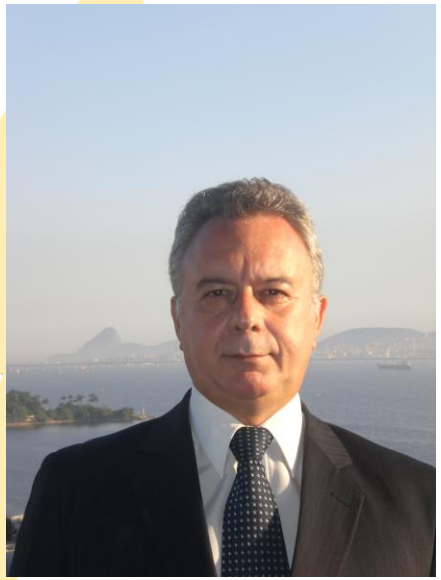
DESIGN CONCEPTS + software SwitchgearDesign

for SWITCHGEAR, SWITCHBOARDS, BUSDUCTS & SUBSTATIONS"



Item 1:

Contents of the complete training

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CV of the lecturer

Presented by Sergio Feitoza Costa – Cognitor Consultancy & Training sergiofeitoza@cognitor.com.br www.cognitor.com.br

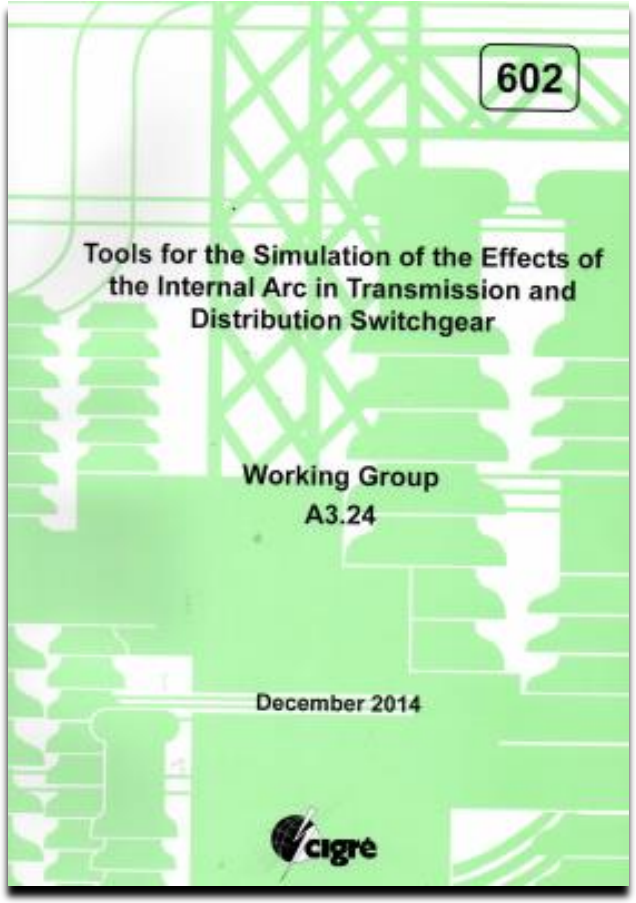
Experience of the lecturer Sergio Feitoza Costa

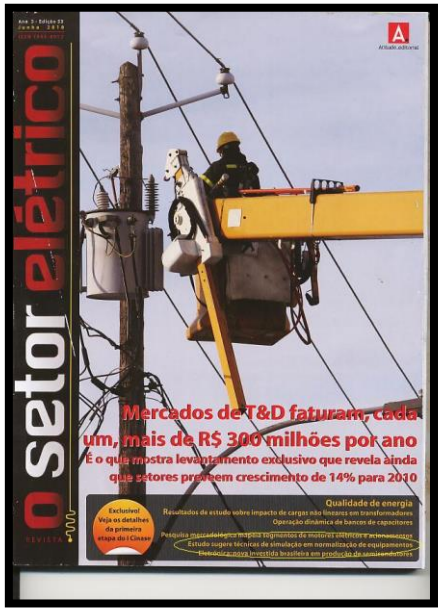
http://www.cognitor.com.br/en_curriculum.htm

- Design & management of testing laboratories: high power, high voltage, temperature rise & other
  - 25 years: designer, test engineer, researcher and general manager of 14 CEPEL testing laboratories
  - Consultant for implantation of the new Brazilian testing labs under construction in 2016 at Itajubá - MG (ISI – CEDIIEE, SENAI, FIEMG – MG). High Power 2500 MVA , High Voltage 500/765 KV class
- 16 years: Design of medium and low voltage switchboards, switchgear, busways(attending > 30 companies)
- WG A3.24 CIGRÉ International - Simulations and Engineering Tools for Internal Arc Tests (member)
  - Coauthor brochure CIGRE 602 / 2014 Simulation of The Effects Of the Internal Arc in T&D Switchgear.
- WG A3.36 CIGRÉ International - Simulations & Engineering Tools for Temperature Rise Calculation (member)
- IEC SC 17 C / WG31: coauthor of IEC 62271-307 (2015): : Guidance for the extension of validity of type tests of ac metal-enclosed switchgear and controlgear
- Chairman (1990-1994) Technical Committee 32 - IEC - International Electrotechnical Commission (Fuses).
- Coordinator of Forum LinkedIn Switchgear, Substations & Superconductivity

