

Generator Circuit Breaker (GCB) type FKG1N/F/X/XP/XV/XW with FK3-12 mechanical drive

Operation and maintenance – (M1 and M2)

Réf. V9542E



Destinated for

Technical team involved in operation and maintenance of GCB installations. Normal experience un H.V. switchgear, basics in electrical and mechanicals.



Required knowledge

Ø



Method

Theory: 50% / Practice: 50%



Duration

3 days



Number of participants

5 to 8 (for better efficiency and safety on application)



Place

Factory/Site



Objectives

The participants will be able to know the GCB FKG1 type, the O&M philosophy and according to procedures, they will get knowledge on routine maintenance and simple inspections.



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

Handling procedures for SF₆ and its mixtures according to IEC62271-4

Module A: Awareness

Basic knowledge of environmental issues.
Environmental relevance of SF₆ emissions and mitigation approaches.
Physical, chemical, and environmental characteristics of SF₆ and its mixtures.
Use of SF₆ and its mixtures in HV electric power equipment.
International and local standards.
Personnel safety and suitable PPE.
Design of HV electric power equipment.

Concept of FKG Generator Circuit Breaker

Why a Generator Circuit Breaker
Presentation and characteristics
General characteristics
Associated components
Induced currents

Module B1: Maintenance not implying gas recovery

SF₆ quality according to 60376 and 60480 IEC standards.

Types of SF₆ filled compartments.
Instruments and procedures for checking SF₆ quality.
Procedures for re-filling (topping-up operation after leaks).
Storage and transportation.

Electrical phenomena related to circuit breaker operations

Definitions and standard applicable
Current withstands, making & interruption
Study of breaking
Fault current

Gas tightness

SF₆ gas tightness testing tools
Gaskets and greases
Sealing procedures

Generator Circuit Breaker – FKG1

Device technology
The circuit breaker FKG1
The disconnecting switch SKG1
The earthing switch MKG1
The starting switch IKG1

Electrical control mechanisms - CMK

Description
Components
Inside view

FK 3-X spring mechanism

Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators
Manual operations
Minor and major maintenance

SF₆ monitoring on FKG

SF₆ densimeter
Levers localization
Wika densimeter
Refill port (valve)
Safety valve
Molecular sieve

Maintenance and tooling for FKG circuit breakers

Maintenance plan and documentation
Electrical wear limit
Tooling

SF₆ compartments (practice)

Pressure with permanent manometer
Pressure with tools
SF₆ quality check
Density thresholds check

Bay design (practice)

Single line layout/diagram
Apparatus location
Monitoring device
Manual and electrical operations

Apparatus maintenance- circuit-breaker following RES337 and spring mechanism (practice)

Contact resistance measurement
Mechanical times (principals and auxiliaries)
Contact tube position
Various checking
Counters
Check general status of the mechanical drive
Remove orders coils
Remove electrical motor (if applicable)
The damper



Practice conditions

In Factory: an apparatus like your own equipment – a cell in dead conditions with gas will be at your disposal for the practical works.

On site: customer must put at disposal a bay of the referenced GCB in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

Generator Circuit Breaker (GCB) type FKG2 (S/M) with FK3-xx mechanical drive

Operation and maintenance – (M1 and M2)

Réf. V9442E



Destinated for

Technical team involved in operation and maintenance of GCB installations. Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

Ø



Method

Theory: 50% / Practice: 50%



Duration

3 days



Number of participants

6 participants



Place

Factory/Site



Objectives

- To be able to apply the safety rules regarding GCB products
- To know the O&M philosophy according to procedures
- To be able to apply routine maintenance and simple inspections (M1 and M2).



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

Handling procedures for SF₆ and its mixtures according to IEC62271-4

Module A: Awareness

People concerned by module A
Greenhouse effect
Environmental impact of the Sulphur hexafluoride SF₆
Physical and chemical characteristics of SF₆
SF₆ applications
Understanding of the design of electric power equipment
Personal safety and first aid.

Module B1: Maintenance not implying gas recovery

People concerned by module B1
SF₆ – IEC Standards (according to 60376 and 60480 IEC standards)
SF₆ quality measurement
Categories of gas-filled compartments
SF₆ filling operation: topping up
Storage, transport, and labelling
Obligation of recording SF₆ data

Electrical phenomena related to circuit breaker operations

Definitions and standard applicable
Current withstands, making & interruption
Study of breaking
Fault current

Gas tightness

SF₆ gas tightness testing tools
Gaskets and greases
Sealing procedures

Concept of FKG Generator Circuit Breaker

Why a Generator Circuit Breaker
Presentation and characteristics
General characteristics
Associated components
Induced currents

