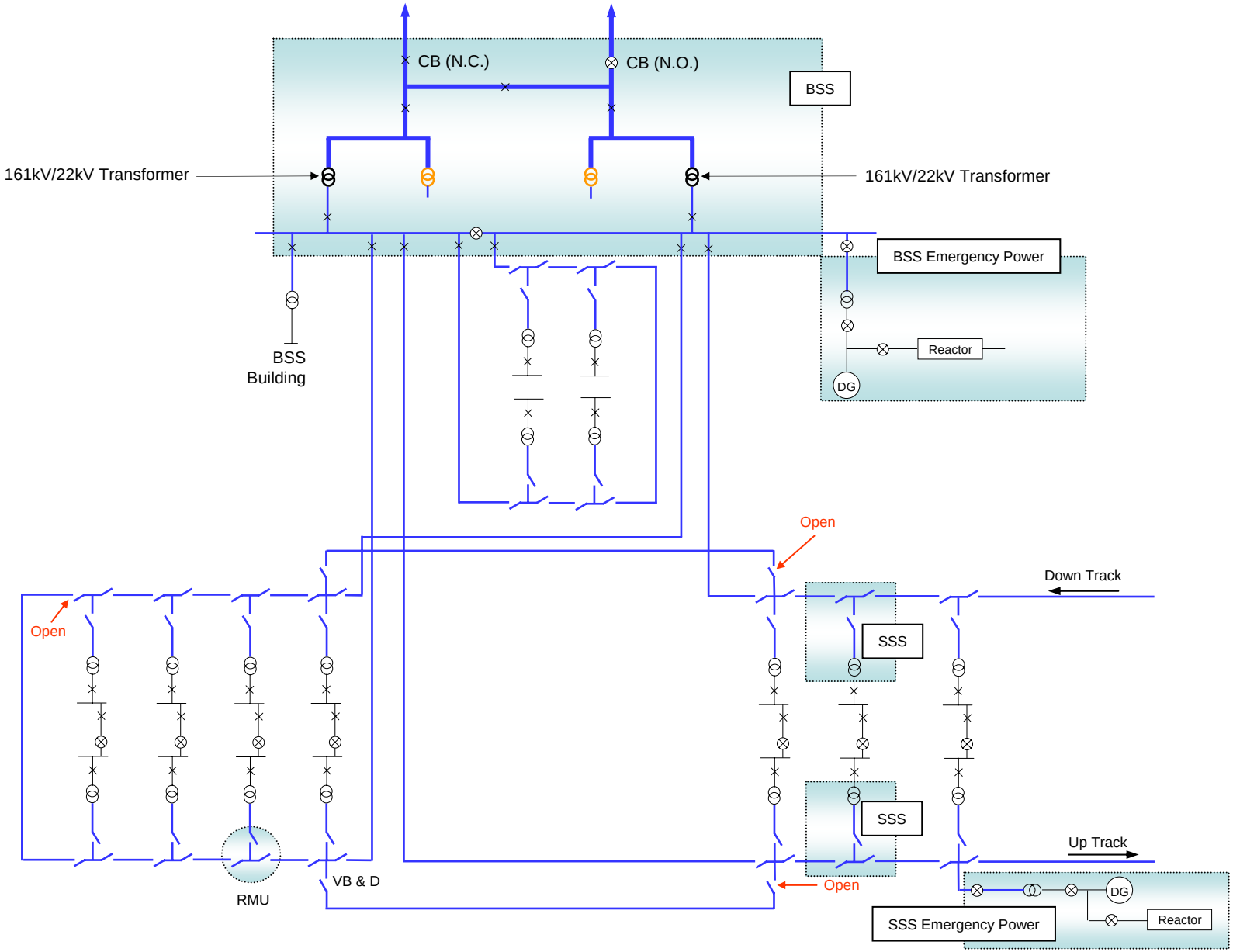


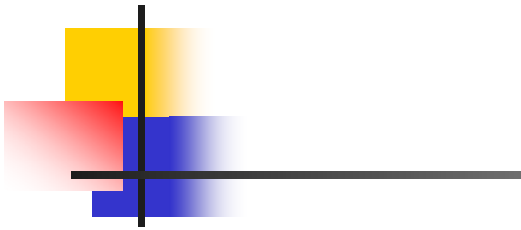
Introduction of Power Supply System

- Traction Power supply



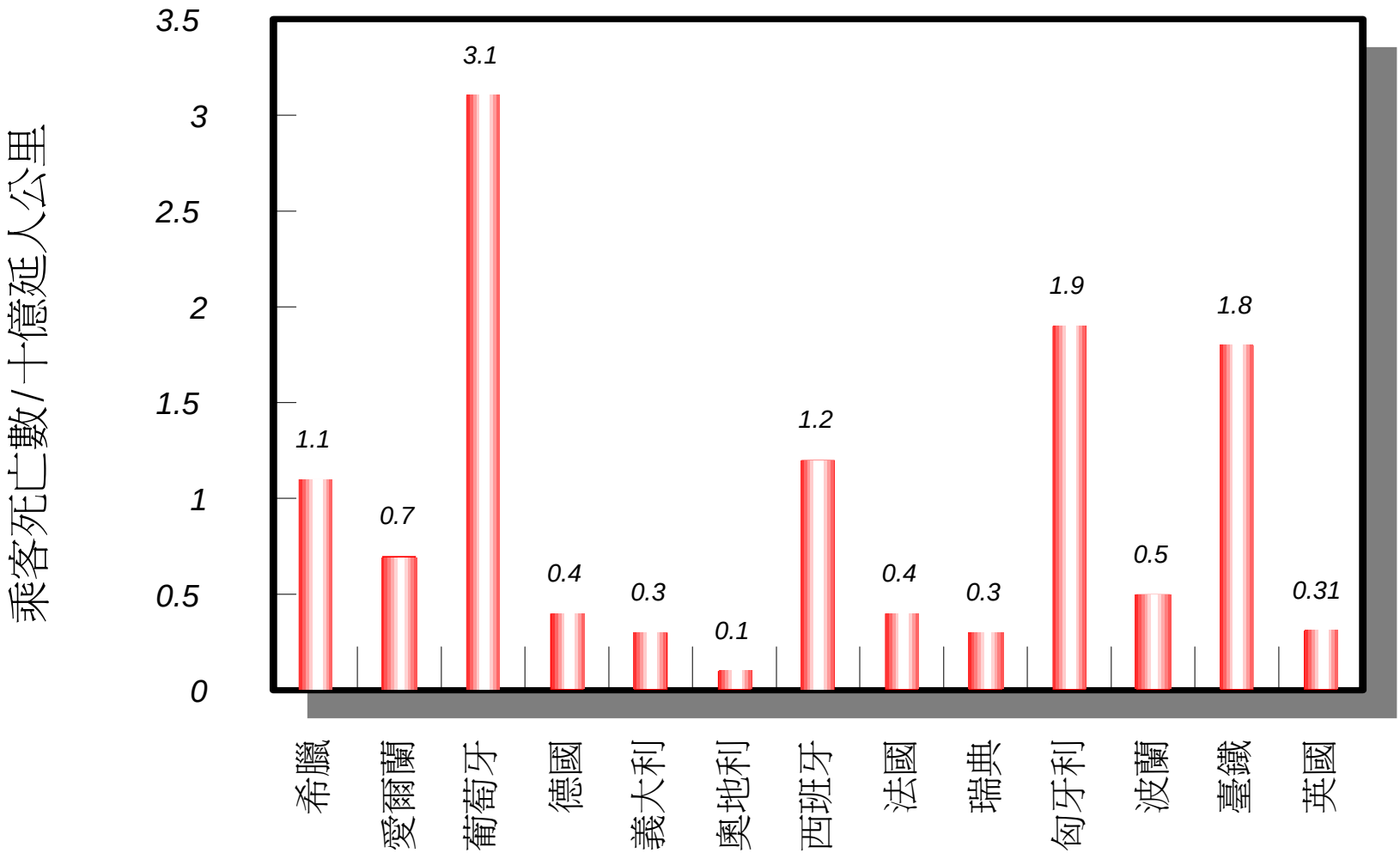
- # Station Service Power supply





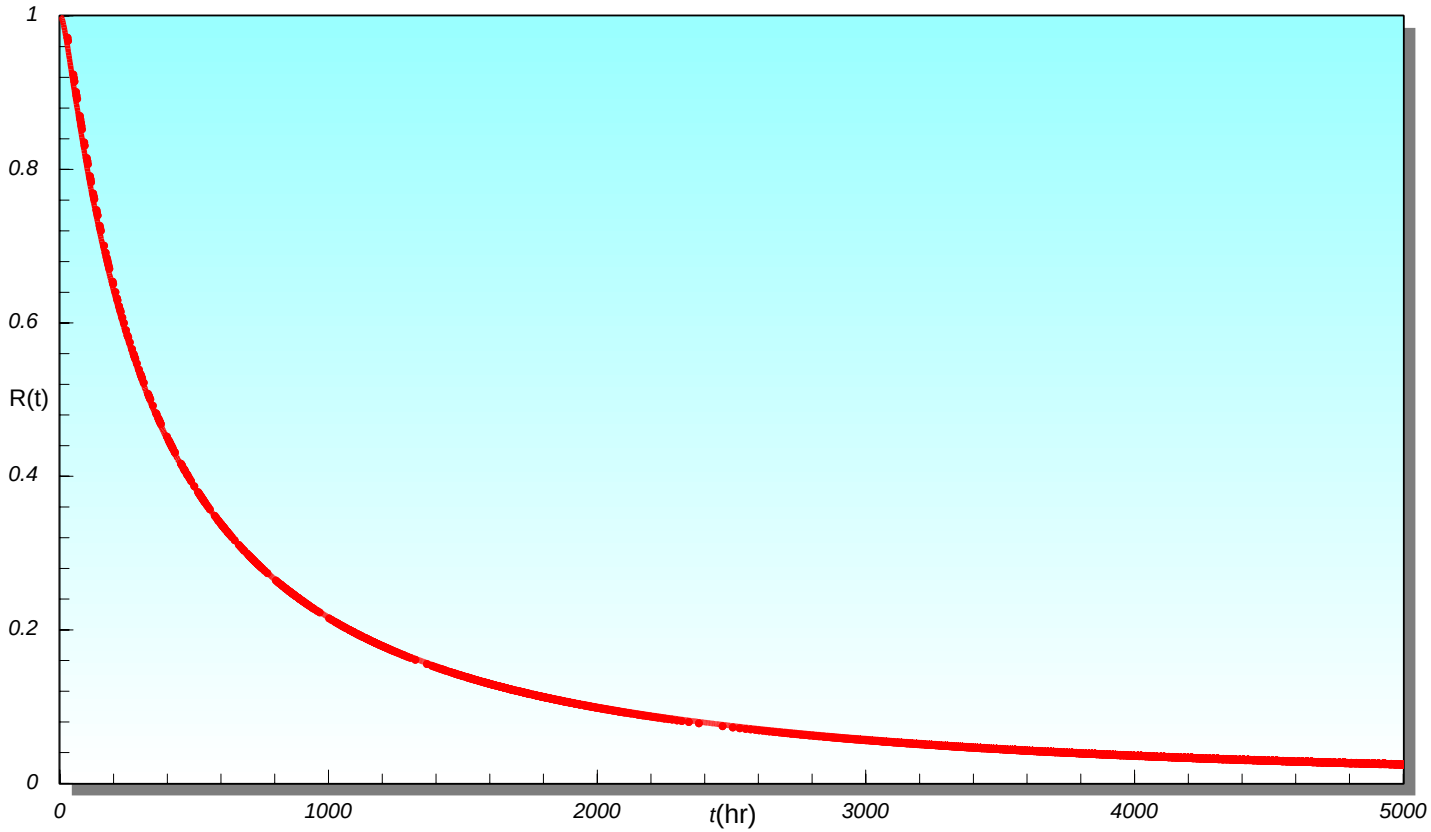
RAMS introduction

Safety


乘客死亡數/十億延人公里
3.5
3
2.5
2
1.5
1
0.5
0
1.1
0.7
3.1
0.4
0.3
0.1
1.2
0.4
0.3
1.9
0.5
1.8
0.31
希臘
愛爾蘭
葡萄牙
德國
義大利
奧地利
西班牙
法國
瑞典
匈牙利
波蘭
臺鐵
英國

