SUPPLIER	Supplier No.
	P.O. No.

DOCNO.: 65703

GPA

GENERATOR AND POWER TRANSMISSION PROTECTION SYSTEM

CHAPTER IV: SYSTEM AND EQUIPMENT DEFINITION AND DESCRIPTION

REV	DATE	DR. By	CH. By	APPR. By	MODIFICATIONS	STATUS
Z5	2007-06-26	RH			MOD. 06027-1; DDR 619/06	ESKOM
Z4	2006-06-20	YS	MH	NB	MOD. 06027-2; DDR 630/06	ESKOM
Z3	2006-02-07	YS	MH	EJK	MOD. 02204; DDR 2348/05	ESKOM
Z2	2004-01-28	MH	ST	NWB	MOD. 02014-1; DDR 1239/02	ESKOM
Z1	2003-08-20	LS	LDS	ARL	MOD. 02014-2; DDR 1248/02	ESKOM

KOEBERG NUCLEAR POWER STATION

Eskom Generation

FRAMATOME – ALSTHOM ATLANTIQUE
SPIE BATIGNOLLES – FRAMATEG

CONTRACT No. OPN 11229

CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM	CONTRACTOR MEMBER Doc. No.	P 4108 A 41494

DOCUMENT NUMBER	K	B	A	1	2	1	7	G	P	A	0	0	4		A	A	-	-	L	T	P	1/25
REV	Z1	Z2	Z3	Z4	Z5																	

4.1 - DESCRIPTION

4.1.1 - General Description

The G. P. A. comprises the following main components:

- a box 001 CR including : current transformers connection to generator terminals.
- a cubicle 001 AR containing : voltage transformers
- a cubicle 002 AR containing : generator neutral earthing resistor.
- cubicle 003 and 004 AR including : protection static relays
- cubicle 005 AR including : numerical protection relay.

Z3

- rotor shaft high peak current or voltage alarm is generated in cubicle 005 AR

REV	DR BY	DATE	MODIFICATION	CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM
Z3	YS	2006-02-07	MOD. 02204; DDR 2348/05		
Z2	MH	2004-01-28	MOD. 02014-1; DDR 1239/02	CONTRACTOR MEMBER DWG NO.	P 4108 A 41494
Z1	LS	2003-08-20	MOD. 02014-2; DDR 1248/02		

DWG NO.	K	B	A	1	2	1	7	G	P	A	0	0	4	[redacted]	A	A	-	-	L	T	P	2 / 25

4.1.1.1 - Current transformers at generator terminals

These transformers are erected in the generator terminal enclosure and they are air cooled by the ventilation plant dedicated to the generator terminal enclosure (see system GSY), 3 CT's are arranged per terminal from top to bottom in the following order.

- neutral side :
  RATIO 30000/5A
  GPA 001 TI, 002 TI, 003 TI : supply of the differential relays
  GPA 004 TI, 005 TI, 006 TI : supply of the loss of synchronism and Overload relays – 005 and 006 TI supply of load imbalance Relays.

Z2 [redacted]

  GEX 007 TI, 008 TI 009 TI : supply of the unit voltage and excitation – regulation (see system GEX)

- phases side :
  RATIO 30000/5A
  GPA 012 TI, 013 TI, 014 TI : supply of the differential relays

  GPA 018 TI : supply of the reverse power relay

  GPA 015 TI, 016 TI, 017 TI : supply of the metering and measuring apparatuses
  RATIO 30000/1A (see system KKO)

The secondaries of each CT are connected to terminal blocks located in the 001 CR cubicle, except those of GEX 007 TI, 008 TI, 009 TI.

4.1.1.2 - voltage transformers cubicle

This cubicle 001 AR is installed in the turbine hall, at the level 6m, and is connected to a tee off from the 24 kV bus-bars between the generator and the generator circuit breaker.

The connection a sealed bushing prevention cubicle faults from propagating up to the enclosures (see system GSY).

The cubicle is made up of three panels, one per phase, each compartments, one on top of the other.

The upper compartments include :

- GPA 004,005, 006 TU ($\frac{24kV}{\sqrt{3}} / \frac{100\ V}{\sqrt{3}}$) : excitation regulation supply (system GEX)

- GPA 007,008,009 TU have two secondaries each
  1) The First one ($\frac{100\ V}{\sqrt{3}}$) supplies the protection relays and the turbine regulation (GRE)
  2) The Second one ($\frac{110\ V}{\sqrt{3}}$) supplies the metering system (KKO) and the synchronizing system (GSY)

- the poles of the isolators GPA 001 JS for the tests

- the tap connections to the excitation transformers. The lower compartments include the test transformers GPA 001, 002, 003 TU ($\frac{24\ kV}{\sqrt{3}} / \frac{100\ V}{\sqrt{3}}$)

Each compartment is equipped with a lockable door, with the key trapped when door is open.

The keys for the upper part are kept in an auxiliary box and are freed following the introduction of a key obtained from the power station control room

The keys for the lower part are freed by opening the isolation switch.

The isolation switch can only be operated after being unlocking. The key is available only when the unit is out of service. The position of the disconnecting switch can be checked trough a glass port hole using a torch.

4.1.1.3 - Generator neutral earthing resistor cubicle

This cubicle (002 AR) includes :

. 1 resistor of 1 000 ohms limits the neutral earth currents to ≃ 14 A under normal operation and to ≃ 15,3 A under exceptional operation (1,1 Vn).

. 2 current transformers GPA 010 TI, 011 TI both with 5/5 ratios located on the earthing resistor. One of them being for stator earth protection, the second one for oscillograph recording (system KKO).