Generator Circuit Breaker – FKG2

Device technology
The circuit breaker FKG2
The disconnecting switch SKG2
The earthing switch MKG2
The starting switch IKG2

Electrical control mechanisms - CMK

Description
Components
Inside view

FK 3-X spring mechanism

Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators
Manual operations
Minor and major maintenance

SF₆ monitoring on FKG

SF₆ densimeter
Levers localization
Wika densimeter
Refill port (valve)
Safety valve
Molecular sieve

Maintenance and tooling for FKG circuit breakers

Maintenance plan and documentation
Electrical wear limit
Tooling

SF₆ compartments (practice)

Pressure with permanent manometer
Pressure with tools
SF₆ quality check
Density thresholds check

Bay design (practice)

Single line layout/diagram
Apparatus location
Monitoring device
Manual and electrical operations

Apparatus maintenance- circuit-breaker following RES332 and spring mechanism (practice)

Contact resistance measurement
Mechanical times (principals and auxiliaries)
Contact tube position
Various checking
Counters
Check general status of the mechanical drive
Remove orders coils
Remove electrical motor (if applicable)
The damper



Practice conditions

In Factory: an apparatus like your own equipment – a cell in dead conditions with gas will be at your disposal for the practical works.

On site: customer must put at disposal a bay of the referenced GCB in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

Generator Circuit Breaker GCB type FKG1xx and FKG2x with mechanical drive type FK3-xx

Operation & Maintenances (M1 & M2)

Réf. **V9542E & V9442E**



Audience

Technicians for the operation and maintenance of GCB installations, with a background in electrical and mechanical engineering.



Method

30% theory / 70% practice
GE training support – practice in workshop



Number of participants

6 trainees



Prerequisite

None



Duration

3 days



Lieu

TIA, Aix-les-Bains



Objectives

- Master the safety rules specific to products
- Understand the procedures for operating and maintaining FKG1xx & FKG2x GCB circuit breakers with their associated controls
- Perform preventive and corrective maintenance on minor incidents



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

SF₆ following the IEC62271-4

Reminder

Monitoring of the SF₆

The densimeter (WIKA)
Density test device
Filling valve
Safety devices
The molecular sieve

Gas tightness

SF₆ gas tightness testing tools
Gaskets and greases
Sealing procedures

Concept of FKG - GCB

Why a Generator Circuit Breaker
Presentation and characteristics
General characteristics
Associated components
Induced currents

Introduction to SF₆ type FKG1 & FKG2 Generator Circuit Breakers

The range - FKG1&2
Principle of cooling
Pole of the Architecture for the
FKG1&2
SKG1&2
MKG1&2
IKG1&2
Operating sequences of an interrupting
chamber

FK3-x mechanical drive

Presentation and evolution
Principle of operation
The damper and travel curves
The optical indicators
Manual operation
Minor and major maintenance on FK3-x

Maintenance for GCB - FKG1&2

Maintenance Plan
Electrical wear
Spare parts

Practical work in SF₆

Measurement of pressure and quality of SF₆ gas
Test of the SF₆ thresholds of the densimeter

Apparatus maintenance- circuit-breaker following RES332 & RES337(practice)

Contact resistance measurement
Mechanical times (principals and auxiliaries)
Contact tube position
Check the interlocking following the diagram/drawing (VSxxxxxxIDD01D)
Various checking
Counters



Trainer

- Experienced trainer
- Strong field experience



Evaluation

At the start of the training, participants will be invited to express their expectations to confirm the adequacy between their knowledge, their individual objectives and those of the training (positioning grid).

These expectations will be taken up during a roundtable discussion to refine, if necessary, the content and progress of the training.

The assessment of acquired knowledge and skills is done via a theoretical multiple-choice question and a practical work grid, if applicable.

At the end of the training, a live assessment must be completed by each trainee. At the end of the session, a certificate of attendance will be given.

High Voltage SF6 Circuit Breaker type GL ≤ 100 kV with associated mechanical drive FK3-xx

Operation and Maintenance - (M1 & M2)

Ref: V5642E



Destinated for

Technical team involved in Operation and Maintenance of GL ≤ 100 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

Ø



Method

Theory: 50% /Practice: 50%



Duration

3 days



Number of participants

5 trainees



Place

TIA – Training Center of Aix Les Bains



Objectives

- To be able to perform the Operation & Commissioning of a CB LV type GL ≤ 100 Kv
- To know how to proceed during the maintenances level M1 & M2
- To apply the safety rules



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

High voltage Safety

Practical work risks in the environment
Handling
Elements under pressure
Mechanical risks
Voltage risks (LV)
Chemical risks