Articles from Sergio Feitoza

http://www.cognitor.com.br/download.htm



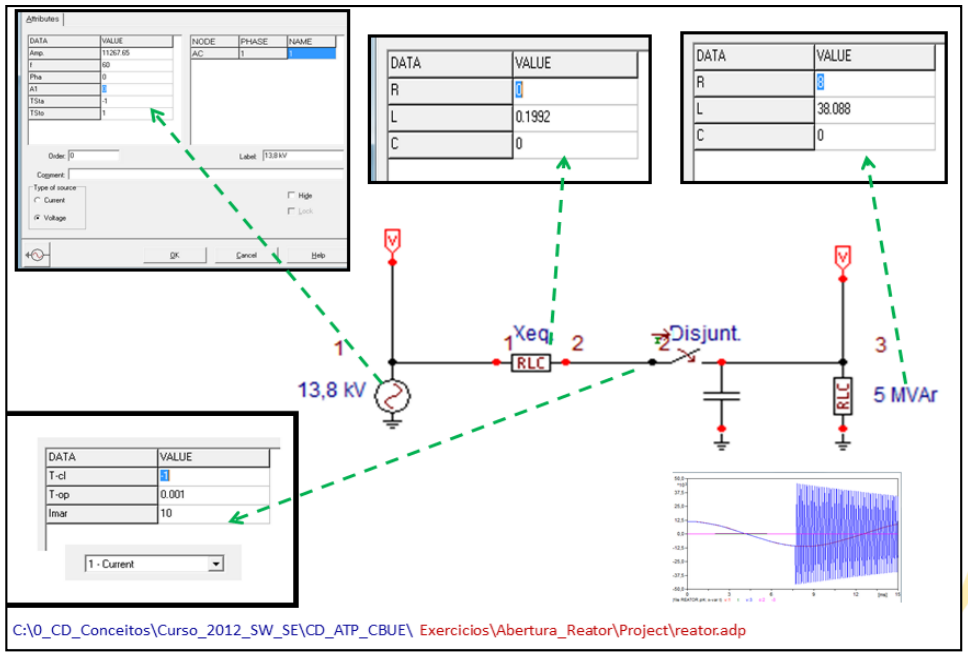


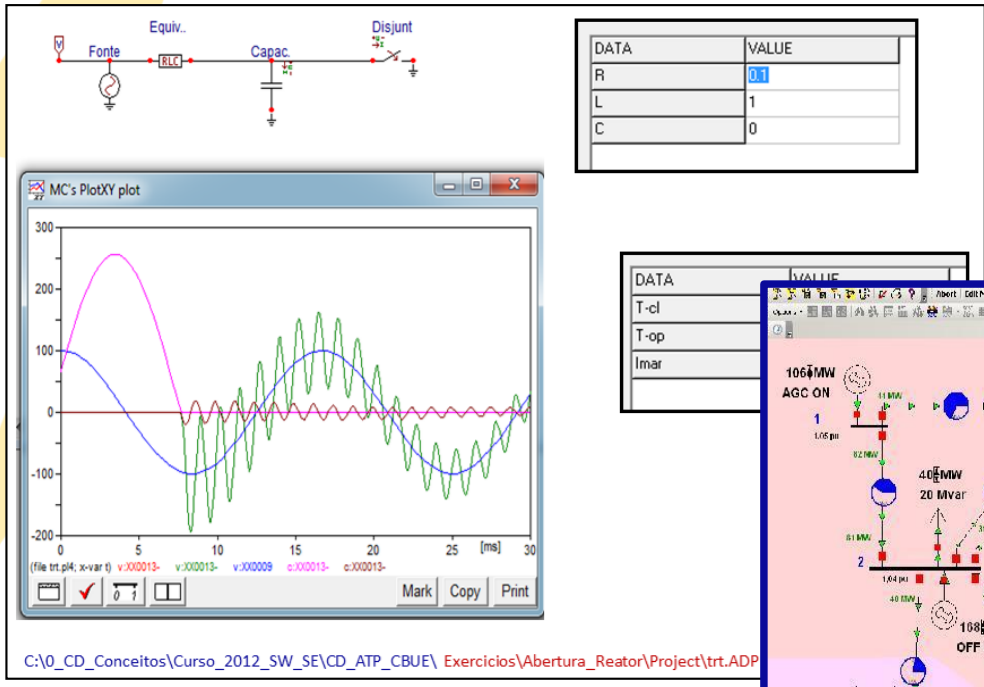
In this video

- Topics of the complete course (parts may be obtained separately).
- Focus on:
  - manufacturers of equipment for high / low voltage substations
  - experts working in certification and testing laboratories.
  - engineering concepts required for a good design.
  - How to use the software SwitchgearDesign