The cubicle 002 AR is located in the turbine hall at the level 6 m. This cubicle is fitted with a door and lock "key trapped - door open". This key can be freed when the unit is taken out of service.

...

The secondaries of the CT's are brought back to the regrouping box 001 CR.

4.1.1.4 - Regrouping box for current and voltage circuits

This box 001 CR includes :

- the terminal blocks connected to the secondaries of the measurement and protection transformers located respectively at generator terminals (except excitation CT's) on generator neutral cubicle 002 AR and in cubicle 001 AR as well,
- voltage circuit fuses,
- the current short circuiter on the CT secondaries 003 JS,
- the test boxes units for the test CT's and VT's (022 BC and 021 BC),
- the disconnecting switch with visible break for all the voltage circuits.

4.1.1.5 - Protection relays cubicles

The cubicles 003 and 004 AR, housing the static protection relays, and their associated logic are of the GSX5 type, CEM-BBC manufactured and are installed in the electrical building at the 15,50 m level in room L 605. In cubicle 005 AR there is an ABB REG 216 numerical protection relay installed. See KBA 1217 GPA 710 for the relay functions.

Each cubicle includes :

For cubicles 003 and 004 AR

- on the front face, a pivoting frame comprising :
  - the protective relays distributed in groups (1 group for generator protection, one group for transformer protections)
  - the logic for action elaboration, comprising a programming Matrix
  - 2 supply devices (1 per relay group) for the conversion of the 48V to 24V (two 48V outgoings are necessary)
  - Seal in modules
  - Test module
- Inside, modules receiving external digital signals, the elaboration of tripping orders and signalling.
- At the rear, ESSAILEC terminal boxes for current and voltage circuit connections.

Z3

Box GPA 002 CR

- Contains GPA 001 XU shaft monitor

				CONTRACTOR MEMBER	**ALSTHOM ATLANTIQUE CGEE ALSTHOM**
Z3	YS	2006-02-07	MOD. 02204; DDR 2348/05		
Z2	MH	2004-01-28	MOD. 02014-1; DDR 1239/02	CONTRACTOR MEMBER	**P 4108 A 41494**
Z1	LS	2003-08-20	MOD. 02014-2; DDR 1248/02		
REV	DR BY	DATE	MODIFICATION	DWG NO.	

DWG NO. K B A 1 2 1 7 G P A 0 0 4 [redacted] A A - - L T P 5/25

4.1.1.5.1 - Protection relays

The protections consist of modular, withdrawable sub-assemblies of static relays fitted on cubicle front face.

The setting signalling and testing elements are mounted on front of each relay.

The relays are detailed below with their reference marks, setting ranges, signalling and testing devices.

IBX 164 - Single phase definite time overcurrent relay

current setting range IE = k1 x k2 x In
k1 = 10 step switch (0.1/0.2 - 1.0)
k2 = 3 step switch (0.25/1/2.5)
time setting (if used) t = C (t1 +t2)
C = 2 step switch (0.1/1)
t1 = 10 step switch (1/2/3 - 10 s)
t2 = 10 step switch (0/0.1/0.2 - 0.9 s)
hl = starting indicator (yellow)
ha = delayed tripping indicator (red)
bp = test button
br = reset button

DIX 111 - Three phase differential relay

eg = basic setting 10 to 25 %
ev = pick-up ratio setting 5 to 25 %
ha = tripping indicator
br = reset button
bp R-S.T. = test buttons

USX 115 - Single phase definite time overvoltage relay

ea1 = time tripping setting range (1.0 to 1.6 Vn)
et = timer adjustment (0.5 to 6 s)
ea2 = instantaneous tripping setting range (1.4 to 2.1 Vn)
hl = starting indicator
ha = tripping indicator
hm = instantaneous tripping indicator
br = reset button
bp = test button

RGX 101 - Pulse Counter (with 2 independent counters)

bz1-bz2 = stepped rotary switch for adjustment of pulses
ha = tripping indicator
hl = starting indicator
bp = test button
br = reset button

PPX 113 - Power relay for reversal of active power

Type of relay connection - min or max power
- method of 2 (2 WM) or 3 (3 WM) Wattmetters

18 = test button
19 = reset button

IPX 146 - Inverse Time negative sequence relay

K1 = constant setting range 5-30
K2 = constant setting range 0.02-0.2
tr = reset
ha = tripping indicator
hl = starting indicator
hz = counter indicator
bp = test button
br = reset button
Moving coil indicator for unbalance

IPX 132 b - Definite time negative sequence relay

gm1 = setting switch for the unbalance current (1st stage 3 - 15% of In)
gm2 = setting switch for the unbalance current (2nd stage 15 - 40% of In)
gt1 = timer adjustment 1st step 0,5 to 5 s
gt2 = timer adjustment 2nd step 1,5 to 15 s
ha1 = tripping indicator 1st stage
ha2 = tripping indicator 2nd stage
br = reset button
bp = test button
Moving coil for unbalance

ISX 147 - Three phase definite time overcurrent relay

ea = tripping setting switch range 0,5 to 2,5 In
gt = timer adjustment 0.1 to 5 s 0.2 to 10 s for ISX147t2
ha = tripping indicator
hl = starting indicator
br = reset button
bp = test button

IWX 161a1 - Rotor earth fault relay with ancillary unit YWX 111.1

Rf = adjustment of the fault resistance 0 to 5 000 Ω
t = adjustment of the trip time 0.5 to 5 s
A = tripping indicator
R = reset button
T = test button