Handling procedures for SF6 and its mixtures according to IEC62271-4

Module A: Awareness

Module B1: Maintenance not implying gas recovery

Main reminder

Evolution of SF6 circuit breakers in AIS

Historical
Meaning of the designation
Changes in energy requirements for operations per pole

Presentation of GL ≤ 100 kV SF6 circuit breakers

Range GL3xx
Pole architecture
Pole / mechanical control link
Operating sequences of interrupting chamber
Circuit breaker operating sequence

FK 3-X spring mechanism

Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators Manual operations
Minor and major maintenance

Gas tightness

SF6 gas tightness testing
tools Gaskets and greases
Sealing procedures

SF6 monitoring

WIKA SF6 densimeter
Test device
Refill port (valve)
Safety devices
Molecular sieve

Maintenance and tooling for GL circuit breakers with spring mechanism

Maintenance plan
Dedicated documentation for maintenance
Maintenance in detail
Dedicated tooling for maintenance

Practical works with SF6

Pressure measurement
Quality check of the gas
Densimeter thresholds check

Practical works with mechanical drive FK3-x

Manual operations on model
Replacement of order coils
Presentation of the tools

Practical works with the circuit breaker (following the check list in the instruction manual)

Timing test measurements
Contact resistance measurement
Various checking



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

High Voltage SF₆ Circuit Breaker type **GL311 ->GL313** (123 kV -> 170 kV) with associated mechanical drive FK3-xx

Operation and Maintenance - (M1 & M2)

Ref: V5342E



Destinated for

Technical team involved in Operation and Maintenance of 123 kV ≤ GL ≤ 170 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

Ø



Method

Theory: 50% /Practice: 50%



Duration

3 days



Number of participants

5 trainees



Place

TIA – Training Center of Aix Les Bains



Objectives

- To be able to perform the Operation & Maintenance of a CB LV type 123 kV ≤ GL ≤ 170 kV.
- To know how to proceed during the maintenances level M1 & M2
- To apply the safety rules



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

High voltage Safety

Practical work risks in the environment
Handling
Elements under pressure
Mechanical risks
Voltage risks (LV)
Chemical risks

Handling procedures for SF₆ and its mixtures according to IEC62271-4

Module A: Awareness

Module B1: Maintenance not implying gas recovery

Main reminder

Evolution of SF₆ circuit breakers in AIS

Historical
Meaning of the designation
Changes in energy requirements for operations per pole

Presentation of GL3xx SF₆ circuit breakers

Range GL311 -> GL313
Pole architecture
Pole / mechanical control link
Operating sequences of interrupting chamber
Circuit breaker operating sequence

FK 3-X spring mechanism

Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators
Manual operations
Minor and major maintenance

Gas tightness

SF₆ gas tightness testing
tools Gaskets and greases
Sealing procedures

SF₆ monitoring

WIKA SF₆ densimeter
Test device
Refill port (valve)
Safety devices
Molecular sieve

Maintenance and tooling for GL circuit breakers with spring mechanism

Maintenance plan
Dedicated documentation for maintenance
Maintenance in detail
Dedicated tooling for maintenance

Practical works with SF₆

Pressure measurement
Quality check of the gas
Densimeter thresholds check

Practical works with mechanical drive FK3-x

Manual operations on model
Replacement of order coils
Presentation of the tools

Practical works with the circuit breaker (following the check list in the instruction manual)

Timing test measurements
Contact resistance measurement
Various checking



Practice conditions

In Factory: an apparatus like your own equipment – a cell in dead conditions with gas will be at your disposal for the practical works.

On site: customer must put at disposal a bay of the referenced GIS in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

High Voltage g³ Circuit Breaker type **GL312g** with associated mechanical drive FK3-1

Operation & Maintenance (M1 & M2)

Réf.V5342g3E



Destinated for

Technical team involved in Operation and Maintenance of GL up to 145 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

None



Method

Theory: 50% /Practice: 50%
GE Training supports – Operation manual



Duration

3 days



Number of participants

4 to 6 trainees



Place

Customer site



Objectives

- To apply the safety rules
- To know the fundamentals and how to handle the g³
- To be able to use properly the documentation in relation of the O&M.
- To be able to perform the operation and maintenance of a CB LV type GL in 145 kV.



