

NSV Energy LLC
35 Hickory Springs Industrial Drive
Canton GA 30115



1600 KW UNUSED BIOGAS ENGINE COGENERATION POWER PLANT

Manufacturer: CAT TGC 2016 V 16C
Rating each: 800 KW each Total 1600 kw
Number of units: 2
Speed: 1800 rpm
Number of cylinder: 16
Bore x stroke 5.2 x 6.3 inch
Displacement: 2135 cu. inch
Generator:
Rating each: 1500 kva each
Voltage: 480 v, 3 phase, 60 hz
PF: 0.8
Type: Air cooled

Fuel consumption 6551 Mbtu/hr at 100% load
Total efficiency 85.6%
Minimum heating value 483 btu/cu. ft
Lube oil consumption 0.15 lbs/hr per engine
Hot water generated 22.8 cfm @ 201.2 deg f.

Scope of supply:

Two (2) engine generator sets
Zero pressure fuel gas train
Heat exchanger (CHP) for the waste heat
Generator breaker and protection , voltage regulator and engine control panel

History: year built 2015 never installed still in original shipping crates.

Technical data

800 kWel; 480 V, 60 Hz; Acc. to gas analysis

Design conditions

Comb. air temperature / rel. Humidity:	[°F / %]	86 / 60
Altitude:	[ft]	4429
Exhaust temp. after heat exchanger:	[°F]	356
NO _x Emission (tolerance - 8%):	[g/bhph]	1,07

Genset:

Engine:	TCG2016V16C.	
Speed:	[1/min]	1800
Configuration / number of cylinders:	[-]	V / 16
Bore / Stroke / Displacement:	[in / in / in ³]	5,2 / 6,3 / 2138
Compression ratio:	[-]	15
Mean piston speed:	[ft/s]	31
Mean lube oil consumption at full load:	[lb/hr]	0,4
Engine-management-system:	[-]	TEM EVO
Generator:	Marelli MJB 400 LC4	
Voltage / voltage range / frequency:	[V / % / Hz]	480 / ±5 / 60
Speed:	[1/min]	1800

Fuel gas data:

Methane number:	[-]	139
Lower calorific value:	[BTU/ft ³]	578
Gas density:	[lb/ft ³]	0,08
Acc. to gas analysis		
Analysis: CO ₂	[vol%]	40
N ₂	[vol%]	0
O ₂	[vol%]	0
H ₂	[vol%]	0
CO	[vol%]	0
CH ₄	[vol%]	60
C ₂ H ₆	[vol%]	0
C ₃ H ₈	[vol%]	0
C _x H _y	[vol%]	0
H ₂ S	[vol%]	0

Energy balance

Load:	[%]	100	75	50
Electrical power COP acc. ISO 8528-1:	[kW]	800	600	400
Generator efficiency with cos Phi = 1 / ind	[%]	96,9	96,5	95,7
Engine power acc. ISO 3046-1:	[bhp]	1108	833	561
Engine jacket water heat:	[MBTU/hr±8%]	1337	1102	877
Intercooler LT heat:	[MBTU/hr±8%]	198	119	72
Lube oil heat:	[MBTU/hr±8%]			
Exhaust heat with temp. after heat exchanger:	[MBTU/hr±8%]	1505	1215	901
Exhaust temperature:	[°F]	932	964	999
Exhaust mass flow, wet:	[lb/hr]	9817	7489	5234
Combustion mass air flow - ISO 3046/1:	[lb/hr]	8942	6810	4749
Radiation heat engine / generator:	[MBTU/hr±8%]	102 / 89	78 / 72	51 / 61
Fuel consumption:	[MBTU/hr +5%]	6629	5145	3681
electrical / mechanical / thermal efficiency:	[%]	41,2 / 42,5 / 42,9	39,8 / 41,2 / 45,1	37,1 / 38,8 / 48,3
Total efficiency:	[%]	84,1	84,9	85,3

System parameters ¹⁾

Ventilation air flow (comb. air incl.) with ΔT = 15 K	[lb/hr]	48900
Combustion air temperature minimum / design:	[°F]	68 / 86
Exhaust back pressure from / to:	[inWC]	12 / 20
Maximum pressure loss in front of air cleaner:	[inWC]	2
Zero-pressure gas control unit selectable from / to: ²⁾	[inWC]	8 / 80
Pre-pressure gas control unit selectable from / to: ²⁾	[psi]	7 / 145
Starter battery 24V, capacity required:	[Ah]	286
Starter motor:	[kWel. / VDC]	9 / 24
Lube oil content engine / base frame:	[gal(US)]	36 / -
Dry weight engine / genset:	[lb]	6349 / 14617