REV	DR. by	DATE	MODIFICATIONS
B	PERNIN	18.3.82	BROUGHT UP TO DATE

CONTRACTOR MEMBER: ALSTHOM ATLANTIQUE / CGEE ALSTHOM
CONTRACTOR MEMBER DWG No: P 4 1 0 8 A 4 1 4 9 4

DWG No: KBA 1 2 1 7 G P A 0 0 4 A A L T P 7/25

B A4 NORME AFNOR 70

PPX 105b - Single phase power relay

ea = setting switch for the pick-up value (0.5-5% of Pn)
gt1 = timer adjustment (0.5 - 5s) (5-25% of Pn)
gt2 = timer adjustment (5 - 50 s)
ha1 = tripping indicator
ha2 = tripping indicator
br = reset button
bp = test button

FCX 103 - Frequency relay 3 thresholds

et = timer adjustment (75 to 750 ms)
ha = tripping indicator
br = reset button
bp = test switch
pr = socker for test

USX 116 - Definite time undervoltage relay (with input filter EBC 111)

ea = setting switch range 60 to 100 % Vn
et = timer adjustment 50 to 500 ms
ha = tripping indicator
hl = starting indicator
br = reset button
bp = test button

SGX 115-116 - Integrator relay

	SGX115 158	SGX115 1S22	SGX115 1S23	SGX116
er = drop out switch value setting	1-10s	0.1-1s	0 s	1-10 s
ea = pick-up switch value setting	0.5-6s	0 s	0.5-6s	6-60 s

ha = tripping indicator
br = reset button

IKC 602 Ni S 32 - Inverse time overcurrent relay

K = constant setting range 0.05 to 1.0
Imo = instantaneous tripping setting range (Not used)
13a = time delay tripping indicator
13b = instantaneous tripping indicator
13c = starting indicator

REV	DR. by	DATE	MODIFICATIONS
B	PERNIN	18 3 82	BROUGHT UP TO DATE

CONTRACTOR MEMBER
CONTRACTOR MEMBER DWG No.
ALSTHOM ATLANTIQUE
CGEE ALSTHOM
P 4 1 0 8 A 4 1 4 9 4

DWG No KBA 1 2 1 7 G P A 0 0 4 A A L T P 8_5

B A4 NORME AFNOR 70

3a, 3b = Reference current (Phases R, T) range 1 = 1 to 2.8 IN
range 2 = 3 to 4.8 IN
3c = Reference current (Phase S) range 1 = 0.2 to 0.56 IN
range 2 = 0.6 to 0.96 IN
2a,b,c = range selector switch

16 = reset button
18 = test button

ZSX 102 - Impedance Relay

et = timer adjustment 0.5 to 5s
ea = tripping setting range 0.5 to 5 Ohms/phase
ha = tripping indicator
hl = starting indicator
br = reset button
bp = test button

UNK 3338 a, z - Internal angle measure relay

- On voltage converteur (XZ 8923a, Var. 1)
  P1, P2, P3 } = compensating of the external phase-shifts (0-120°)

- Filter, monitoring (XZ 8822a, Var. 10)
  P3 = Setting of the electrical zero of the internal angle
  P5 = minimal valve threshold of the stator voltage (0 to 100 %)

- Threshold value detector (UN 0516a-P, Var. 1)
  P2 = Internal angle setting (0-180°)

AAT 451 - Output amplifier

The module AAT 451 (printed circuit) contains 4 amplifiers which, though quite independant of one another, each provides a potential free contact.

Each protection is made of the following relays with their using reference in the cubicle and drawings :

CUBICLE 003 AR

Differential protection

DIX 111 - E 11

REV	DR. by	DATE	MODIFICATIONS	CONTRACTOR MEMBER	CONTRACTOR MEMBER DWG No.
	PERNIN	18.3.82	BROUGHT UP TO DATE	ALSTHOM ATLANTIQUE CGEE ALSTHOM	P 4 1 0 8 A 4 1 4 9 4

DWG No. KBA 1 2 1 7 G P A 0 0 4 A A L T P 9/25

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Overvoltage protection 1st step

USX 115 - E 371
AAT 451 - E 431 1st way

Overvoltage protection 2nd step

USX 115 - E 372
AAT 451 - E 431 2nd way

Overload protection

ISX 147 t2 - E 141
AAT 451 - E 431 3rd way

Stator earth protection

IBX 164 - E 311
AAT 451 - E 431 4th way

Load imbalance 1st and 3rd step protection

IPX 146-5s6 - E 181
SGX 115-1s8 - E 251 (timer relay)
AAT 451 a - E 437

Load imbalance 2nd step protection

IPX 132 b - E 182
AAT 451 - E 432 1st way

Rotor earth protection

IWX 161a-1 - E 19
AAT 451 - E 432 2nd way

Loss of synchronism protection

- Active reverse power :

  PPX 113-1 - E 22
  RGX 101 - E 20
  AAT E 432 - 4th way (timing)
  AAT E 433 - 1st way (starting)

- Internal angle

  RGX 101 - E 20
  AAT E 432 - 3rd way

Reverse power protection

PPX 105 b - E 211
SGX 116 - E 261 (integrator)
AAT 451 - E 433 2nd way

Tank earth fault protections

IBX 164 - E 312
AAT 451 - E 434 1st way — generator transformer phase R

IBX 164 - E 313
AAT 451 - E 434 2nd way — generator transformer phase W

IBX 164 - E 314
AAT 451 - E 434 3rd way — generator transformer phase B

24 kV earth fault protection

IBX 164 - E 315
AAT 451 - E 434 4th way

6,6 kV Busbars short circuit protection

ISX 147 - E 142
AAT 451 - E 435 3rd way — LGA switchboard

ISX 147 - E 143
AAT 451 - E 435 4th way — LGD switchboard

Undervoltage protection

USX 116 - E 38
SGX 115 1s22 - E 252
SGX 115 1s23 - E 256
SGX 115 1s23 - E 253
AAT 451 - E 436 1st way