Program

Presentation of the session

Presentation of the training documents
Review of the basics in safety

Greenhouse gases and global warning

Regulation in Europe/World
Environment impact
g³ versus other technologies
g³: the sustainable alternative to SF₆

Physical and chemical characteristics

Liquid versus gaseous
Vapor pressure
Breakdown voltage
Standards gas mixtures
g³ standard quality

High voltage application

Gas insulated lines (GIL)
GIS & AIS circuit breakers
Future applications

g³ gas handling

Handling processes for filling and recovery
g³ quality analysis
Gas handling rules and recommendations
Specific g³ components
Storage and transportation

Safety for g³ handling

Mandatory safety devices
Risks analysis according to the different situations

High voltage Safety

Practical work risks in the environment
Handling
Elements under pressure
Mechanical risks
Voltage risks (LV)
Chemical risks

Presentation of GL3xx SF₆ circuit breakers

Range GL3xx
Pole architecture
Pole / mechanical control link
Operating sequences of interrupting chamber
Circuit breaker operating sequence

FK 3-X spring mechanism

Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators Manual operations
Minor and major maintenance

Gas tightness

Gas tightness testing tools
Gaskets and greases
Sealing procedures

Maintenance and tooling for GL circuit breakers with spring mechanism

Maintenance plan
Dedicated documentation for maintenance
Maintenance in detail
Dedicated tooling for maintenance

Practical works with g³

Pressure measurement
Quality check of the gas
Densimeter thresholds check

Practical works with the circuit breaker (following the check list in the instruction manual)

Preliminary inspections / identification
Note down the counter reading
Contact resistance measurement
Mechanical times measurement (principals and auxiliaries)
Various checking
Note down the counter reading

Trainer evaluation

Filling the check list and validation
Filling the training evaluation

Evaluation of the session

Free discussions with the trainer



Practice conditions

On site: customer must put at disposal a bay of the referenced Live Tank in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

High Voltage g³ Circuit Breaker type **GL312g** with associated mechanical drive FK3-1

Installation & Commissioning

Réf.V5343g3E



Destinated for

Technical team involved in Erection and Commissioning of GL up to 145 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

None



Method

Theory: 10% / Practice: 90%
GE Operation manual - Tools



Duration

4 days



Number of participants

4 to 6 trainees



Place

Customer site



Objectives

- To apply the safety rules
- To know the fundamentals and how to handle the g³
- To be able to use properly the documentation in relation of the O&M.
- To be able to perform the Erection and commissioning of a CB LV type GL in 145 kV.



Program

Presentation of the session

Presentation of the training documents
Review of the basics in safety

Safety for g³ handling

Mandatory safety devices
Risks analysis according to the different situations

Greenhouse gases and global warning

Regulation in Europe/World
Environment impact
g³ versus other technologies
g³: the sustainable alternative to SF₆

High voltage Safety

Reminder

Physical and chemical characteristics

Liquid versus gaseous
Vapor pressure
Breakdown voltage
Standards gas mixtures
g³ standard quality

g³ gas handling

Handling processes for filling and recovery
g³ quality analysis
Gas handling rules and recommendations
Specific g³ components
Storage and transportation

Installation of the GL312g circuit breaker (following the check list in the instruction manual)

Collect and consult the appropriate documentation
Check if all the parts are present
Unpack the GL312g
Check if transportation pressure is present
Install the base frame and the operating mechanism
Install the pole columns
Install the drive and connecting rods
Aligning pole columns
Mounting terminal pads
Connecting the cables
Fill the Installation check list document

Commissioning of the GL312g circuit breaker

Connect the density monitor
Fill the breaker with g³ gas
Check the pressure
Check the quality of the gas (if applicable)
Measuring the contact resistance
Measuring the operating time
Checking manual operation
Checking the anti-pumping system
Checking the functional lockout
Densimeter thresholds check (if applicable)
Note down the counter reading
Fill the commissioning check list document

Trainer evaluation

Filling the training evaluation

Evaluation of the session

Free discussions with the trainer



Practice conditions

On site: customer must put at disposal a bay of the referenced Live Tank in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

High Voltage SF6 Circuit Breaker type GL314 (245 kV) with associated mechanical drive FK3-1

Operation and Maintenance - (M1 & M2)

Réf. V5442E



Destinated for

Technical team involved in Operation and Maintenance of GL > 245 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

Ø



Method

Theory: 50% /Practice: 50%



Duration

3 days



Number of participants

5 trainees



Place

TIA – Training Center of Aix Les Bains



Objectives

- To be able to perform the operation & maintenances of a CB LV type GL in 245 kV.
- To know how to use the required documentation.
- To apply the safety rules



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

High voltage Safety

Practical work risks in the environment
Handling
Elements under pressure
Mechanical risks
Voltage risks (LV) Chemical risks

Handling procedures for SF6 and its mixtures according to IEC62271-4

Module A: Awareness

Module B1: Maintenance not implying gas recovery

Reminder

Evolution of SF6 circuit breakers in AIS

Arc breaking
Cut-off levels in SF6
SF6 circuit breakers in AIS

Presentation of GL314 SF6 circuit breakers

The range
Pole architecture
Interrupting chamber
GL314 characteristics
Circuit breaker operating sequence