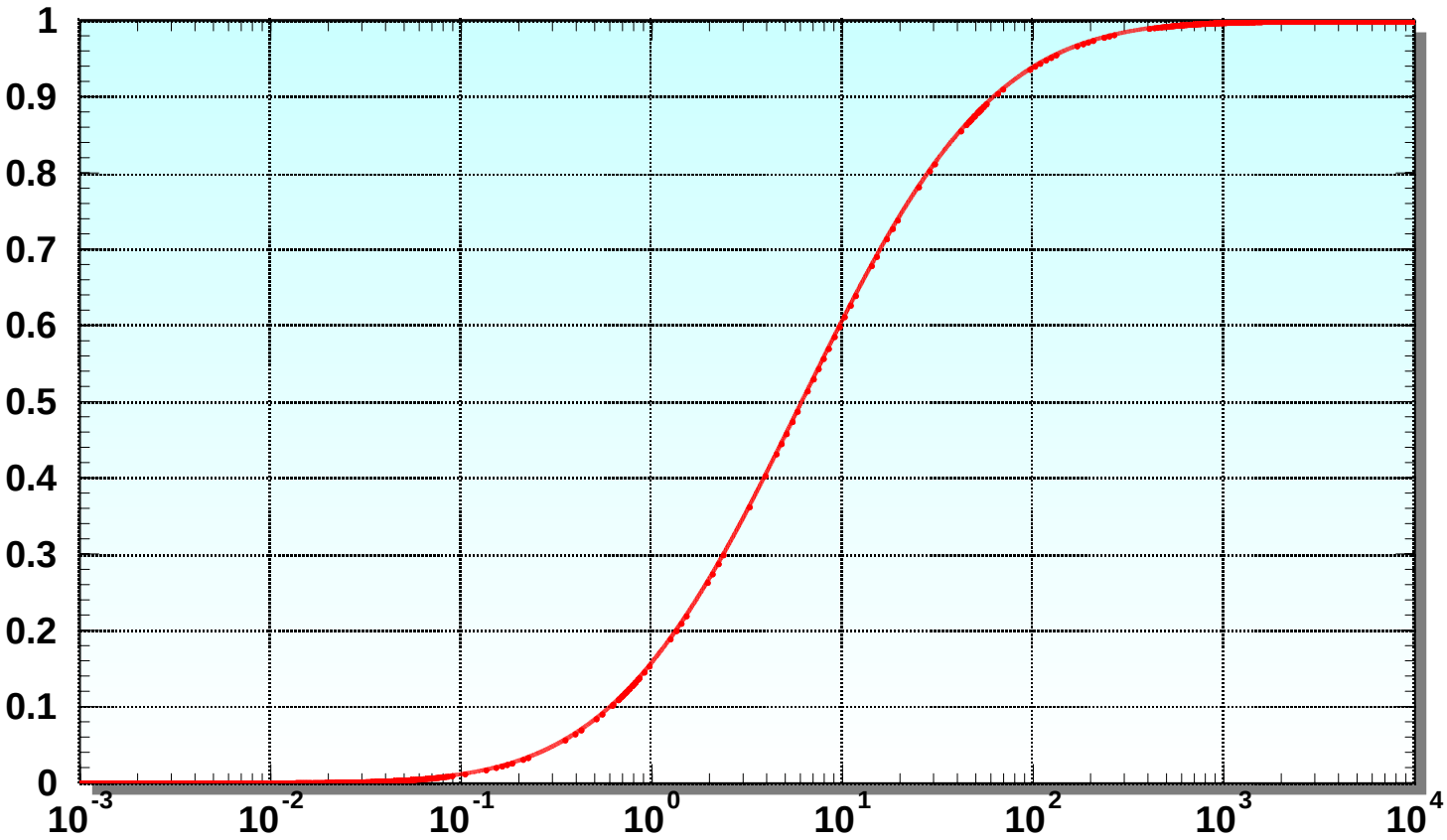
Reliability

- $R(0) = 1$
- $R(\infty) = 0$
- monodecrese
- $0 \leq R(t) \leq 1 \quad for \quad 0 \leq t < \infty$
- MTTF



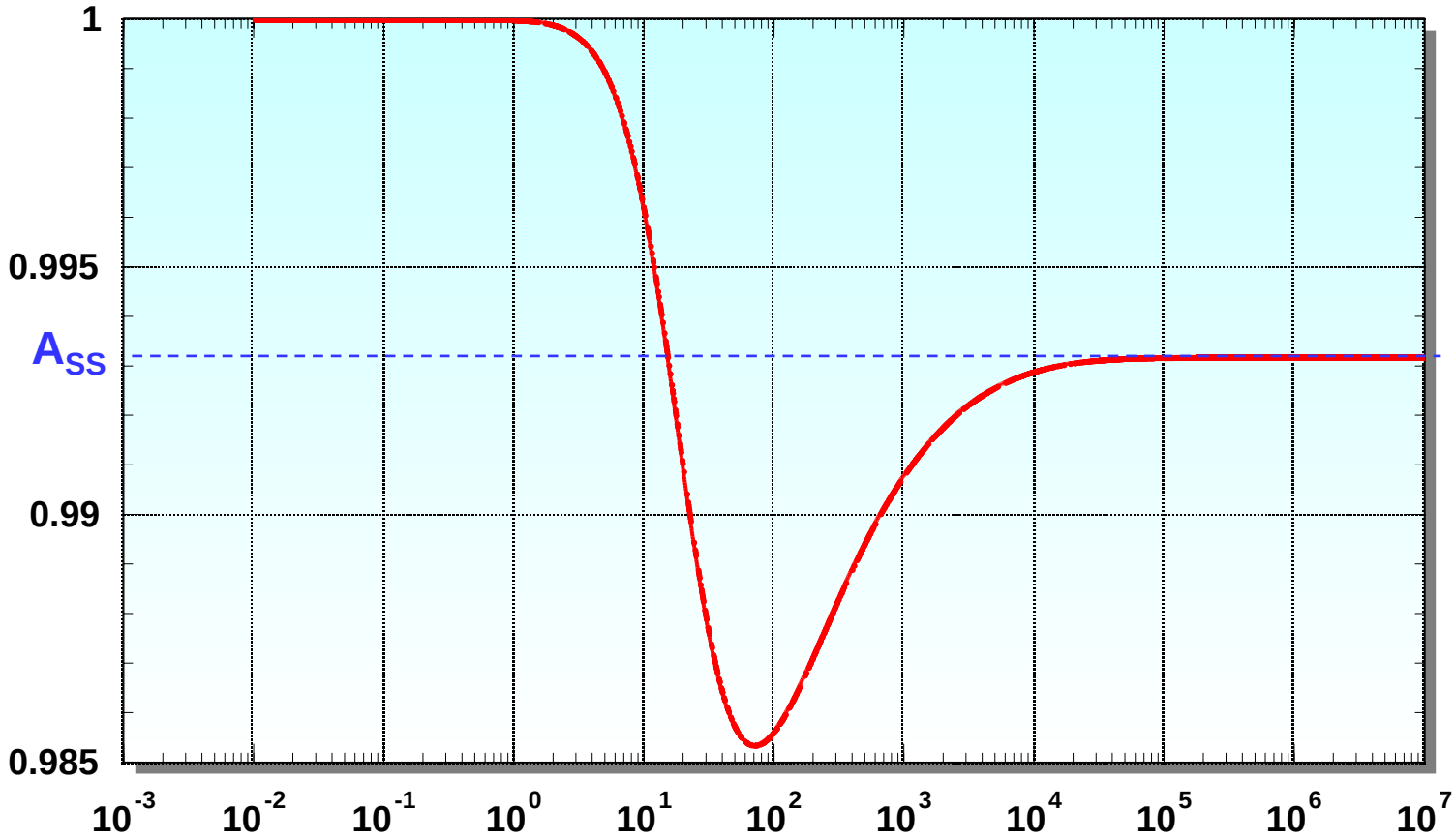
Maintainability

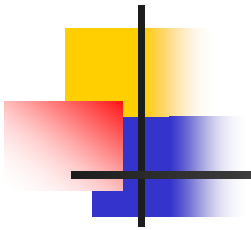
- $M(0) = 0$
- $M(\infty) = 1$
- mono-increase
- $0 \leq M(t) \leq 1$ *for* $0 \leq t < \infty$
- MTTR



Availability

- $A(t) = f(R(t), M(t))$
- $0 \leq A(t) \leq 1$
- $A(0)=1$
- $A_{ss}=MTTF/(MTTF+MTTR)$