Frequency protection

FCX 103 s27 - E 42
AAT 451 - E 436 4th way

REV	DR. by	DATE	MODIFICATIONS	CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM
				CONTRACTOR MEMBER DWG No.	P 4 1 0 8 A 4 1 4 9 4

DWG No.	KBA	12	17	GPA	004		AA		LTP	11/25

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CUBICLE 004 AR

400 kV Earth fault Protection

IDMT — IKC 602 ni 532 - E 17
AAT 451 - E 432 1st way

D.T. — IBX 164 - E 31

AAT 451 - E 432 2nd way

400 kV Overcurrent (Tap change O/C blocking)

ISX 147 - E 14
AAT 451 - E 432 3rd way

UNDER IMPEDANCE

ZSX 102 - E 28
AAT 451 - E 431 1st way

UNDER POWER

PPX 105b - E 21
AAT 451 - E 431 2nd way

INTERNAL ANGLE MEASURE

UNK 3338a, z - E 51/53

REV	DR. by	DATE	MODIFICATIONS
	PERNIN	18.3.82	BROUGHT UP TO DATE

CONTRACTOR MEMBER: ALSTHOM ATLANTIQUE CGEE ALSTHOM

CONTRACTOR MEMBER DWG No. P 4 1 0 8 A 4 1 4 9 4

DWG No. KBA 1 2 1 7 G P A 0 0 4 — A A - - L T P 12/25

B A4 NORME AFNOR 70

4.1.1.5.2 - Programming Matrix

The programming matrix is divided into two identical parts. The left part is connected to the first relay group and the right part to the second relay group.
Each part of the matrix comprises 13 vertical channels, on which data is received from the matrix relay, and 12 horizontal channels forming 12 different trip channels, diode connectors are used to direct data received on a vertical channel to the various horizontal channels.

- the vertical channels are marked 1 to 13L and 1R to 13R
- the horizontal channels are marked AL to NL and AR to NR

The vertical channel receive data from :

- CUBICLE 003 AR LEFT PART

1 - Differential protection
2 - Overvoltage protection 1st stage
3 - Overvoltage protection 2nd stage
4 - Overload protection
5 - Stator earth protection and 100% Stator E/F from REG 216 Z5
6 - Load imbalance protection 1st stage
7 - Load imbalance protection 3rd stage
8 - Load imbalance protection 2nd stage
9 - Rotor earth protection
10 - Loss of synchronism protection (reverse active power)
11 - Loss of synchronism protection (internal angle overtake)
12 - Reverse power 1st stage and reverse power from REG 216
13 - Reverse power 2nd stage and reverse power from REG 216

- CUBICLE 003 AR RIGHT PART

1 - Generator transformer tank earth protection phase R
2 - Generator transformer tank earth protection phase W
3 - Generator transformer tank earth protection phase B
4 - 24 kV earth protection 2nd stage
5 - 24 kV earth protection 1st stage
6 - Not used
7 - 6,6 kV LGA busbars protection
8 - 6,6 kV LGD busbars protection
9 - Undervoltage protection 1st stage
10 - Undervoltage protection 2nd stage
11 - Underfrequency protection (1st stage)
12 - Overfrequency protection
13 - Underfrequency protection (2nd stage)

- CUBICLE 004 AR LEFT PART

1 - Under impedance protection
2 - Under power (manual tripping authorization)
3 to 13 not used

- CUBICLE 004 AR RIGHT PART

1 - 400 kV_IDMT earth fault (normal inverse) 1st stage
2 - 400 kV D.T. earth fault
3 - 400 kV overcurrent protection (O.L.T.C. O/C blocking)
4 to 13 not used

The horizontal channel is used for :

- CUBICLE 003 AR LEFT PART

Z2

A - H.V. Circuit breaker tripping and from REG 216
B - Not used
C - Excitation tripping (Field switch trip) and from REG 216
D - Turbine tripping and from REG 216
E - Stator water pumps tripping and from REG 216
F - Generator circuit breaker tripping and from REG 216
G - Not used
H - Reverse power 2nd stage and from REG 216
K - Generator circuit breaker tripping 2nd stage
L - Not used
M - Alarm and from REG 216
N - Used for time measuring

- CUBICLE 003 AR RIGHT PART

A - H.V. circuit breaker
B - Not used
C - Excitation tripping (Field switch trip)
D - Turbine tripping
E - Stator water pumps tripping
F - Generator circuit breaker tripping
G - Not used
K - Not used
H - Under frequency fault
L - Not used
M - Alarm
N - Used for time measuring

				CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM
Z2	MH	28/01/04	MOD. 02014-1; DDR 1239/02	CONTRACTOR MEMBER	P 4108 A 41494
Z1	LS	20/08/03	MOD. 02014-2; DDR 1248/02		
REV	DR BY	DATE	MODIFICATION	DWG NO.	