SPECIFICATION OF CURRENTS AND VOLTAGES IN NEW SUBSTATIONS

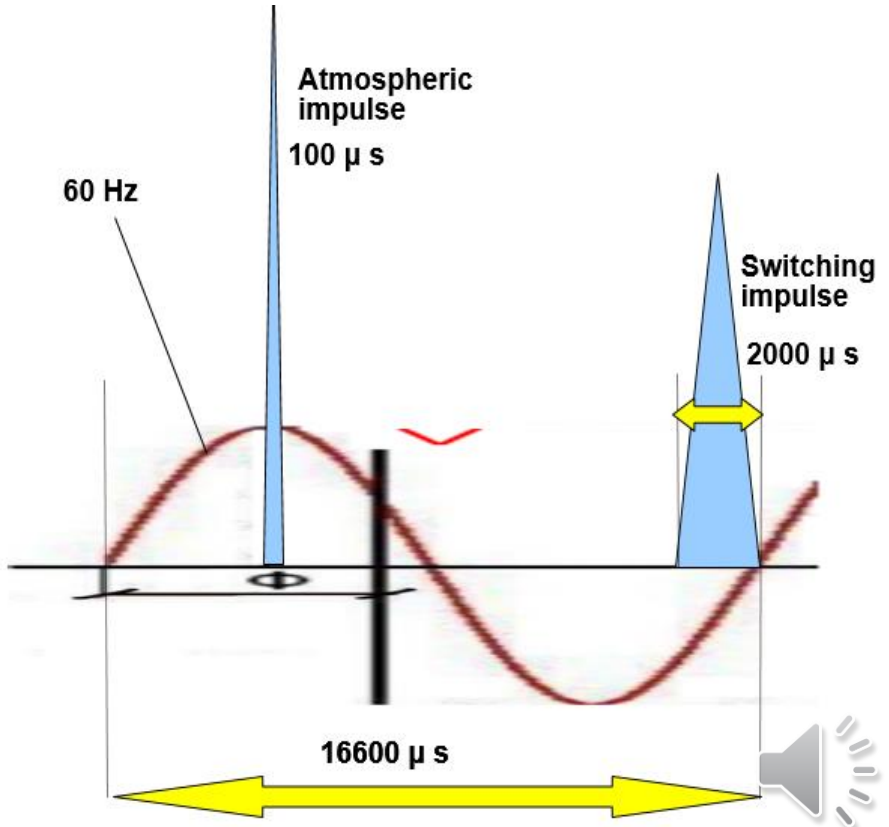
- Load flow studies (definition of normal currents).
- Short circuit studies (short circuit currents and durations)
- Software ATP / ATPDRAW (concepts)





OVERVOLTAGES AND INSULATION COORDINATION

- Transients and insulation coordination.
- Techniques to reduce over voltages (synchronizers, resistors, surge arresters)
- Selection of levels of withstand voltages (industrial frequency & impulse)
- Dielectric tests (impulse, AC, corona, RIV, …)
- Electric fields and distances in installations



SHORT CIRCUITS, OVERLOADS AND AMPACITIES

- Electrical contacts and temperature rise
- Reduction of lifetime, supportability of materials to temperatures
- Ventilation and contact resistances
- Overloads in power transformers
- Temperature rise tests

Part	Contact material and medium where it is used	Temperature Rise máx. (K) amb 20°C	Temperature máx. (°C) ambient 40°C	Comments
SPRING CONTACT	Copper and copper alloys uncoated - in air / - in SF6 / - in oil	35 / 50 / 40		
	Tinned , in air, SF6 oru oil	50		
	Silver or niquel plated - in air / - in oil	65 / 50		
	For contactors in oil		105	Oil deterioration
BOLTED CONTACT	Copper , aluminum and alloys uncoated in air / uncoated in SF6	50 / 65		
	Tinned, in air or SF6		105	Tin "creep point"
	Silver or niquel plated air or SF6	75		
	Silver or niquel plated in óleo		100	Oil deterioration
	For contactors in oil		105	Oil deterioration
METALIC PARTS	In contact with insulation class • Y / A / E • B / F / H		90 / 105 / 120 30 / 155 / 180	Isolation ageing
	• Acting as spring • In soldering position		caso a caso 100	Permanent deformation /Break
SURFACES	Can be touched (met / non met.) Acessible but not touched		70 / 80 80 / 90	Do not injure persons