Reliability Analysis

of

Station Service Loads

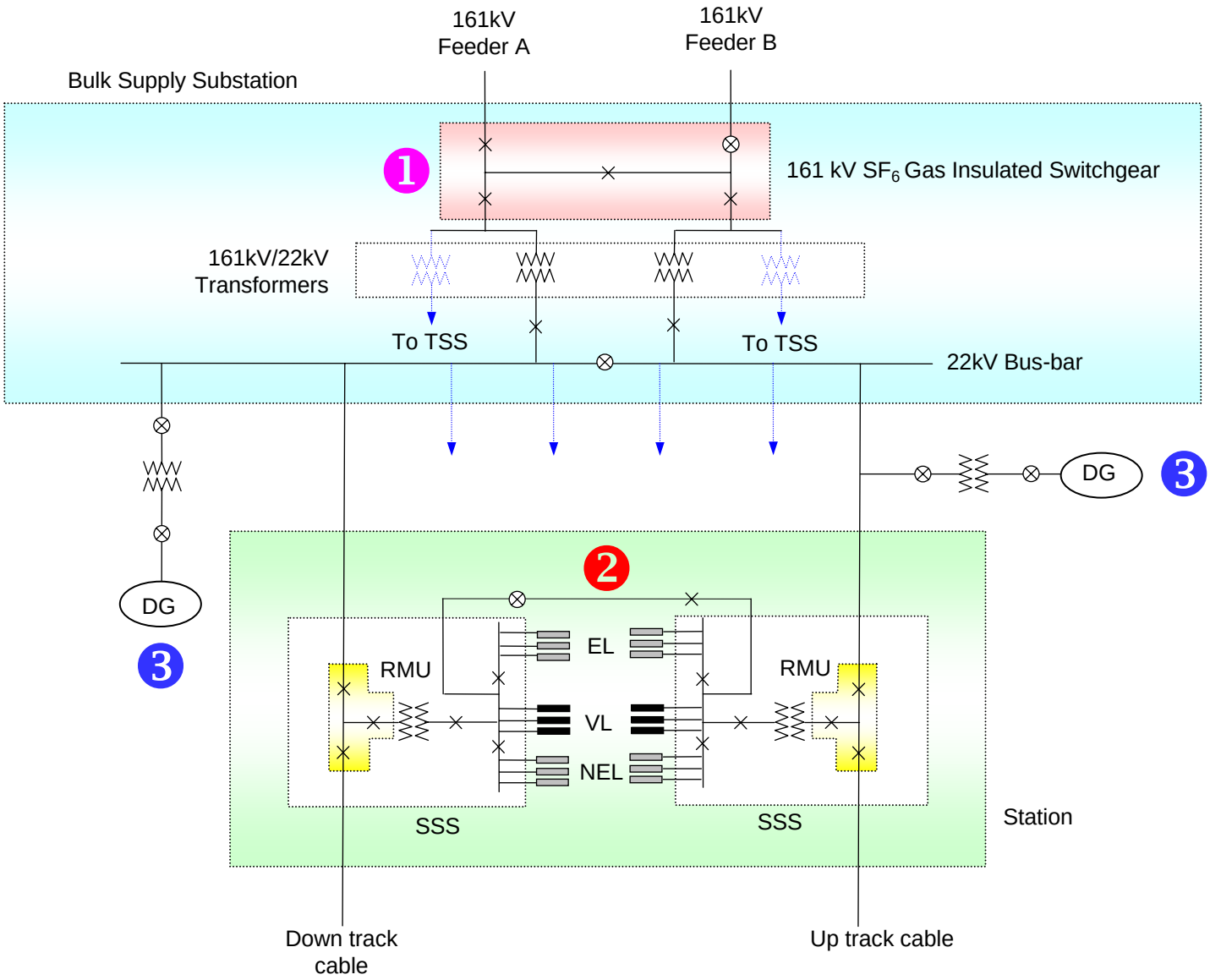
- Reliability Definition:

Electricity structure

The probability that an item can perform a required function under given conditions for a given time interval.

Power supply to NEL, EL or VL

- Station Service Loads



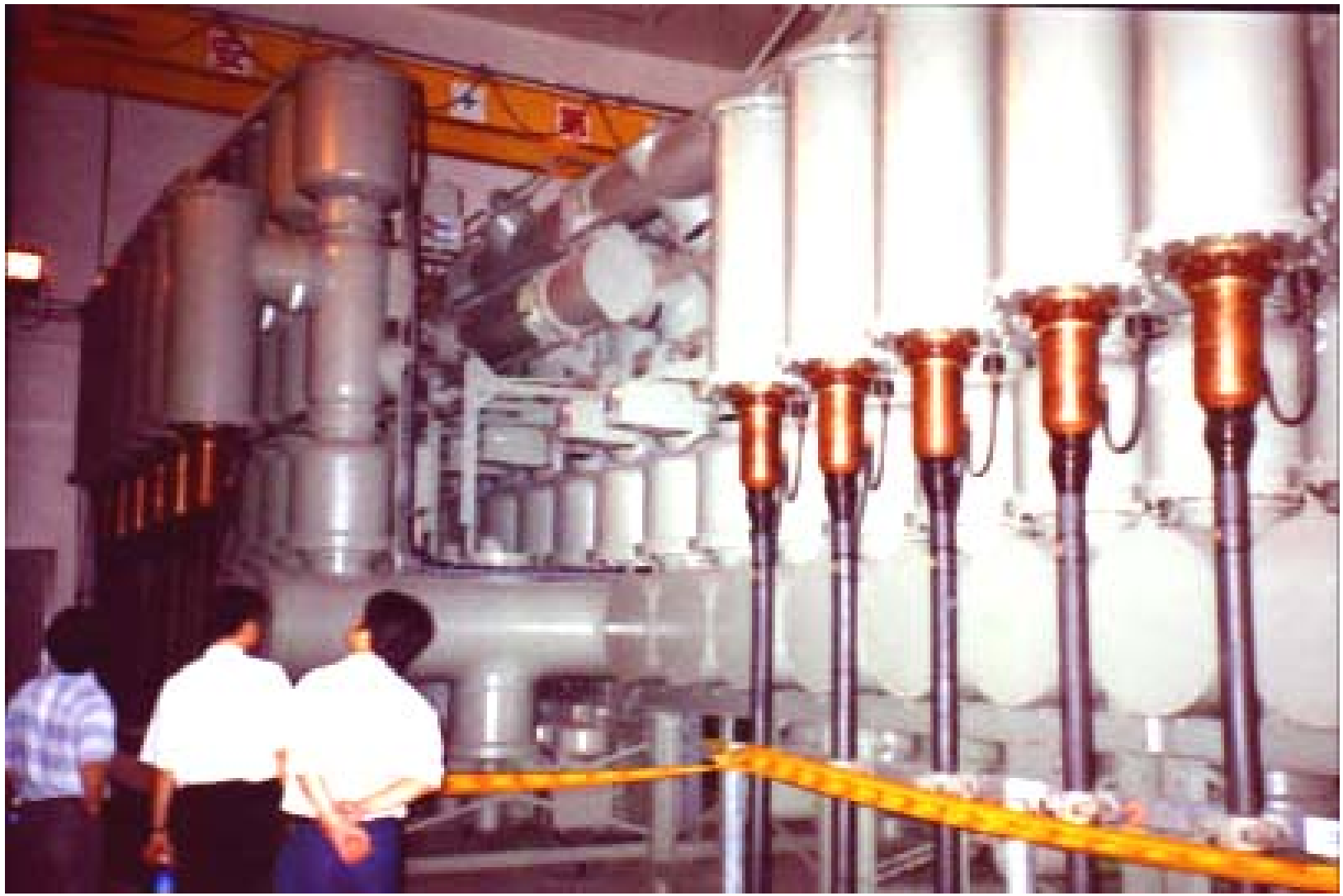
- Power Supply Logics

❶ 161kV redundancy configuration of ‘h’