DWG NO. K B A 1 2 1 7 G P A 0 0 4 [redacted] A A - - L T P 14/25

- CUBICLE 004 AR LEFT PART

A - } Not used
B - }
C - Excitation tripping (Field switch trip)
D - Turbine tripping
E - Not used
F - Generator circuit breaker tripping
G - } Not used
K - }
H - Manual tripping authorization
L - Not used
M - Alarm
N - Used for time measuring

- CUBICLE 004AR RIGHT PART

A - H.V. circuit breaker tripping
B - Not used
C - Excitation tripping (Field switch trip)
D - Turbine tripping
E - Not used
F - Generator circuit breaker tripping
G - } Not used
K - }
H - Blocking of O.L.T.C.
L - Not used
M - Alarm
N - Used for time measuring

Connections between vertical and horizontal channels are made using 2 diodes and placed according to the desired sequence of actions.

Two two-positions "SERVICE" and "TEST" key-switches , which are located near each matrix, allow for a separate check on the operation of each relay group and corresponding tripping circuits. The key is trapped in the "TEST"position. These switches also allow for a check on the relays under injection of an analog signal by action on the "TEST" push-button of the relays.

The tests can be carried out only if the unit is shut down.

Push-buttons marked R, S, T located under each vertical channel allow, when in "TEST" position, the switching of polarities onto the tripping circuits and currents or voltages onto prospective relays, by means of contacts.

These push buttons light the green lamps corresponding to the actions which must be involved by the Tested Protection Relay.

REV.	DR. by	DATE	MODIFICATIONS
B	PERNIN	18.3.82	BROUGHT UP TO DATE

CONTRACTOR MEMBER
CONTRACTOR MEMBER DWG No.

ALSTHOM ATLANTIQUE
CGEE ALSTHOM

P 4 1 0 8 A 4 1 4 9 4

DWG No. KBA 1 2 1 7 G P A 0 0 4 A A L T P 15/15

A4 NORME AFNOR 70

Green and red lamps placed in the continuation of each horizontal bar light up as a result of the tests when the operation of the corresponding relays is satisfactory.
In "SERVICE" position, only the red lamps are lit when the relay operates.
One set of green, red and yellow signal lamps per matrix indicates whether the corresponding relay group is operating under test and supplied.

4.1.1.5.3 - Power Supplies

These two devices are located at the top of the pivoting frame and each one is connected to two 48 V feeders from LCA switchboard. Each of them includes one 48 V - 24 V NWx 443 (U2) and (U5) converter, one EBP 458 (U1) and (U4) input filter and one RUT 414 (U3) and (U6) stabilizer.
They supply each relay group on a fully independent basis. The filter includes one STOTZ 10 A protective circuit-breaker and is intended to eliminate the harmonics and the transient over-voltages.

The converter produces 24 V voltage for the supply of the protective relays.
The converter includes a (br) resetting button for re-actuation after complete loss of 24 V as the consequence of a fault.

The stabilizer produces a 18 V stabilized voltage necessary for some relays, from the 24 V voltage.
The presence of 18 V is indicated by a (ms) lamp.

4.1.1.5.4 - Seal in circuit

This circuit is divided in two parts for each relay group.
The first part, located behind the programming matrix, allows to seal-in or not the operation of a Protection relay (by mean of a strap).
The second part, located under the programming matrix includes the individual luminous reset push button, the general reset push button and the general Test-lamp.

4.1.1.5.5 - Test device

This single device in the cubicle allows for the injection of voltage or current variables into the protective relays when the key-switch of a group is on "TEST" position. It includes one voltmeter, one ammeter and potentiometers for vary the test voltage and current independently.

The test variables are injected in the tested relay by action on the push-buttons placed under the matrix.

The test can be performed only when the unit is shut down.

4.1.1.5.6 - Auxiliaries relay modules

Each module includes auxiliaries relays with their connections and one terminal block for connection to the cables outside the cubicle. There are 8 modules of this type arranged inside the cubicle, ensuring the decoupling between the protective relays and the external system. They perform the following functions :

AAX 111 : connections of the digital data coming from the external circuits

AAX 109 L : Signallings for the 1st protective relay group

AAX 110 L : Actions for the first protective relay group

EDX 105 L : Test contactors for the first protective relay group

EDX 106 : 220 V supply for the protective test device

EDX 105 R : Test contactors for the 2nd protective relay group

AAX 105 R : Actions from the 2nd protective relay group

AAX 109 R : Signallings for the 2nd protective relay group

Z2 See KBA 1217 GPA 710 for interface from REG 216

4.1.1.5.7 - Cabinet-rear panel

A connection channel is provided on the central part of the cabinet rear panel, through which the current and voltage transformer wiring can pass, to the test blocks.

4.1.1.6 - Cubicle 005 AR

The cubicle 005 AR is located near the cubicle GPA 004 AR in the electrical building at the level 15.50m.

This cubicle includes :

Z2
- REG 216 numerical protection
- Test plug facility to measure secondary currents in all the CT circuits.

4.1.2 - Interconnections with other systems

Functional boundaries

GEX : - connection terminals between the generator neutral and the limiting resistance.
- current transformers on generator terminals

GSY : voltage transformer 24 kV connections

GEV : Connection terminals located in GPA cubicles connected to GEV cables carrying analog data.

H.V. YARD : Appropriate cable terminals located in Marshalling kiosk (M.K)

(Lzi) For connection of GPA cables carrying analog data

LGA : appropriate cable terminals located in incoming voltage transformer panel for connection of GPA cables carrying analog data

GSE : controls terminals located in the GPA system

GRE : voltage terminals located in the GPA 001 CR

GST : controls terminals located in the GPA system

KKO : appropriate cable terminals located in the GPA 001 CR for voltage and current circuits

KKO : control terminals in the GPA system for the digital data to the oscillograph recorder.