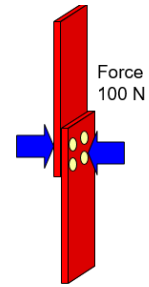
Total resistance per phase (circuit breaker + busbar + connections) = 72 µΩ
Circuit breaker resistance per phase = 30 µΩ

CONTACT RESISTANCE

$$R_c = \frac{\rho}{2.\eta.a} + \frac{\sigma_0}{\eta.\pi.a^2}$$

$$a = \sqrt{\frac{100}{18.\pi.(0.45).(5.5x10^8)}} = 85x10^{-6}\,m$$

$$n = 2.5x10^{-5}\ x(5.5x10^8)^{0.625}\ x100^{0.2} = 18.2 = 18$$

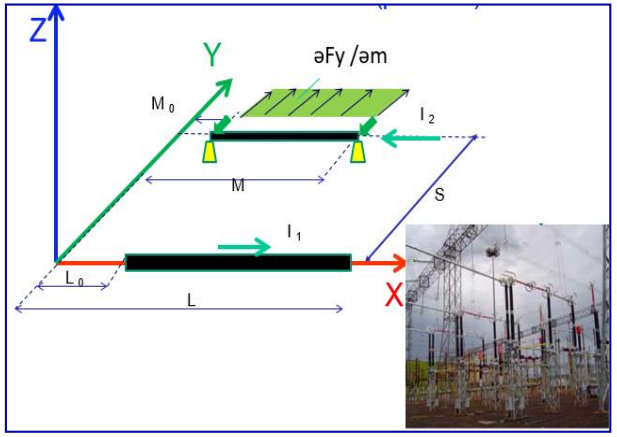


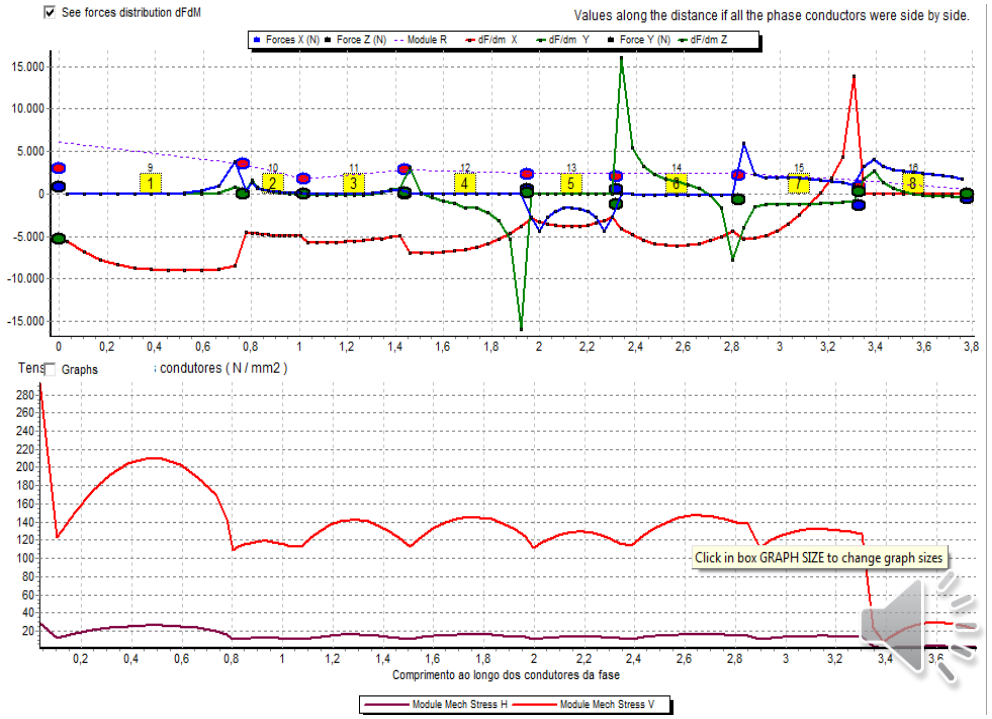
$\rho = 1.78 \times 10^{-8}\ \Omega.m$
$\sigma_0 = 5 \times 10^{-12}\ \Omega.m^2$

$R_c = 6 + 12 = 18\ \mu\Omega$

SHORT CIRCUITS, OVERLOADS AND AMPACITIES

- Electrodynamic forces and mechanical stresses during short circuits
- Calculating and assessing supportability.
- Limit values for insulators and conductors.
- Short-time withstand & peak currents test
- Magnetic induction