❷ 380V bus tie-in connection

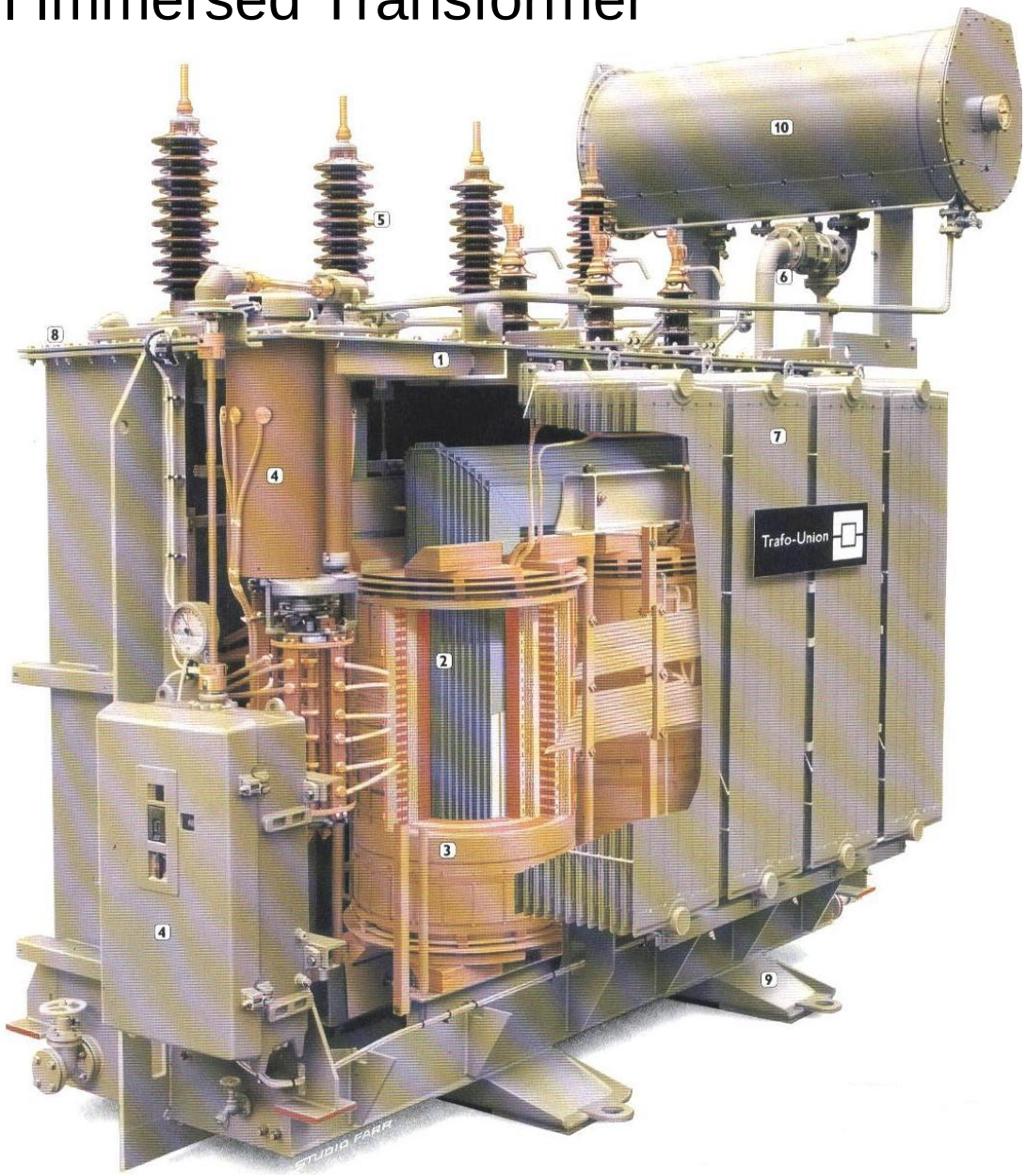
❸ D/G back-up power supply

161 kV SF_6 Gas Insulated Switchgear



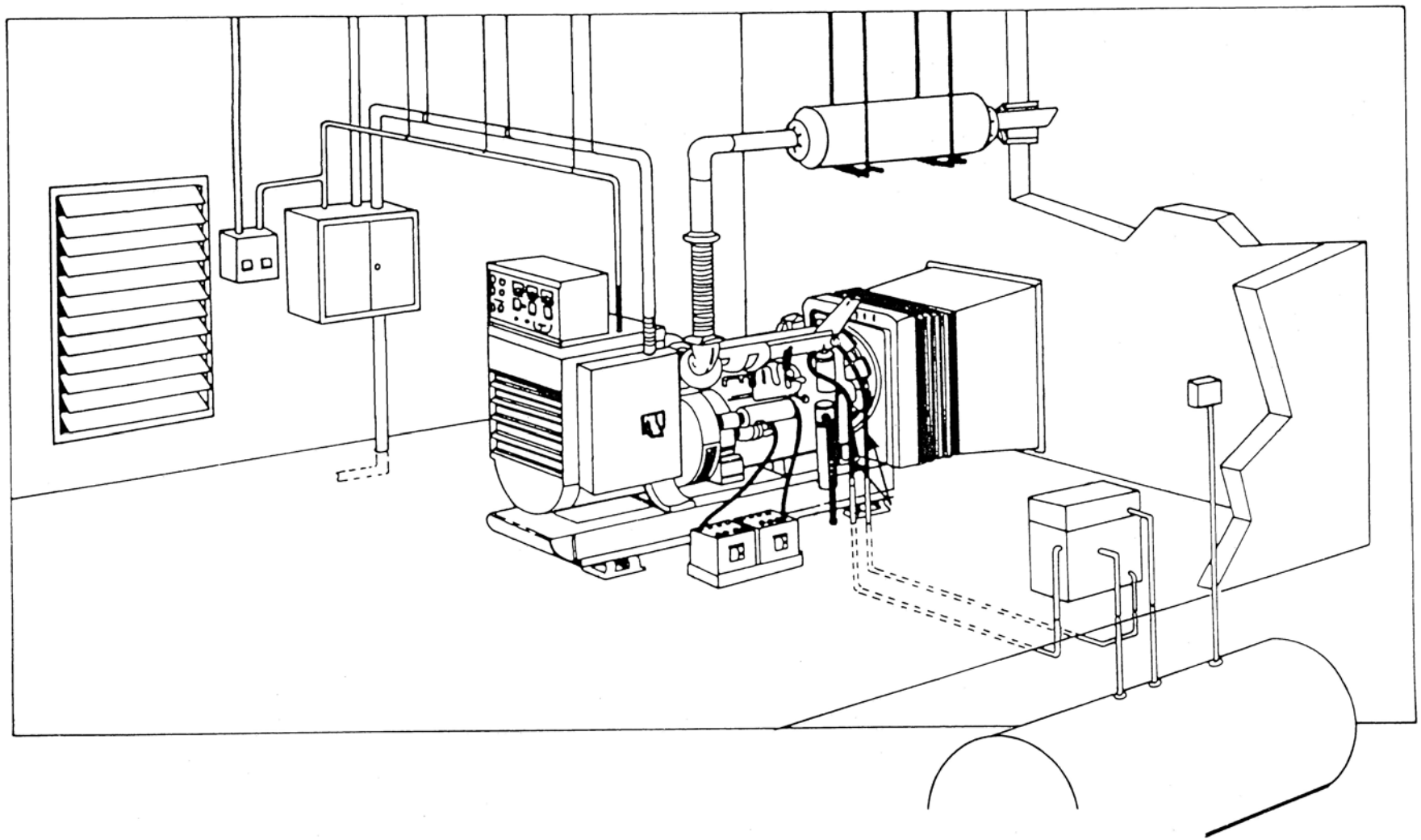
161kV/22kV Oil Immersed Transformer

161kV/22kV Oil Immersed Transformer

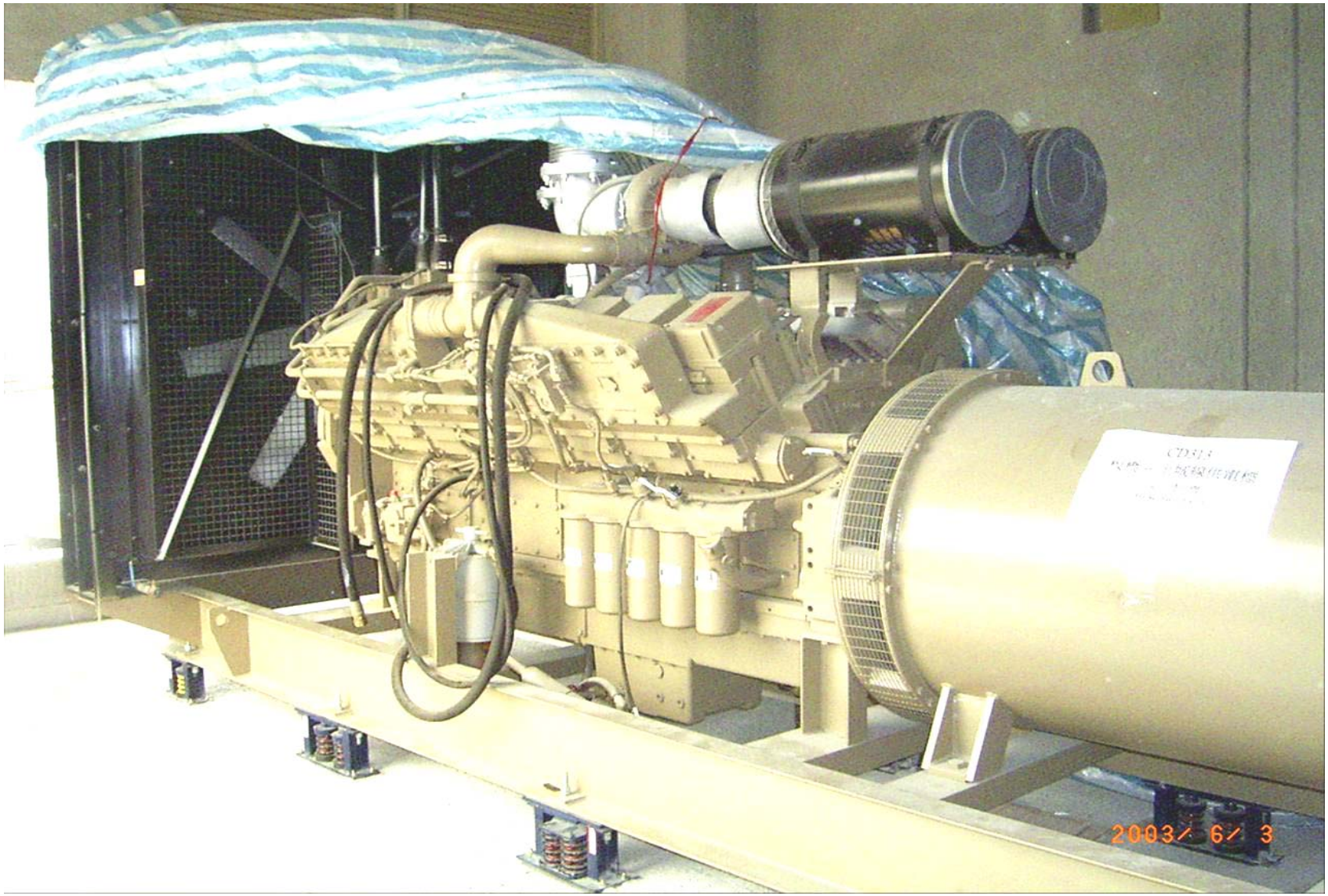


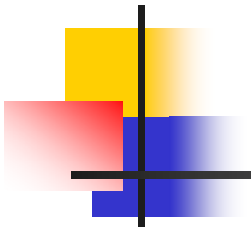
Ring Main Unit (RMU)

Diesel Generator, DG



Diesel Generator, DG





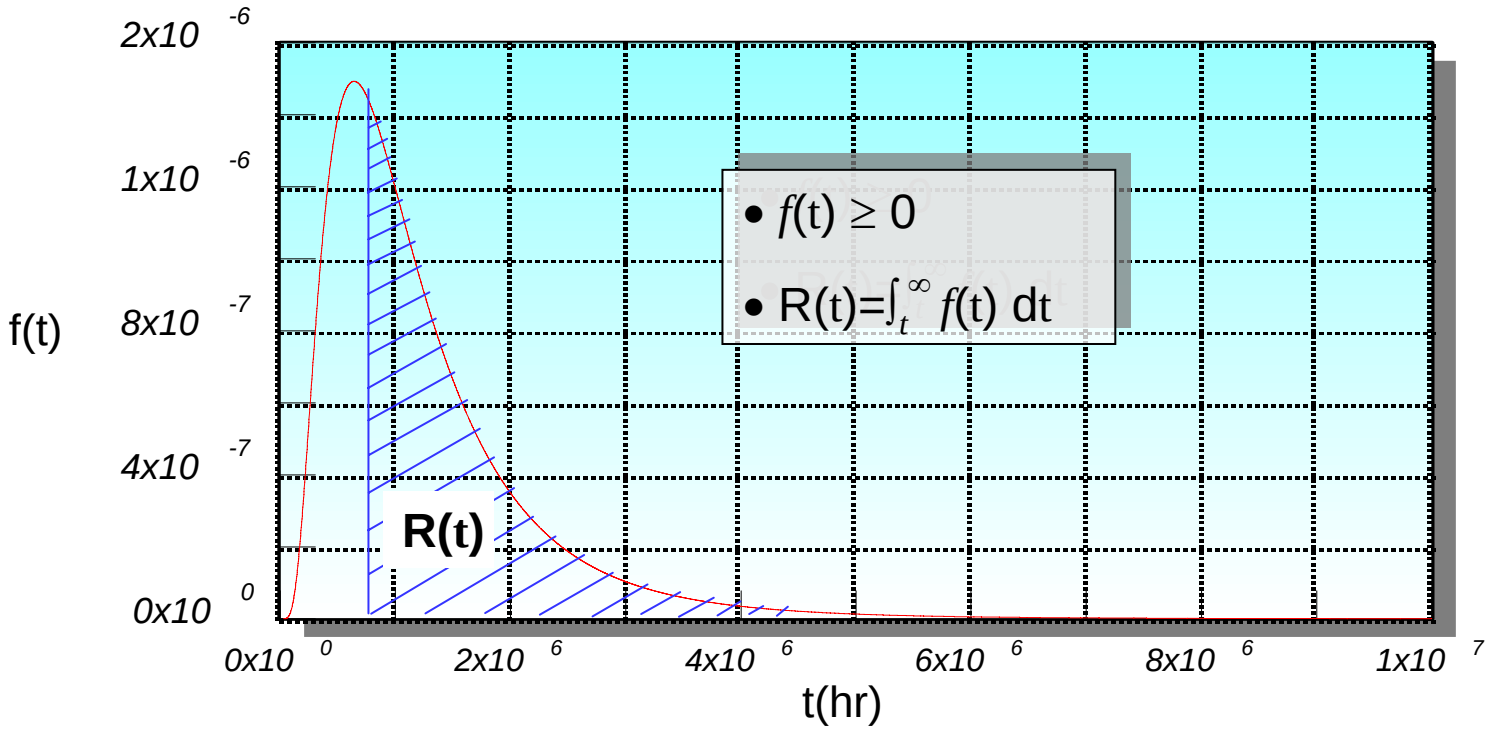
Component Reliability Behaviors

$$f(t) = e^{-\frac{(\ln t / t_{median})^2}{2(\ln EF / 1.645)^2}} \Big/ t \cdot (\ln EF / 1.645) \cdot \sqrt{2\pi}$$