GEV : control terminals located in GPA system

GEX : control terminals located in GPA system

GSY : control terminals located in GPA system

KIT : appropriate cable terminals in acquisition panel for connection of cables, to the computer and data processing system, carrying monitoring data

KSA : appropriate cable terminals in alarm cabinet for connections of cables to the "alarm processing system" and carrying relaying data

LCA : D.C. System terminals inside the GPA system

LNE : 220 V 50 Hz system terminals inside the GPA system

GEX : rotor shaft monitor

LBA : 125 V dc for 100% Stator E/F in GPA 005 AR. Z5

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Z5	RH	2007-06-26	MOD. 06027-1; DDR 619/06		
Z4	YS	2006-06-20	MOD. 06027-2; DDR 630/06		
Z3	YS	2006-02-07	MOD. 02204; DDR 2348/05		P 4108 A 41494
Z2	MH	2004-01-28	MOD. 02014-1; DDR 1239/02		

DWG NO.	K	B	A	1	2	1	7	G	P	A	0	0	4		A	A	-	-	L	T	P	18/25

Z2

The principle diagram of system GPA is given hereafter. (See Sheet 25/25).

4.2 - CHARACTERISTICS

4.2.1 - Current transformers

- At generator terminals

Differential protection ratio 30000/5A	:	GPA 001 – 002 – 003 – 012 – 013 – 014 TI 30 VA 5P15
Generator protections 30000/5A	:	GPA 004 – 005 – 006 TI 50 VA Cl : 1
Excitation 30000/5A	:	GEX 007 – 008 – 009 TI 15 VA Cl : 1
Test and reverse power 30000/5A	:	GPA 018 – 019 – 020 TI 30 VA Cl : 0,2
Measuring and counting 30000/1A	:	GPA 015 – 016 – 017 TI 75 VA Cl : 0,2

Z2

- in the earthing connection of the generator resistance earthing
  GPA 010-011 TI
  5/5A 30 VA Cl : 1
- in the earthing connection of the transformers tank
  GEV 001 – 002 – 003 TI
  1000/1A 15 VA Cl : 10P20
- in the earthing connection of the generator transformers
  GEV 004 TI 1600/1A 15 VA Cl :10P10
  GEV 005 TI 1600/1A Cl : ×
  GEV 006 TI 1600/1A 30 VA Cl : 1
- in the earthing connection of the unit transformer resistance earthing
  GEV 007 – 008 TI 5/5A 30 VA Cl : 1
- at the terminal of the secondaries of unit transformer
  GEV 2a1 – 2c1 10000/5A 50 VA Cl : 3
- in the 400 kV line (ESCOM SUPPLY)
  400/1200/1600/1A

4.2.2 - Voltage transformers

– at the generator terminals

Regulation GPA 004 – 005 – 006 TU

$$\frac{24\,000}{\sqrt{3}} \Big/ \frac{100V}{\sqrt{3}} \quad 100\,VA\ Cl{:}2$$

Protections – Measuring – Synchronization – Turbine regulation
GPA 007 – 008 – 009 TU

$$\frac{24\,000}{\sqrt{3}} \Big/ \frac{100V}{\sqrt{3}} \ (70\ VA\ Cl{:}0{,}5) \Big/ \frac{110V}{\sqrt{3}} \ (30\ VA\ Cl : 0{,}2)$$

Test GPA 001 – 002 – 003 TU

$$\frac{24\,000}{\sqrt{3}} \Big/ \frac{100V}{\sqrt{3}} \quad 50\,VA\ Cl{:}0{,}2$$

At the terminals of the LGA incoming voltage transformers panel

$$\frac{6600}{\sqrt{3}} \Big/ \frac{100V}{\sqrt{3}} \quad 50\,VA\ Cl{:}0{,}5$$

4.2.3 - Isolating switch of test voltage transformers 001 JS

rating current : 400 A
rating voltage : 24 kV
insulation voltage : 36 kV

4.2.4 - Generator earthing resistor

insulation voltage : 17,5 kV
resistor value : 1000 Ω
permissible current continuously : 1,5 A
10 s per hour : 15 A

4.2.5 - Protection cubicles 003 – 004 – 005 AR

Z2

– D.C. supply : 48 V (2 feeders from LCA switchboard)
– D.C. supply for 005 AR : 48 V (from LCC)
– A.C. supply : 220 V (from L.N.E. system) for tests
– Insulation voltage

2000 V 50 Hz for the circuits connected to the alternative current supply and to the current or voltage transformers
500 V 50 Hz for the circuits connected to the direct current supply

- Protective relays : each protective relay has a local indication, a reset push button and a test push button so as to check the relay without the using of the test unit module, or the test blocks

- the main characteristics of the protective relays are the following :

IBX 164 - Single phase definite time overcurrent relay

Rated current : 1 A
Setting range : 0,025 to 2,5 A
Operating time $\leqslant$ 35 ms
Time setting range : 0.1 to 10,9 s
(if used)
Internal consumption : measure 0.15 A
Auxiliary d.c. at rest 0.8 W
" " tripping 4 W

DIX 111 - Three phase differential relay

Rated current : 5 A
Basic setting (g) 10 - 25%
Pick-up ratio (v) 5 - 25%
Tripping time $<$ 50 ms
Internal consumption : measure 0.3 VA
Auxiliary d.c. 1 W

USX 115 - Single phase definite time overvoltage relay

Rated voltage : 100 V
Time tripping setting range : 1 to 1.6 Vn
Time setting range : 0.5 to 6 s
Instantaneous tripping setting range : 1.4 to 2.1 Vn
Internal consumption : measure : 0.5 VA
Auxiliary d.c. at rest 1,5 W
" " tripping 3 W