FK3-1 spring mechanism

Evolution and Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators Manual operations
Minor and major maintenance

Gas tightness

SF6 gas tightness testing tools Gaskets and greases
Sealing procedures

SF6 monitoring on GL3xx

SF6 densimeter Wika
Testing device
Refill port (valve)
Safety valve
Molecular sieve

Maintenance and tooling for GL circuit breakers with spring mechanism

Maintenance plan for SF6 circuit breakers type GL314
Dedicated documentation for maintenance of the GL316
Maintenance in detail
Dedicated tooling for maintenance
Spare parts

Practical work in SF6

Pressure measurement and quality of SF6 gas
Testing the SF6 thresholds of the densimeter

Practical work on the FK3-1 mechanical control

Manual operations
Replacement order coils
Presentation of tools

Circuit breaker practical work (according to checklist RES310M in the manual)

Measuring circuit breaker operating time
Contact resistance measurement
Various checking



Practice conditions

In Factory: an apparatus like your own equipment – a cell in dead conditions with gas will be at your disposal for the practical works.

On site: customer must put at disposal a bay of the referenced GCB in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

GL314F1 (245 kV) SF₆ HV Circuit Breaker with FK3-4 Mechanical Control

Erection and commissioning according to Process OJT1&2 (WI-004)

Ref. V5443E



Audience

Technicians operating and maintaining installations with voltages > to 50 kV with bases in electrical engineering and mechanics.



Prerequisites

None



Method

20% theory/80% practice
GE brackets — complete assembly manual



Duration

5 days



Capacity

2 trainees



Location

Site - France



Objectives

- List product-specific safety regulations
- Describe the main principles and operation of GL245 circuit breakers
- Erect and commission a GL314F1 (245 kV) circuit breaker
- Be certified in erection and commissioning on this circuit breaker for 3 years according to the OJT1 and OJT2 process (WI-0004)



Program

High voltage safety

Risks in the practical work environment
Handling
Under pressure elements
Mechanical risks
Risk of voltage (LV & HV)
Chemical products

The SF₆

Reminder of modules A and B1

Evolution of SF₆ circuit breakers

Breaking in SF₆

Evolution levels in the SF₆

SF₆ AIS circuit breakers

GL314 circuit breaker concept (245 kV)

The range
Architecture of the pole
Interrupting chamber — sequence
GL314 characteristics
Manoeuvre sequence

FK3-4 mechanical control

Presentation and evolution
Principle of operation
Manoeuvring mechanism
The damper and curves
Optical indicators
Manual operations
Minor and major maintenance on FK3-x

Tightness

Leak testing tools
Gaskets and greases
Clogging procedure

SF₆ monitoring

The WIKA densimeter
Test device
Filler valve
Security organs
The molecular sieve

GL314 circuit breaker maintenance

Maintenance plan
Electrical wear
Spare parts

ERECTION AND COMMISSIONING

According to the [installation manual](#) and the RES310M [pre-commissioning](#) test report

On-site preparation

Gather all required documentation
Collect and check the necessary tools

Preparing for assembly

Compliance with safety regulations
Case identification
Acquaintance with the rules for assembly, tightening and greasing.
Reading and understanding the plans

How to assemble a GL314F1

Unpacking and identification
Control of gas presence in the poles
Mounting the frames on their columns
Setting up poles on mountain ranges
Setting up command support
Assembly and adjustment of the connecting rod
Assembly of the control unit

Electrical wiring

Connect densimeter
Wiring of the control and central cabinet

SF₆ gas work

Filling of the poles at nominal pressure
SF₆ gas quality measurement
Densimeter SF₆ threshold test

Commissioning of GL314F1 circuit breakers (according to the RES310M checklist and the acceptance criteria in the instruction manual)

Report assembly data to the protocol
Manoeuvre meter reading
Measuring the operating times of the circuit breaker
Contact resistance measurement
Various measures
Manoeuvre meter reading
Construction site closure



Trainer

- Experienced trainer
- Strong experience in the field



Assessment of achievements

At the beginning of the training, participants will be invited to express their expectations to confirm the adequacy between their knowledge, their individual objectives and those of the training (positioning grid).

These expectations will be taken up during a round table discussion to refine, if necessary, the content and the course of the training.

The evaluation of achievements and skills is carried out via a checklist of theoretical and practical work, according to the OJT1 & OJT2 process according to the WI-0004.

At the end of the training, a hot evaluation must be completed by each of the trainees. At the end of the session, **an assembly/commissioning certification valid for 3 years** will be issued by the training centre (TIA).