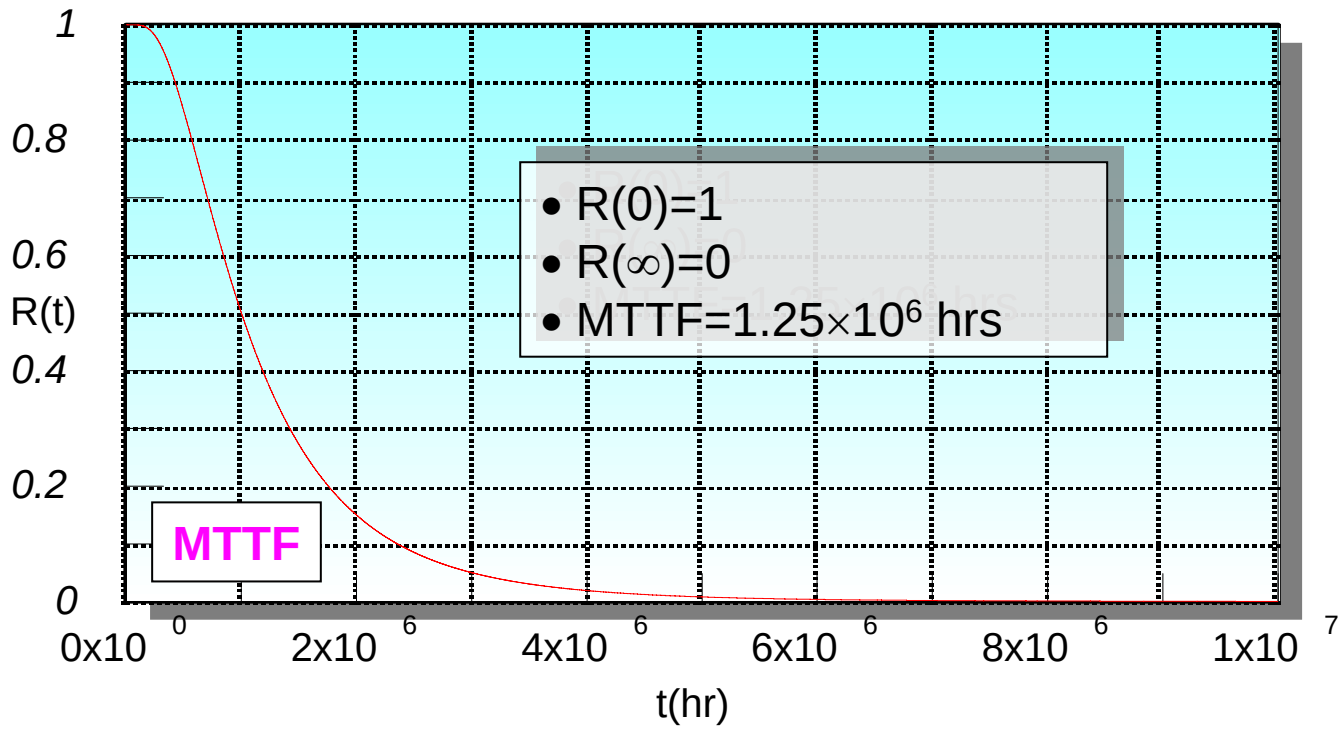
$$R(t) = 1 - \int_0^t f(t)dt = \frac{1}{2}\left[1 - erf\left(\frac{\ln t / t_{median}}{(\ln EF / 1.645) \cdot \sqrt{2}}\right)\right]$$

$$MTTF = \int_0^\infty t\, f(t)\, dt = t_{median} \cdot e^{(\ln EF / 1.645)^2 / 2}$$

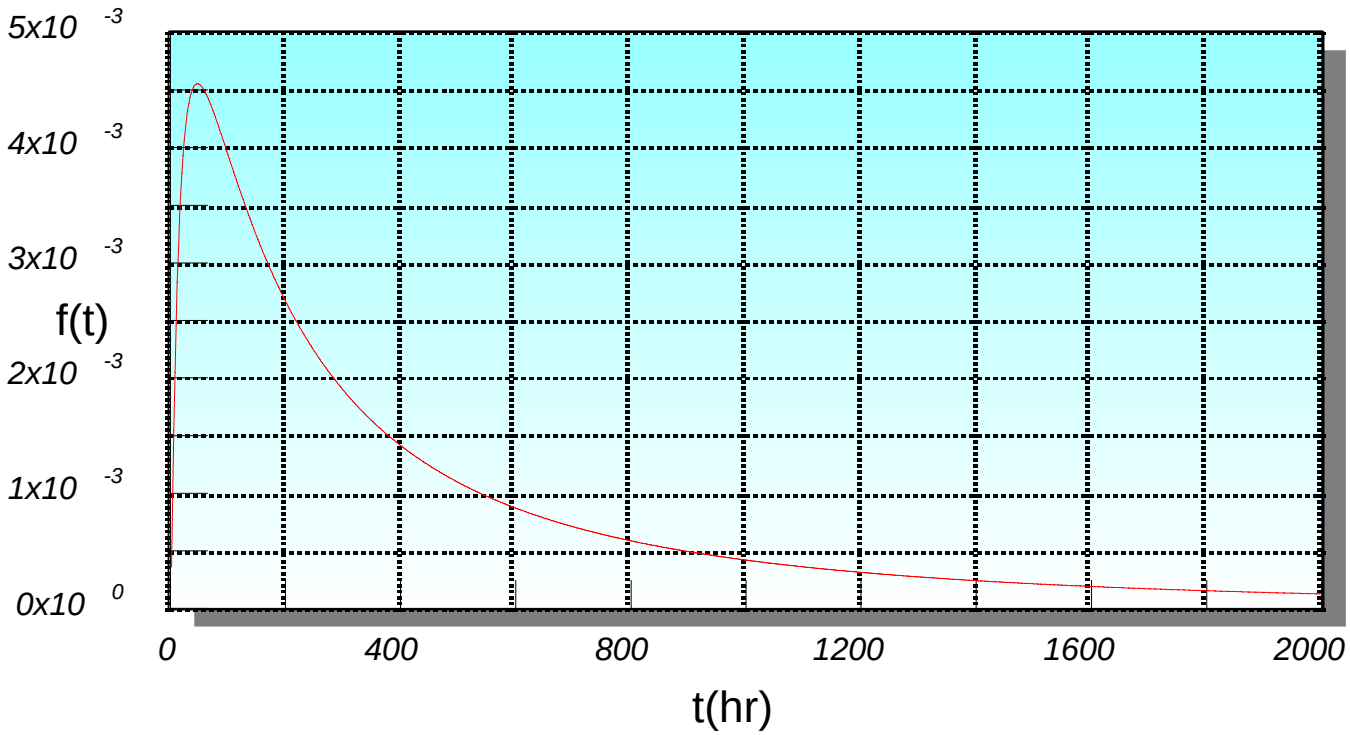
Failure probability density function, f(t) of Circuit Breaker