RGX 101 - Pulse counter (with 2 independent counters)

Adjustment range : from 2 to 38 impulses in steps of 2
Internal consumption at rest : 4,8 W
" " operating : 6 W
Automatic resetting : to zero after 5 mn

REV	DR. by	DATE	MODIFICATIONS	CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM
3	PERNIN	23.82	BROUGHT UP TO DATE	CONTRACTOR MEMBER DWG No.	P 4 1 0 8 A 4 1 4 9 4

DWG No. KBA 1 2 1 7 G P A 0 0 4 A A L T P 21/25

B A4 NORME AFNOR 70

PPX 113 - Power relay for reversal of active power

Rated voltage : 100 V
Rated current : 5 A
Operating range : ± 2 to ± 20 % of PN
Internal consumption mesure : voltage : 0.2 VA
" " " current : 0.5 VA

IPX 146 - Inverse time negative sequence relay

Rated current : 5 A
Unbalance measuring range : $\frac{I2}{In}$ = 0.02 - 0.7
Tripping function : $\frac{K1}{\left\{\frac{I2}{In}\right\}^2 - K_2^2}$ (s)

Setting range for constant K1 = 5 - 30
Setting range for constant K2 = 0.02 - 0.2
Reset time adjustable = 7 - 45 s
Internal consumption measure ≃ 0.6 VA
" " auxiliary d.c. at rest 6 W
" on starting 10,8 W
" on tripping 12 W

IPX 132 b - Definite time negative sequence relay

Rated current = 5 A
Adjustable value for unbalance current 1st stage 3 - 15 % of In
" " " " " 2nd stage 15 - 40 % of In
Time setting range 1st step 0.5 to 5s
" " " 2nd step 1.5 to 15s
Internal consumption measure 0.6 VA at In
" " auxiliary d.c. at rest 1,35 W
" " " at tripping 4.10 W

ISX 147 - Three phase definite time overcurrent relay

Rated current : 5 A or 1 A
Tripping setting range : 2,5 to 12,5 A or 0.25 A to 2.5 A
Time setting range : 0,1 to 5s
Time setting range : 0,2 to 10s for ISX 147 t2
Internal consumption measure 0,1 VA per phase
" " auxiliary d.c. at rest 1,2 W
" " at tripping 4,3 W

IWX 161a1 - Rotor earth fault relay with ancillary unit YWX 111-1

Range of adjustment of response value : 0 to 5000 Ω
Time setting range : 0,5 to 5 s
Internal consumption at rest 0,84 W
" " at tripping 2 W

REV.	DR. by	DATE	MODIFICATIONS	CONTRACTOR MEMBER	ALSTHOM ATLANTIQUE CGEE ALSTHOM
				CONTRACTOR MEMBER DWG No.	P 4 1 0 8 A 4 1 4 9 4

DWG No KBA 1 2 1 7 G P A 0 0 4 A A L T P 22/25

B A4 NORME AFNOR 70

PPX 105 b - Single phase power relay

Rated current : 5 A
Rated voltage : 100 V
Setting range of pick-up value : 0.5 - 5% of PN
Time setting range Fast step : 0.5 - 5s
" " " slow step : 5 - 50s
Internal consumption current measure : 0.65 VA
" " voltage measure : 0.66 VA
Auxiliary d.c. at rest : 1.08 W
" " at tripping : 3.4 W

FCX 103 - Frequency relay

rated voltage : 100 V
2 max frequency thresholds 53.5 Hz and 40 Hz
1 min " " 47 Hz
Time setting range (53,5 Hz and 47 Hz) 0.075 to 0.75 s
" " " (40 Hz) 0.15 to 1.5s
Internal consumption at rest : 13 VA
" " tripping : 17 VA

USX 116 - Definite time undervoltage relay (with input filter EBC 111)

Adjustment range : 60 to 100% Vn
Adjustable tripping time setting : 0.050 to 0.5s
Internal consumption measure : 1.8 VA
Auxiliary d.c. at rest : 0.9 W
" " at tripping: 2 W

SGX 115 - 116 - Integrators :

	SGX115 1 s 8	SGX115 1 s 22	SGX115 1 s 23	SGX116
Drop out time adjustable :	1-10 s	0.1 to 1s	0 s	1 to 10s
Tripping time adjustable :	0.5-6s	0 s	0.5 to 6s	6 to 60s

Internal consumption at tripping : 1,5 W

AAT 451 - output amplifier

Number of outputs : 4
Auxiliary supply voltage : 18 to 30 V⎓
Load carrying capacity of outputs contacts : 15 VA

REV	DR. by	DATE	MODIFICATIONS
	PERNIN	18.3.82	BROUGHT UP TO DATE

CONTRACTOR MEMBER
CONTRACTOR MEMBER
DWG No.

ALSTHOM ATLANTIQUE
CGEE ALSTHOM

P 4108 A 41494

DWG No. KBA 12 17 GPA 004 AA LTP 23/25

B A4 NORME AFNOR 70

ZSX 102 - Impedance relay

Rated voltage : 100 V

Rated current : 5 A

Setting range : 0.5 to 5 Ω /phase

Time setting range : 0.5 to 5 s.