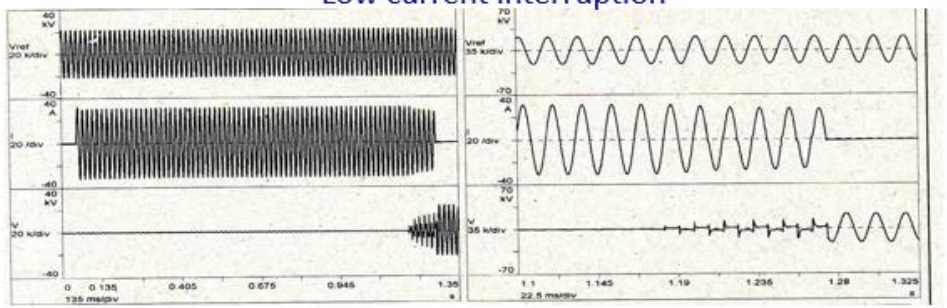


TRANSIENT RECOVERY VOLTAGES AND SWITCHING PROCESSES

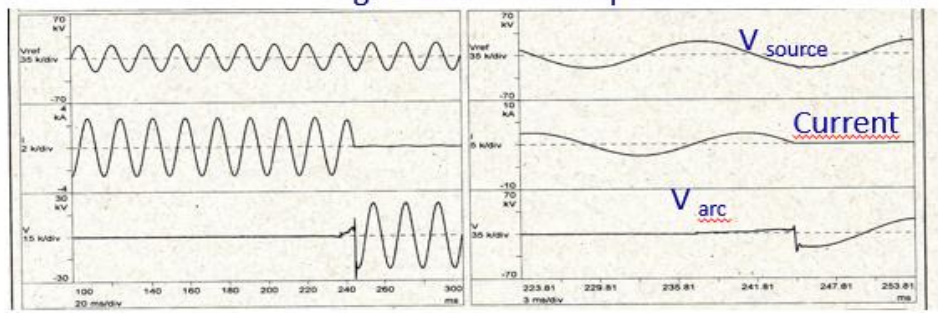
- Technologies: circuit breakers, switches, fuses (current limiting and expulsion)

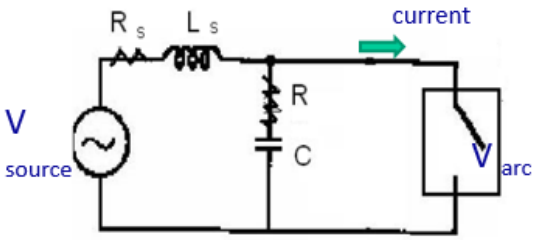
- Breaking Tests

Low current interruption



High current interruption

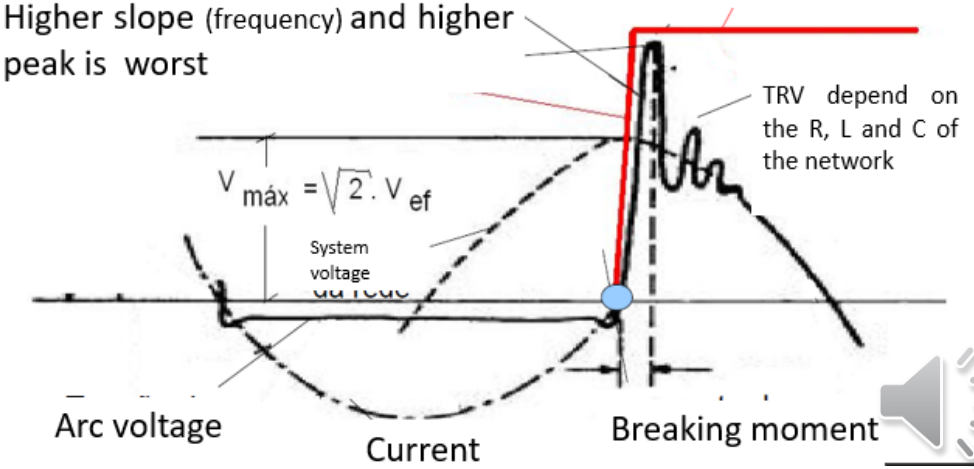




CURRENT INTERRUPTION IN CIRCUIT BREAKERS, FUSES AND SWITCHES

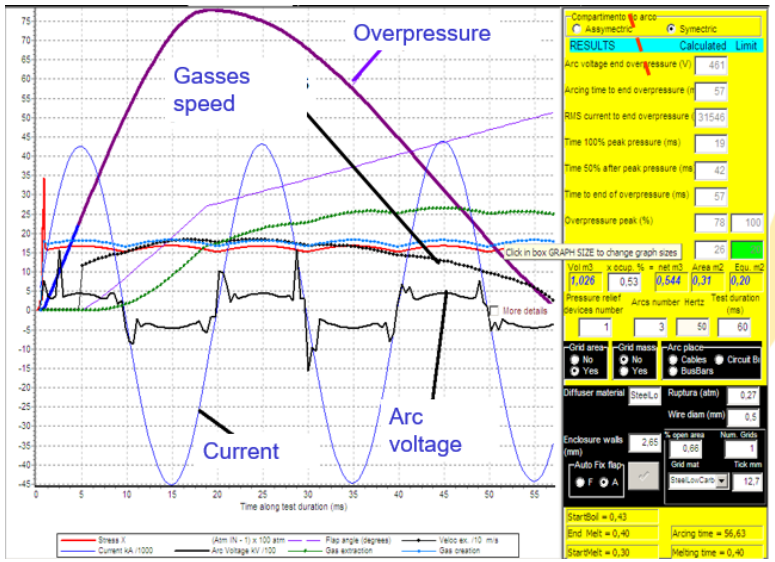
Cold characteristic of the circuit breaker above TRT