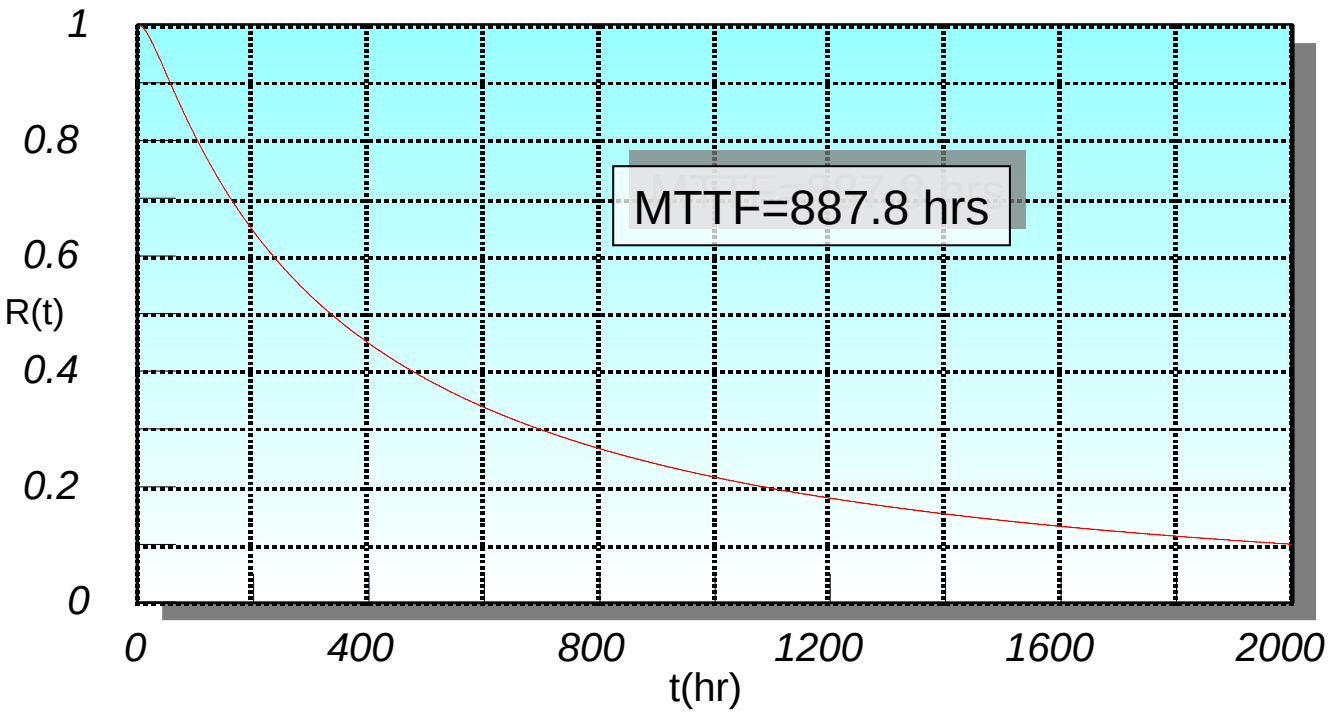
Reliability, $R(t)$ of Circuit Breaker



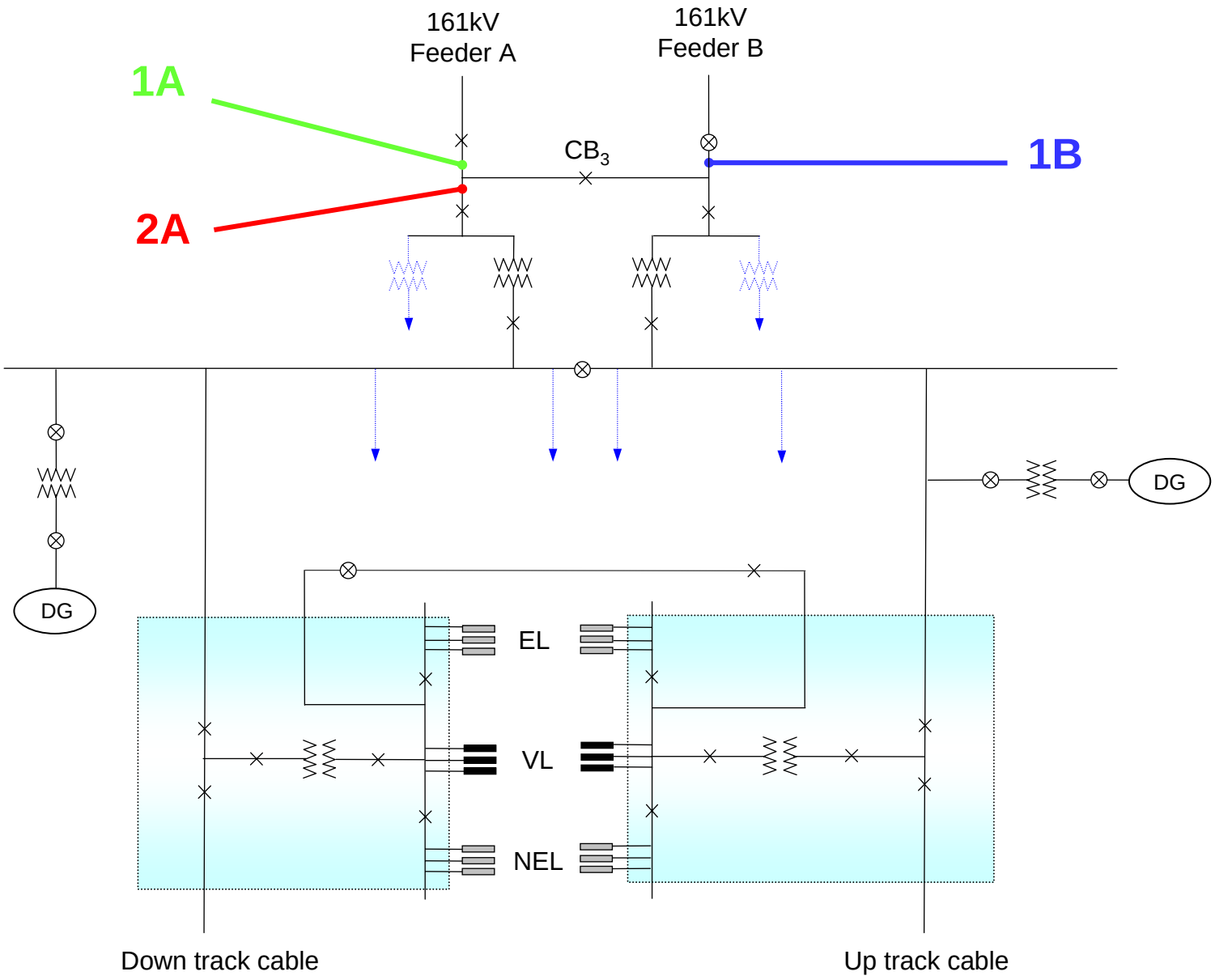
Failure probability density function, f(t) of Diesel Generator