Internal consumption current measure : < 0.1. VA/phase

voltage measure : 1.2 VA/phase

Internal consumption auxiliary d.c. at rest : 2,3 VA

at tripping : 4.4 VA

IKC 602 - Inverse time overcurrent relay

Rated current : 1 A

Tripping function $t = k \times \frac{0.14}{(\frac{I}{Ib})^{0.02} - 1}$

Rated current 1 A

Setting range k : 0.05 to 0.95 - 0.1 to 1.0

Current setting range (Phases R.T.) 1 to 4.8 A
(Phase S) 0.2 to 0.96 A

Internal consumption current measure 0.1 VA

Internal consumption auxiliary d.c at rest : 0.8 W

at tripping : 4.5 W

UNK 3338 a, z - Internal angle measuring equipment

Rated Voltage 100 V

Stator Voltage supervision 0 to 100 V

Internal angle setting range 0 to 180°

Internal consumption voltage measure 0.5 VA/Phase

Internal consumption auxiliary d.c at rest : 7.7 W

at tripping : 31.2 W

REV	DR. by	DATE	MODIFICATIONS
1	PERNIN	83-82	BROUGHT UP TO DATE

CONTRACTOR MEMBER

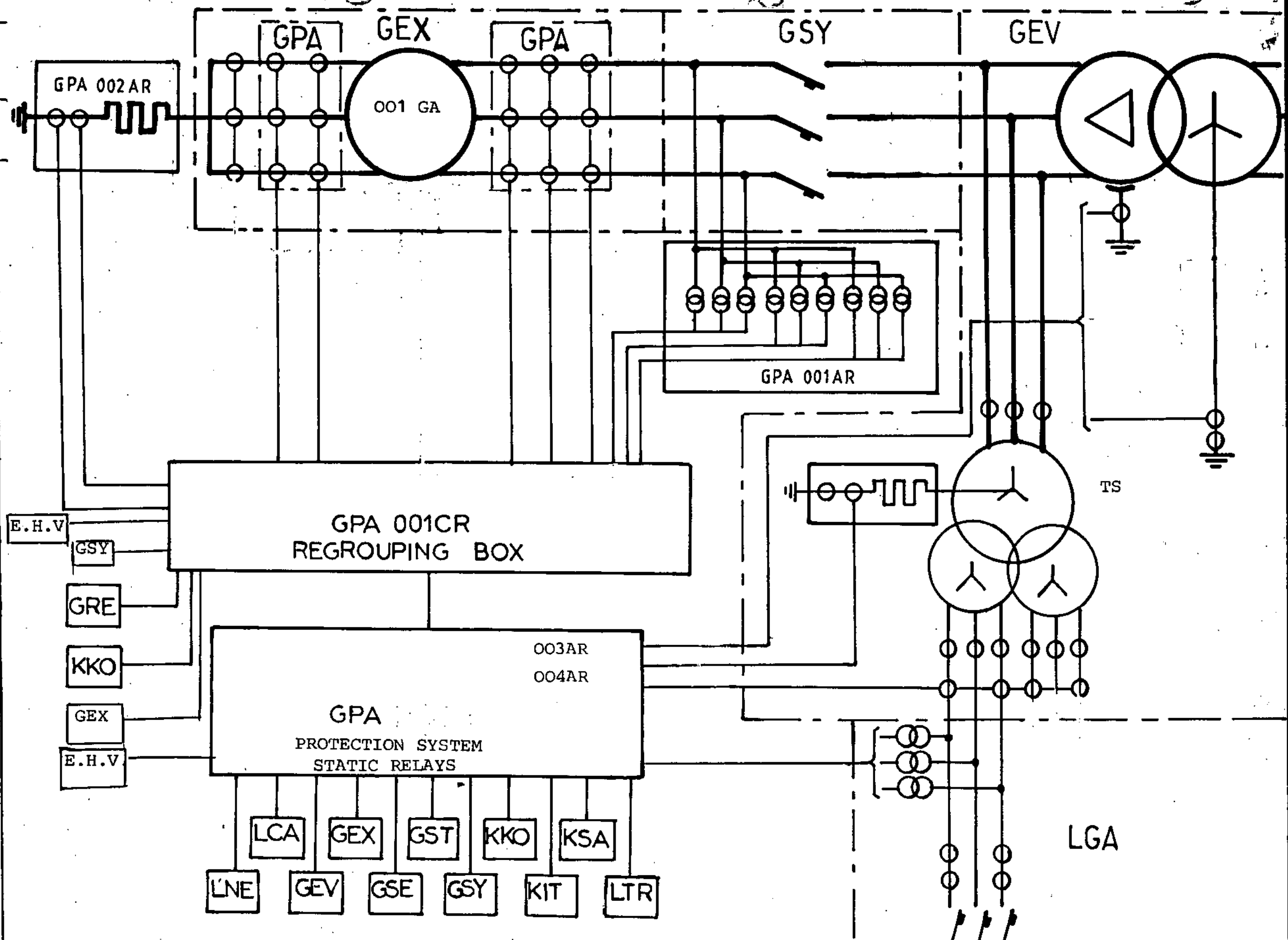
CONTRACTOR MEMBER DWG No

ALSTHOM ATLANTIQUE
CGEE ALSTHOM

P 4 1 0 8 A 4 1 4 9 4

DWG No KBA 1 2 1 7 G P A 0 0 4 A A L T P 24/25

B A4 NORME AFNOR 70



GPA-FUNCTIONAL LIMITS

REV	DR. by	DATE	MODIFICATIONS
3	PERNIN	19-3-82	BROUGHT UP TO DATE

CONTRACTOR MEMBER

CONTRACTOR MEMBER DWG No. P 4 1 0 8 A 4 1 4 9 4

ALSTHOM ATLANTIQUE
CGEE ALSTHOM

DWG No. KBA 1 2 1 7 G P A 0 0 4 A A - - L T P

25/25

A4

NORME AFNOR 70