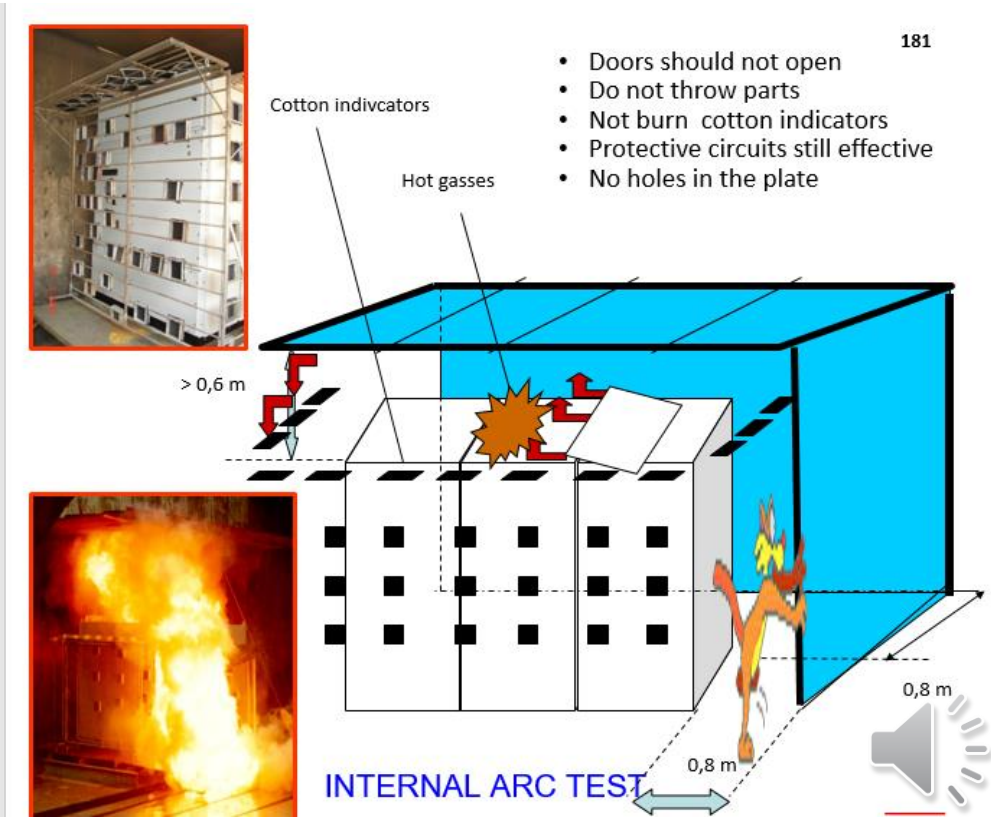
Higher slope (frequency) and higher peak is worst



POWER ARCS AND SAFETY OF PERSONS AND INSTALATIONS

- Internal arc in switchgear (medium and low voltage).
- Technologies to control the effects of arc , overpressure curve, supportability
- Aspects of explosions and fires in transformers.
- Arcs in insulators strings and tests





SWITCHGEAR AND CONTROLGEAR TECNICAL STANDARDS (HV)

- IEC 62271-200 (medium voltage)
- IEC 62271-307 - Parte 307: extension of the validity of type test reports (standard in preparation – Sergio is member of the IEC working group preparing the standard)

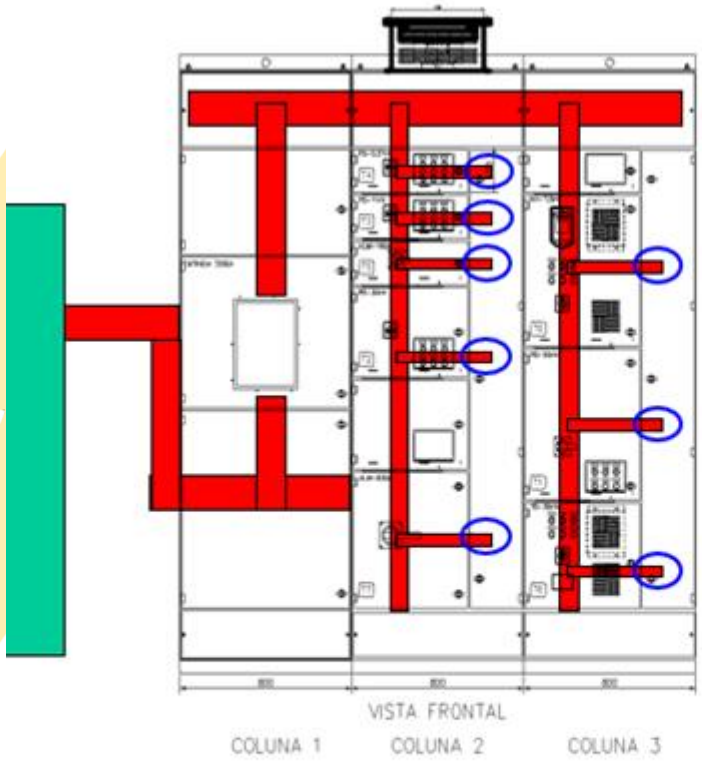
- IEC 62271-1 (common clauses), IEC 62271-100 (circuit breakers),