High Voltage SF6 Circuit Breaker T type GL315 -> GL318 with associated mechanical drive FK3-xx

Operation and Maintenance - (M1 & M2)

Réf. V5542E



Destinated for

Technical team involved in Operation and Maintenance of GL > 245 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

None



Method

Theory: 60% /Practice: 40%



Duration

3 day(s)



Number of participants

6 trainees



Place

TIA – Training Center of Aix Les Bains



Objectives

- To be able to perform the Operation & commissioning of a CB LV type GL > 245 kV
- To know how to use the required documentation
- To apply the safety rules



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

High voltage Safety

Practical work risks in the environment
Handling
Elements under pressure Mechanical risks
Voltage risks (LV) Chemical risks

Handling procedures for SF6 and its mixtures according to IEC62271-4

Module A: Awareness

People concerned by module A
Greenhouse effect
Environmental impact of the Sulphur hexafluoride SF6
Physical and chemical characteristics of SF6
SF6 applications
Understanding of the design of electric power equipment
Personal safety and first aid

Module B1: Maintenance not implying gas recovery

People concerned by module B1
SF6 – IEC Standards (according to 60376 and 60480 IEC standards)
SF6 quality measurement
Categories of gas-filled compartments SF6 filling operation: topping up Storage, transport, and labelling Obligation of recording SF6 data

Electrical phenomena related to circuit breaker operations

Definitions and standard applicable
Current withstands, making & interruption
Study of breaking
Fault current

SF6 monitoring on GL

SF6 densimeter Levers localization Wika densimeter Refill port (valve)
Safety valve
Molecular sieve

Gas tightness

SF6 gas tightness testing tools Gaskets and greases
Sealing procedures

Evolution of SF6 circuit breakers in AIS

Historical
Meaning of the designation Changes in energy requirements for operations per pole

Presentation of GL31x SF6 circuit breakers

Range GL3xx Pole architecture
Pole / mechanical control link Interrupting chamber / insulating column coupling
Operating sequences of interrupting chamber
GL316 rating plate
Circuit breaker operating sequence

FK 3-X spring mechanism

Presentation Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators Manual operations
Minor and major maintenance

Maintenance and tooling for GL circuit breakers with spring mechanism

Maintenance plan for SF6 circuit breakers type GL316
Dedicated documentation for maintenance of the GL316
Maintenance in detail
Dedicated tooling for maintenance

OPERATION AND MAINTENANCE (Following the RES310M “Commissioning test report” and Instruction Manual)

Site preparation

Collect the appropriate documentation
Collect the appropriate tools and procedures

Operation and maintenance of the GL31x T type circuit- breaker following RES310M

- Filling the characteristics
- Preliminary inspections / identification
- Note down the counter reading
- Pressure with tools
- SF6 quality check
- Density thresholds check Contact resistance measurement
- Mechanical times (principals and auxiliaries) Various checking (operations)
- Note down the counter reading



Practice conditions

In Factory: an apparatus like your own equipment – a cell in dead conditions with gas will be at your disposal for the practical works.

On site: customer must put at disposal a bay of the referenced AIS in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

High Voltage SF₆ Circuit Breaker in T-shape type **GL315 – GL316 – GL317** with associated mechanical drive FK3-xx

Erection & commissioning (WI-004 with OJT1 & OJT2)

Réf.V5523E



Destinated for

Technical team involved in Erection and commissioning of GL > 245 kV
Normal experience in H.V. switchgear, basics in electrical and mechanicals



Required knowledge

None



Method

Theory: 20% /Practice: 80%
GE Training supports – Instruction manual



Duration

5 days



Number of participants

4 to 6 trainees



Place

Customer site



Objectives

- To apply the safety rules
- To be able to use properly the documentation in relation of the E&C.
- To be able to perform the Erection and commissioning of a CB LV type GL > 245 kV



Program

Presentation of the session

Presentation of the training documents
Review of the basics in safety

The SF₆ and applications

Review of the basics
The densimeter (description and checks)
The tools to be used

Presentation of the circuit breakers

Range in GL31x
Pole architecture
Rating plate
Circuit breaker operating sequence

FK3-x spring mechanism

Principle of operation
Minor and major maintenance

Maintenance and tooling for GL31x

Description of the maintenance plans
Documentation
Dedicated tooling for maintenance

ERECTION AND COMMISSIONING
(following the RES310M in the
Instruction Manual)

Day 1 (afternoon)

Site preparation

Collect the appropriate documentation
Collect the appropriate tools, consumables,
and procedures