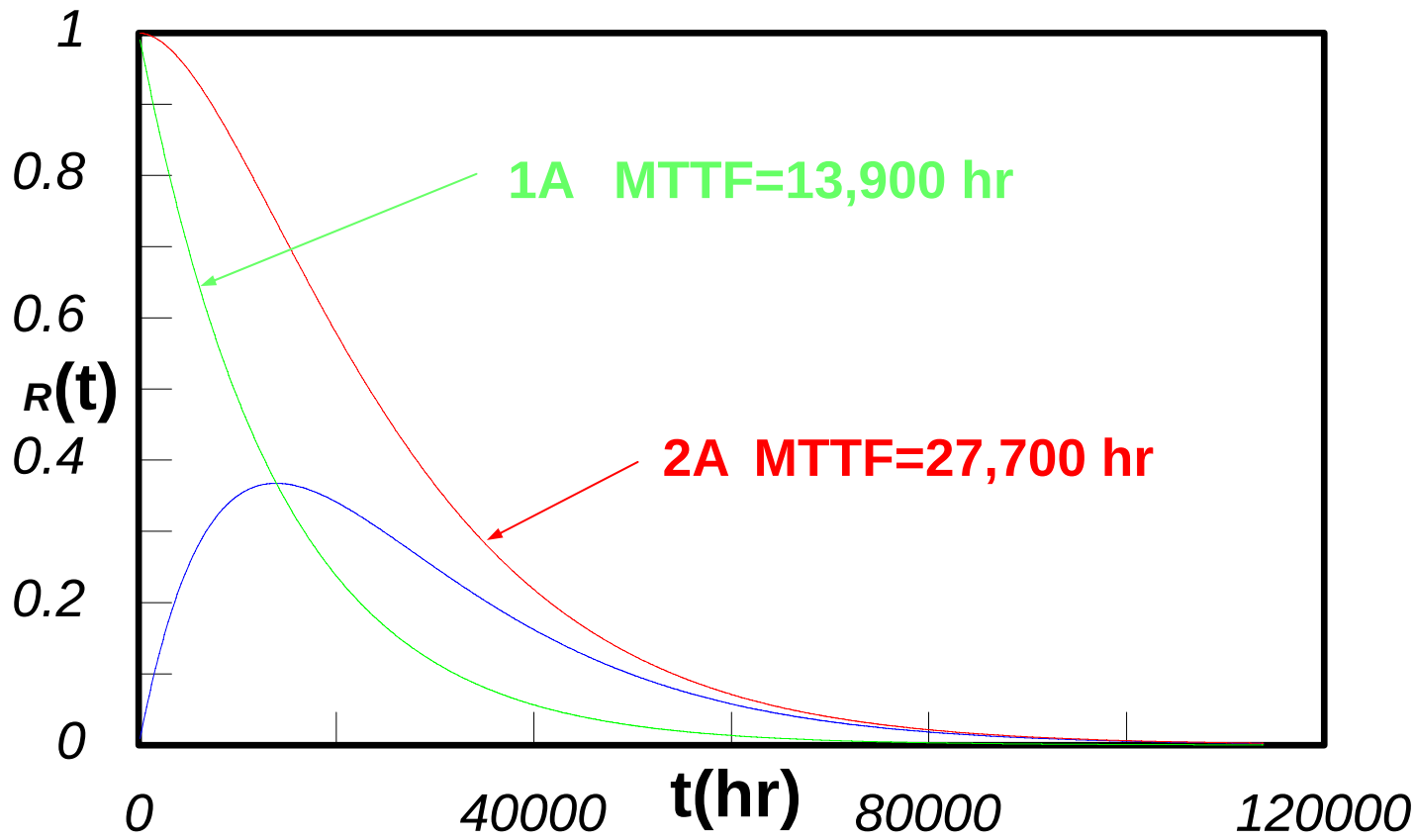


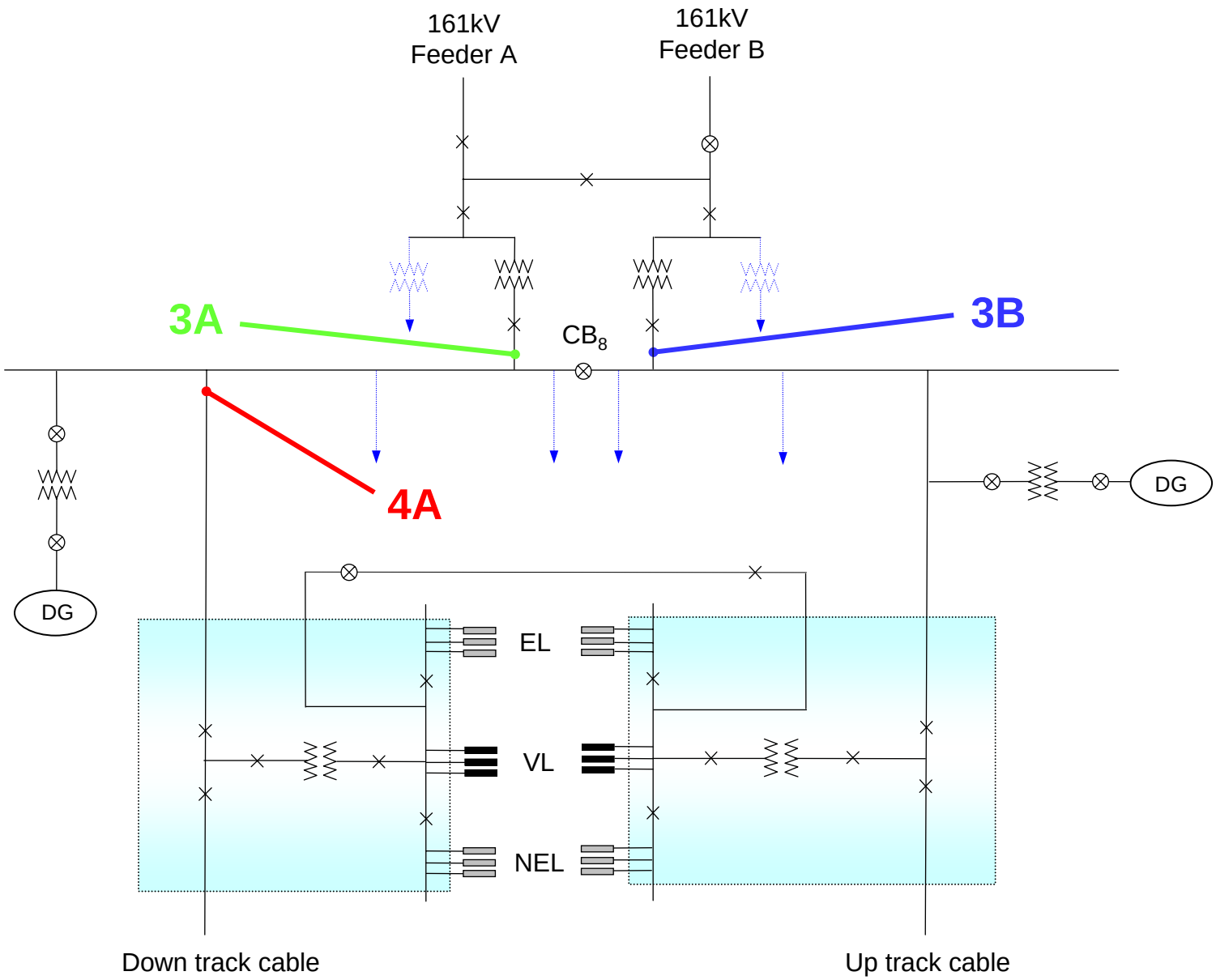
Reliability, $R(t)$ of Diesel Generator

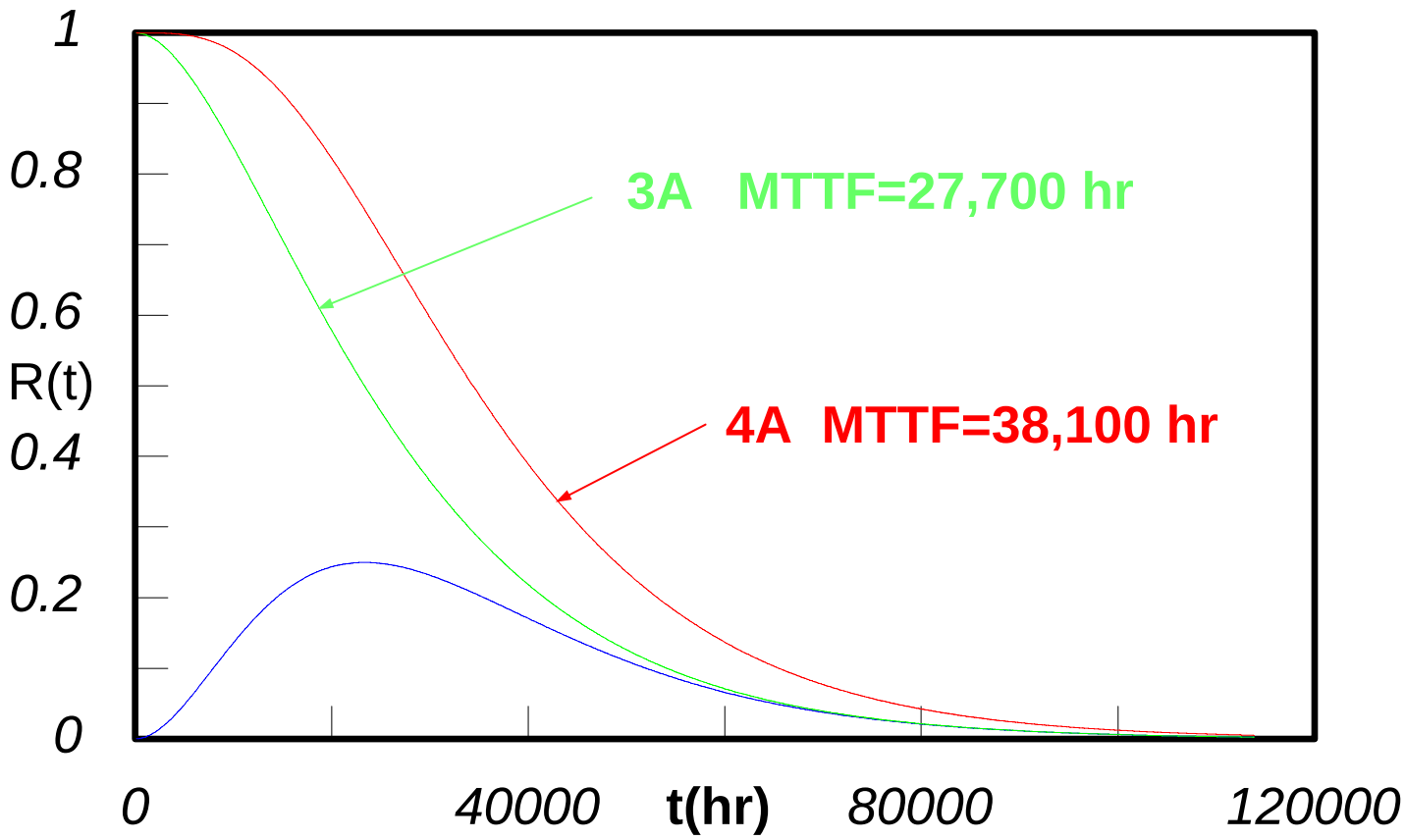


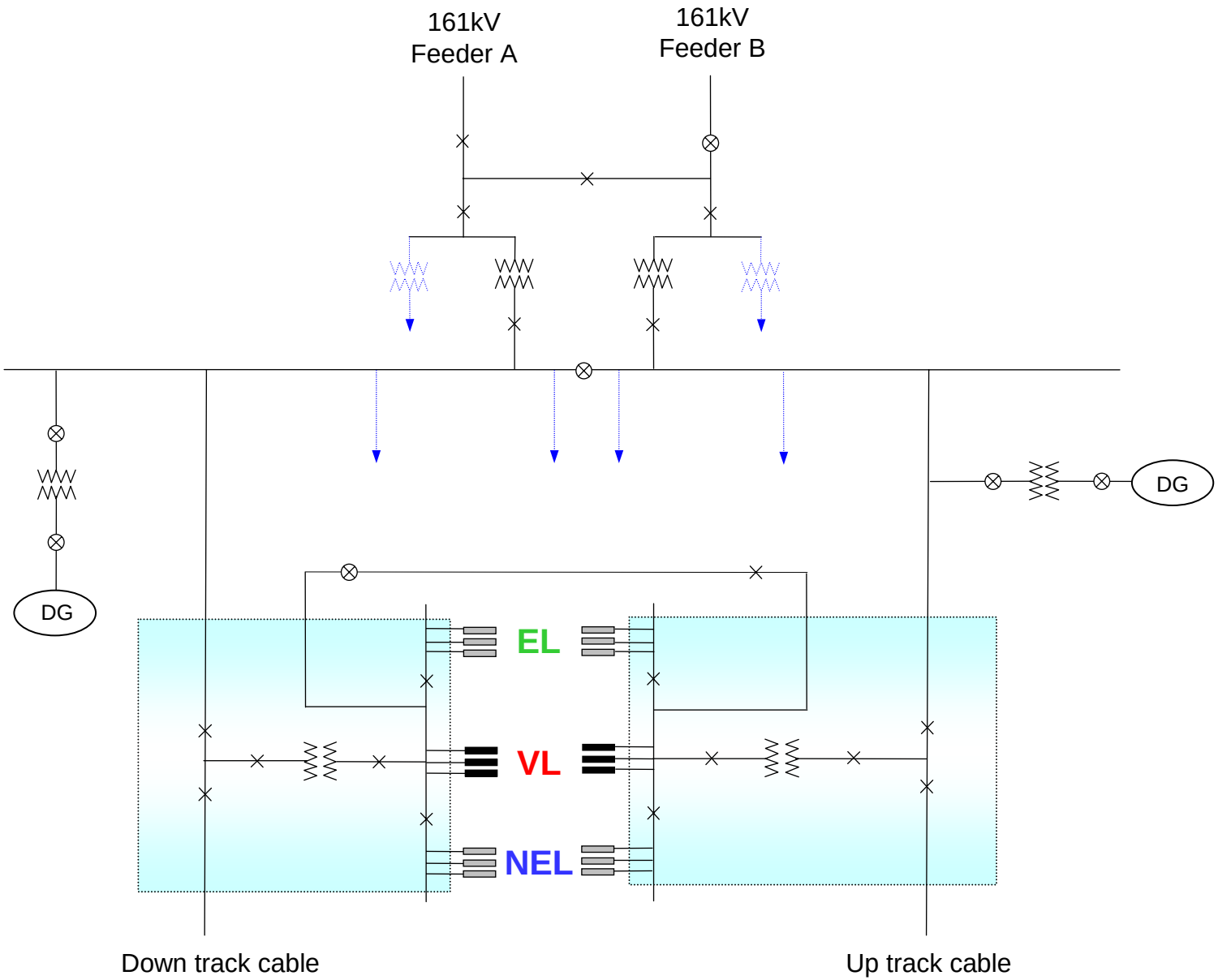
System Reliability Analysis

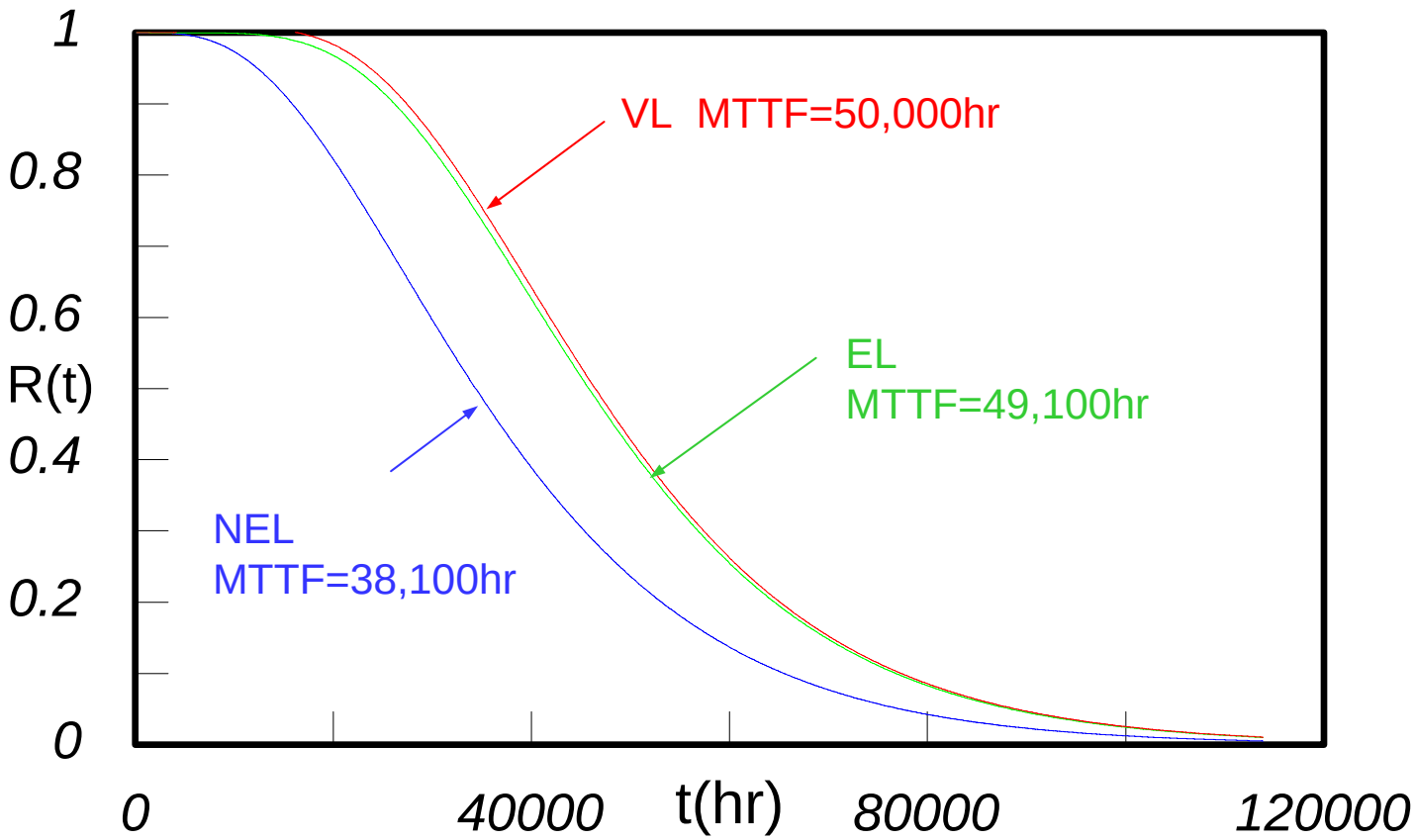

161kV
Feeder A
161kV
Feeder B
1A
2A
CB3
1B
DG
DG
EL
VL
NEL
Down track cable
Up track cable


1
0.8
0.6
R(t)
0.4
0.2
0
0
40000
t(hr)
80000
120000
1A MTTF=13,900 hr
2A MTTF=27,700 hr

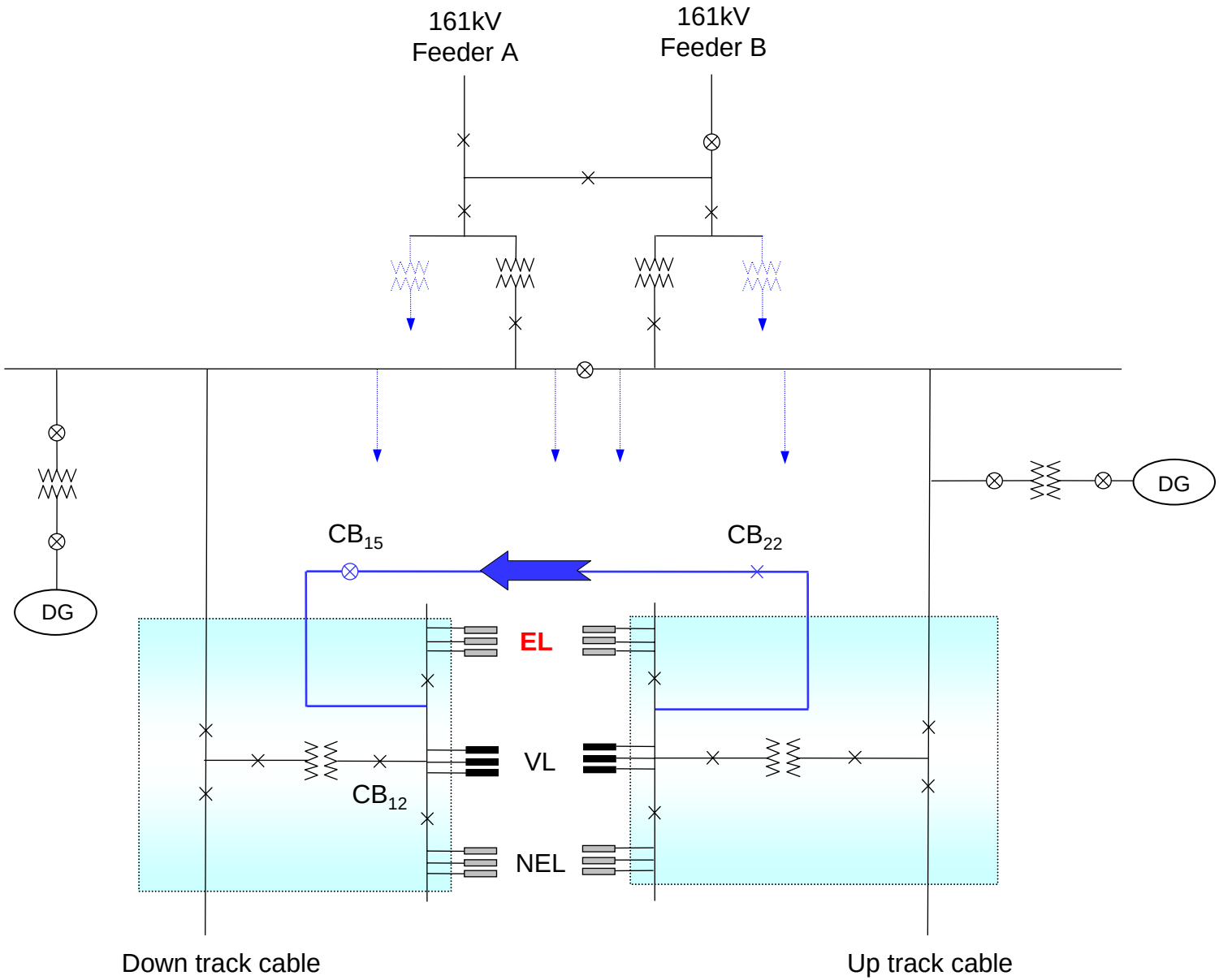

161kV
Feeder A
161kV
Feeder B
3A
3B
CB8
4A
DG
DG
EL
VL
NEL
Down track cable
Up track cable

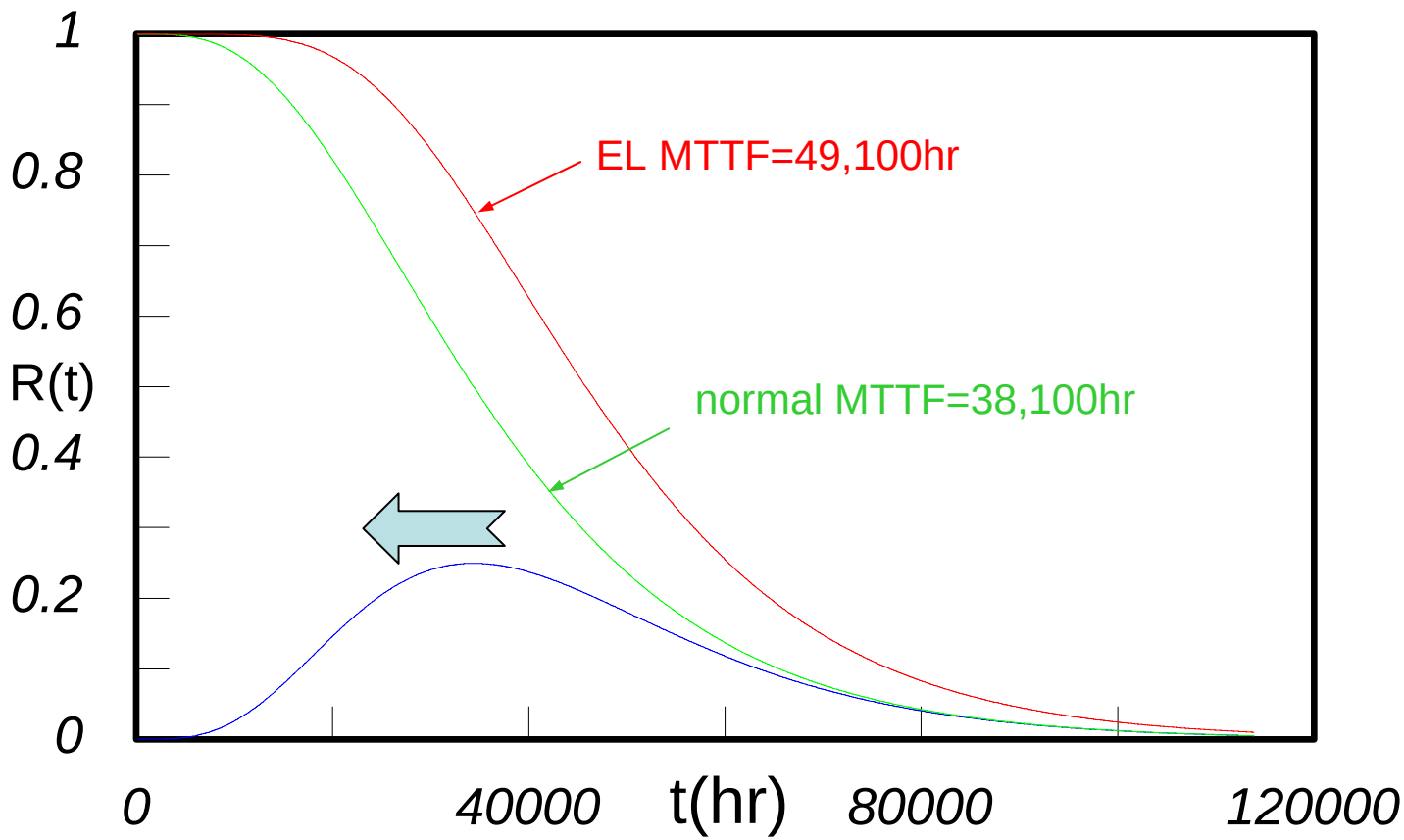

1
0.8
0.6
R(t)
0.4
0.2
0
0
40000
t(hr)
80000
120000
3A MTTF=27,700 hr
4A MTTF=38,100 hr

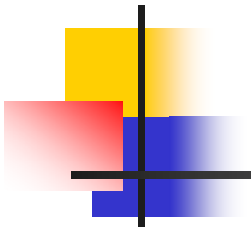

161kV
Feeder A
161kV
Feeder B
DG
DG
EL
VL
NEL
Down track cable
Up track cable



Reliability contribution of D/G is marginal !


161kV
Feeder A
161kV
Feeder B
DG
DG
CB15
CB22
EL
VL
CB12
NEL
Down track cable
Up track cable


1
0.8
0.6
R(t)
0.4
0.2
0
EL MTTF=49,100hr
normal MTTF=38,100hr
0
40000
t(hr)
80000
120000



Conclusions

❶

#	MTTF (hr)
NEL	38,100
EL	49,100
VL	50,000

❷ Redundancy of 161 kV ‘h’ configuration
13,000 hr ⇗ 27,700 hr

❸ Effectiveness of 380V tie-in connection
38,100 hr ⇗ 49,100 hr

❹ Diesel generator contribution is marginal.
49,100 hr ⇗ 50,000 hr