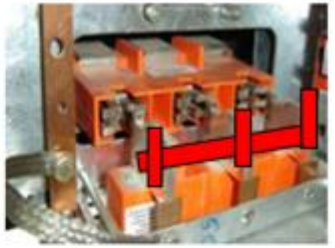
- Others: IEC 60282-2 (expulsion type fuses), IEC 60076 (Power transformers).

SWITCHGEAR AND CONTROLGEAR TECNICAL STANDARDS (LV)

IEC 61439 (low voltage)

- Planning the use of the design rules of IEC 61439.

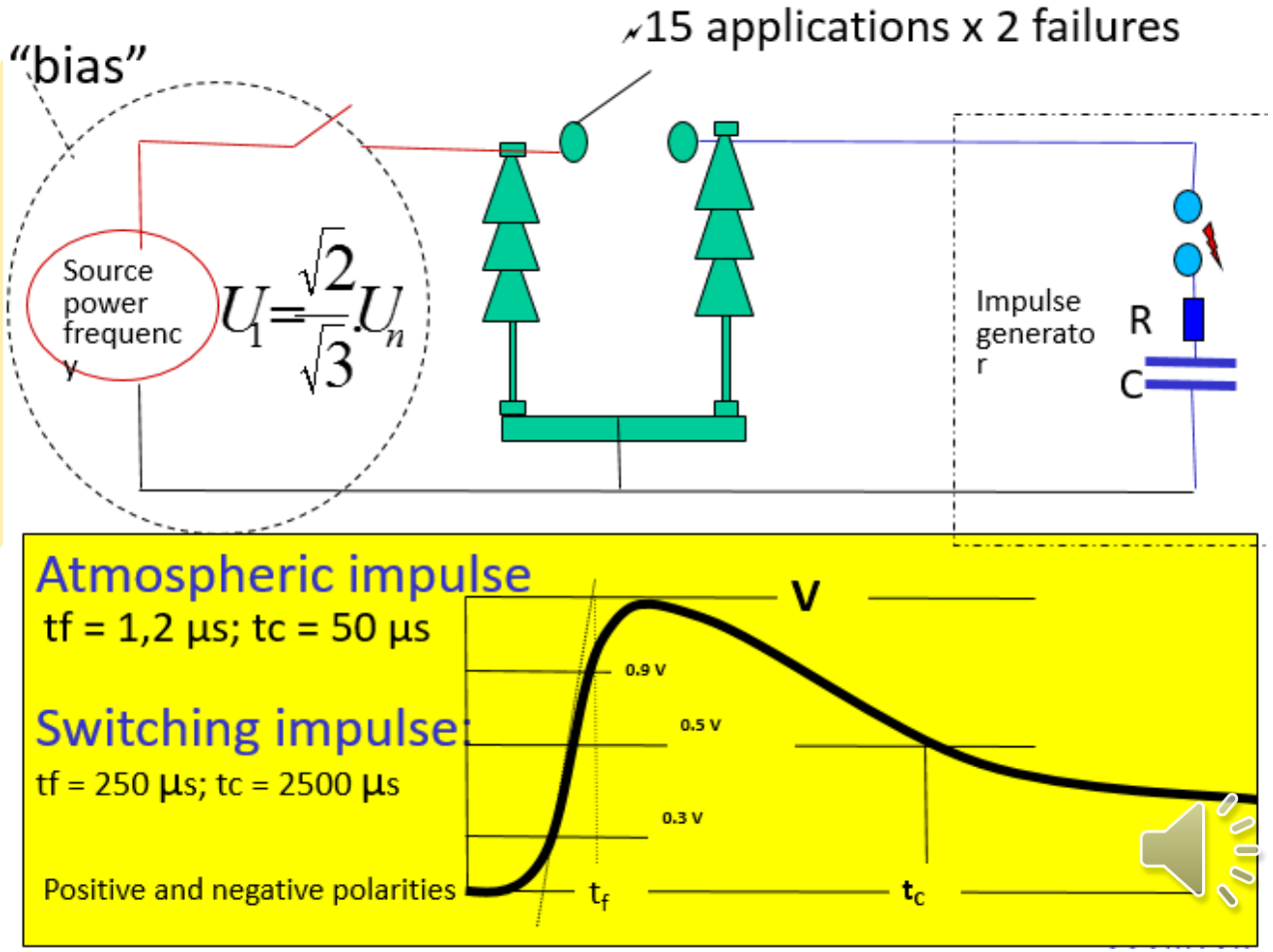




TECHNICAL SPECIFICATIONS OF T&D EQUIPMENT

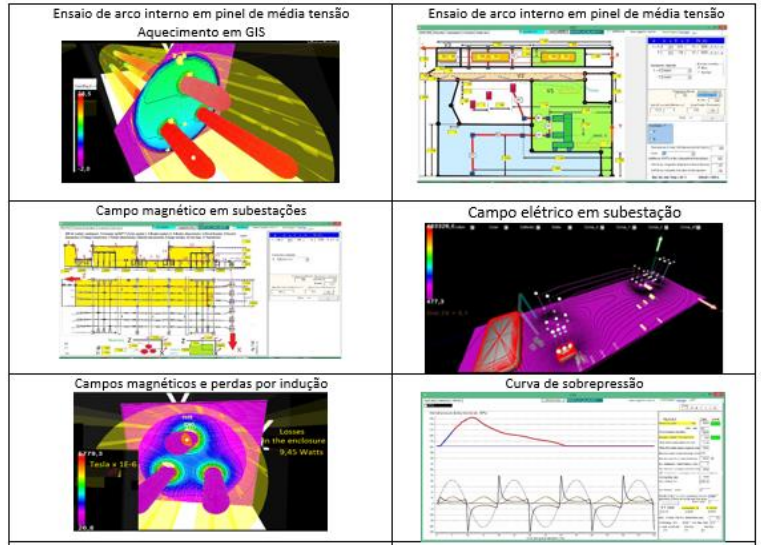
- The most efficient specification is the IEC Standard
- High voltage switches and isolators
- Circuit - breakers
- Surge arresters
- Power transformers and reactors

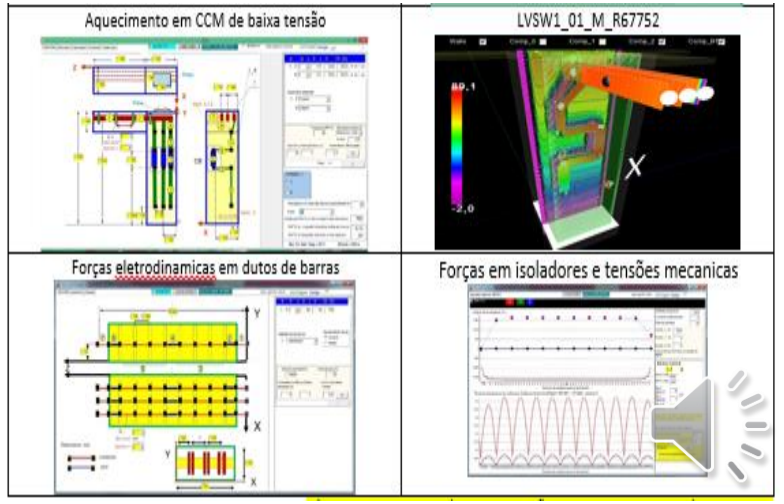
Dados técnicos		Requisito
Tensão nominal	Tensão nominal (fase-fase)	230 KV rms
	Maxima tensão de operação continua (F-F)	242 KV rms
Frequencia	Tensão nominal	60 Hz
Níveis de isolamento	Tensão suportavel à frequencia nominal	Fechada à terra 395 kV Contatos abertos: 460kV
	Tensão suportavel de impulso	Fechada à terra 950 kVcr Contatos abertos: 950 kVcr + 140kV 1min – 60Hz
	Tensão suportavel frequencia nominal (circuitos controle)	3 kV
Numero de polos		3
Corrente nominal	Corrente nominal	2000 Arms
Curto circuito	Corrente suportavel de curta duração e de crista	40 kArms durante 3s / 100 kAcr
RIV	Tensão de rádio interferencia	500 µV
Corona	Mínima tensão de inicio e de extinção	154 KVrms



Software SWITCHGEAR_DESIGN (use and case studies / benchmark)

- State of the art of the use of simulations to replace tests
- Simulation of short-time withstand current and peak tests (electro dynamical forces, mechanical stresses)
- Simulation of temperature rise / heating tests (calculations and how to optimize the design)
- Simulation of internal arc tests (overpressures, burn-through and supportability)
- Case studies with the software (LV and MV switchgear)
- Mapping of magnetic & electric fields





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