Erection preparation

Installation respecting the safety rules
Identification of sub-components

**GL31x erection procedure
(Instruction Manual)**

Packaging and identification
Specific tools (handling, erection)
Identification of the bolting
Identification of the components
Consumables
Necessary tools
N₂ checking (interrupting chambers and
columns)
Supporting frame assembly
Lifting and positioning the poles

Day 2

End of the establishment of the poles

**GL31x erection procedure
(Coupling column and chambers)**

Prepare the area for the chambers
Interrupting chambers preparation
(Terminals, capacitors, stress-shields)
Prepare the operation of coupling
Execute the coupling with the coach
Start the vacuum

Day 3

Coupling column and chambers

Finish the coupling
Finish the vacuum of the circuit breakers
Installation of the 3 operating devices

Day 4

**Wiring and connection of the circuit
breaker to the network**

Day 5

**Commissioning of the GL31x circuit-
breaker following RES310M**

Filling the characteristics
Preliminary inspections / identification
Checks after erection
Note down the counter reading
Pressure with tools
SF₆ quality check
Density thresholds check
Contact resistance measurement
Mechanical times (principals and
auxiliaries)
Various checking
Note down the counter reading

Trainer evaluation

Filling the check list and validation
Filling the training evaluation

Deliverance of the certification

*Check by our quality department
Sending of nominative certificate*



Trainer

Experienced trainer with a strong field experience.



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

Pump Storage Power Plant (PSPP) with GCB type **FKG1N/SDS + Back-to-back + Phase Reversal Disconnecting Switch** equipped with FK3-12 mechanical drive

Main Presentation

Réf. V9642E



Destinated for

Technical team involved in operation and maintenance of GCB installations. Normal experience on H.V. switchgear, basics in electrical and mechanicals.



Required knowledge

Ø



Method

Theory: 100%



Duration

2 days



Number of participants

10



Place

Online - TEAMS



Objectives

The participants will be able to know the PSPP with GCB FKG1N type, the O&M philosophy and according to procedures, they will get knowledge on routine maintenance and simple inspections.



Program

Presentation of the session

Reception and welcome
Confirmation of participants expectations

Handling procedures for SF₆ and its mixtures according to IEC62271-4

Module A: Awareness

Module B1: Maintenance not implying gas recovery

Reminder

Concept of FKG Generator Circuit Breaker

Why a Generator Circuit Breaker
Presentation and characteristics
General characteristics
Associated components
Induced currents

Electrical phenomena related to circuit breaker operations

Definitions and standard applicable
Current withstands, making & interruption
Study of breaking
Fault current

Gas tightness

SF₆ gas tightness testing tools
Gaskets and greases
Sealing procedures

Generator Circuit Breaker – FKG1

Device technology
The circuit breaker FKG1
The earthing switch MKG1
The starting switch IKG1

Starting Disconnecting Switch– SDS

Device technology

Back-to-Back Switch– BtB

Device technology

**Phase Reverse / inverse line
Disconnecter Switch– PRD**
Device technology

Electrical control mechanisms - CMK
Description
Components
Inside view

FK 3-X spring mechanism
Presentation
Principle of operation
The damper
Limit switch and spring status indicator
Operation orders
Optical indicators
Manual operations
Minor and major maintenance

SF₆ monitoring on FKG
SF₆ densimeter
Levers localization
Wika densimeter
Refill port (valve)
Safety valve
Molecular sieve

**Maintenance and tooling for FKG circuit
breakers**

Maintenance plan and documentation
Electrical wear limit
Tooling

Bay design of the PSPP
Single line layout/diagram
Apparatus location
Monitoring device
Study the Manuals

**Apparatus maintenance- circuit-breaker
following RES337 and spring
mechanism**

Contact resistance measurement
Mechanical times (principals and
auxiliaries)
Contact tube position
Various checking
Counters
Check general status of the mechanical
drive
Remove orders coils
Remove electrical motor (if applicable)
The damper

Explanation of the Interlocking drawing



Practice conditions

In Factory: not available.

On site: if customer must put at disposal a PSPP in dead conditions with gas for the practical works with the necessary tools and provide safety access to the site and equipment.



Trainer

Experienced trainer with a strong field experience



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

Power transformer: Operation and maintenance

Réf. A4212E



Destinated for

Engineers and senior technicians involved in the operation and maintenance of power transformers. Basics in electrical and mechanicals, electrical qualification required.



Required knowledge

Ø



Method

Theory: 80 % /Practice: 20%



Duration

4 days



Number of participants

5 maximum (for better efficiency and safety on application)



Place

TIA



Objectives

- to understand power transformer technology
- To know the different transformer type on the grid
- to ensure the operation of the power transformer
- to understand the suitable OLTC technology
- Description and role of components and transformer protections
- to ensure the appropriate maintenance all along the transformer life span
- To acquire basics for oil analysis and interpretation



Program

Presentation of the session

- Reception and welcome
- Confirmation of participants' expectations

- Temperature monitoring and cooling system, valves, pumps, etc.

Technical characteristics

- Reminder, description, technology and operation of dry transformers and transformers immersed in a dielectric fluid
- Operating constraints, disturbances (overvoltage, short-circuits, overcurrent, etc.), harmonics
- the different uses of transformers

Transformer protections

- Buchholz relay, non-return valve, DGPT2, DMCR,
- Desiccant
- Conservator
- Overpressure valves
- Surge arresters
- Main tank
- Thermal image

Components

- Auxiliary cabinet
- Bushing
- Oil level
- Oil circulation indicator

Voltage adjustment

- Off load adjustment
- On load adjustment (Switching in oil)
- On load adjustment (Switching in vacuum)
- Operating mechanism

Factory test

- Routine test
- Type test
- Specific test

Maintenance principle

- Steps and challenges
- Predictive and preventive maintenance
- Oil analysis and results interpretation
- Internal moisture
- FDS (Frequency Domain Spectroscopy), FRA (Frequency Response Analysis)
- Partial discharge
- Scheduled repair
- Oil treatment
- Curative maintenance
- Trouble shooting

Cases study

- Nameplate analysis
- Analysis of components disassembly and reassembly (Buchholz relay, cooling radiator, Bushing)
- Causes analysis of Buchholz relay tripping
- Dissolved gases analysis of oil samplings and results interpretation
- On load tap-changer presentation and operation
- On load tap-changer: Exam of a transfer switch in oil and vacuum.

Session evaluation



Trainer

Experienced trainer with a strong field experience



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.

On Load Tap Changers

Operation and maintenance

Réf. C4532E



Destinated for

Operation and maintenance technicians.
Basic knowledge in electrical and mechanical engineering, and with suitable electrical safety qualification



Required knowledge

Ø



Method

Theory: 30% /Practice: 70%



Duration

4 days



Number of participants

5 maximum (for better efficiency and safety on application)



Place

TIA



Objectives

- To understand the operating principle of on-load tap changers
- To understand the different technologies of oil-commutated and vacuum interrupter or load tap-changers
- To know the advantages of vacuum interrupt switching over oil switching
- To disassemble for maintenance the oil-commutated on-load tap-changers of type C, D, M and V



Program

Presentation of the session

- Reception and welcome
- Confirmation of participants' expectations

Theory

- Reminder of transformer function
- On load tap changer function
- On load tap changer: operation principle
- Operating principle of an inverter selector
- Transfer switching sequence
- Switching sequence of the selector switch
- The different on load tap changers technologies
 - Arc break in oil
 - Arc break in vacuum
- Operation principle of tap changers type C, D, M and V with switching diagram for each type
- Operating principle of VV and VR type vacuum tap changers with switching diagram for each type

Practice

- Workshop presentation of types C, D, M and V:
- Remove the insertable blocks of the 4 types of tap changers
- Examination of the different parts: contacts, springs, resistances, control, and measurement of transition resistances
- Examination of the operation of contacts and insertable blocks of types M and V through a polycarbonate cylinder during changes of taps carried out by crank
- Complete reassembly of insertable bodies and refitting on tap changer
- Presentation of an insertable block of a vacuum interrupter tap changer:
- Interchangeability:
 - Operating principle of the VM-type vacuum interrupter tap-changer whose insertable block is completely interchangeable with the M-type tap-changer
- On-load tap-changer protection:
 - Protective relay: RS1000, RS2001
 - Overpressure valve
 - Desiccant with silica gel
 - Plug-in block oil filter and operating principle
- Maintenance:
 - Lifetime of wearing parts
 - Maintenance interval
 - Complementary operations
 - Precautions to take before starting
- Control cabinets:
 - Presentation of the different elements
 - Components to monitor
 - Passage of position (manual operation) by crank
- Difference between the control of the cabinet and the movement of the tap-changer:
 - Determination of the difference between the two movements
 - Correction of the difference between the two displacements
 - Verification of the result obtained
- On-load tap-changer protection:
 - Examination of an RS1000 and its operation, use of the test buttons and internal examination
 - Examination of an RS2001 and its operation, use of the test buttons and internal examination.

****An apparatus similar to your own equipment and a cell in dead conditions with gas will be at your disposal for the practical works.***

Theoretical Exam

Session evaluation



Trainer

Experienced trainer with a strong field experience



Evaluation

As part of our quality improvement policy, an evaluation sheet is submitted to trainees at the end of the training with the purpose of improving our programs through their comments.