Cooling system

Glycol content engine jacket water / intercooler:	[% Vol.]	0 / 35
Water volume engine jacket / intercooler:	[gal(US)]	15 / 1,3
KVS / Cv value engine jacket water / intercooler:	[ft ³ /h]	1504 / 367
Jacket water coolant temperature in / out:	[°F]	183 / 198
Intercooler coolant temperature in / out:	[°F]	122 / 133
Engine jacket water flow rate from / to:	[gpm]	172 / 264
Water flow rate engine jacket water / intercooler:	[gpm]	192 / 44
Water pressure loss engine jacket water / intercooler:	[psi]	15 / 14

¹⁾ See also MWM "Layout of power plants"

²⁾ See also Techn. Circular 0199-99-3017

Engine noise level	Octave band centre frequency								Sum level (distance 1 meter)
	63	125	250	500	1000	2000	4000	8000	
Exhaust noise [dB(ln)]	108	123	118	112	110	104	105	97	116 (±2,5 dB(A))
Air-borne noise [dB(ln)]	92	96	96	97	99	97	94	100	105 (±1,0 dB(A))



PURCHASER

PURCHASER ORDER

PROJECT

M.M. ORDER

Q.C.P.

INTERNAL PROCEDURE

GENERATOR TYPE

SERIAL N°

MY 22868

CODE

POWER

kva 1500

STATOR VOLT

volt 480

STATOR CURRENT

amp 1805

STAT. CONNECTION

STAR

It verifies mechanical execution

POWER FACTOR

0,8

It verifies execution wirings

SPEED RPM

rpm 1800

FREQUENCY

hz 60

VOLT EXCITATION

volt 34

AMPER EXCITATION

amp 3,6

INSULATION CLASS

H overt. cl. H

MEC. PROTECTION

IP 23

DUTY

S 1

AMB. TEMPERATURE

C° 40

ROTATION DIRECT

Clockwise

A.V.R. CODE

DECS100-B15

STANDARDS

IEC 34-1

TEST BENCH

B4C

date

21/07/2011

TEST ROOM

MARELLI MOTORI S.p.A.

Inspecting Engineer



Order // Purchaser MWM

Date 21/07/2011

3Ph.Synchr.Gener. TYPE MJB 400 LC4 CODE MJB4082K2U1580 N° MY 22868

kVA 1500 Cosφ 0,8 Hz. 60 V. Stat. 480 A Stat. 1805

V excit. 34 I excit. 3,6 r.p.m. 1800 Amb. Temp.°C 40

Connection STAR Insulation Cl. H Overt. cl. H duty S 1 Degree of protect. IP 23

Voltage regulator N° Code DECS100-B15 Standards IEC 34-1

ITEM

NO - LOAD VOLTAGE REGULATION CONTROL					UNDER FREQUENCY PROTECTION CONTROL		
GENERATOR VOLTAGE	EXCITER		RPM	POSITION	MAX FIELD CURRENT	RPM	
	Excit. Voltage	Field current					
434	8,84	0,89	1800	minimum	1,85	1650	
480	11,05	1,13	1800	nominal	3 PHASE SHORT CIRCUIT PERMANENT CURR. I Short Circuit > 3 x In Field current RPM 1800		
529	14,66	1,45	1800	maximum			
PHASE BALANCING U 480 V 480 W 480					OVERLOAD 150% In 120 sec.		
Cyclic sense of phases with clock-wise rotation facing drive end U R V S W T					OVERSPEED 2160 RPM max. 120 sec.		
Residual phase voltage V 27							

LOAD TEST										
Hz	V	I	kVA	W	W	K.wattm.	kW	Cosφ	V excit.	I excit.
60	480	1805	1500,6	==	==	===	===	0,1	34,62	3,45

VOLTAGE DROOP CHECK WITH PARALLEL DEVICE				RESISTANCES MEASUREMENT (COLD) amb.T/°C.. 25,5			
No load voltage	Full load voltage	power factor	Voltage drop	GENERATOR STATOR			GEN. ROTOR
				Phase u-v	Phase u-w	Phase v-w	ohm
480	448,8	0,1	6,5 %	2,917	2,915	2,911	3,095
HIGHT POTENTIAL TEST (Volt a.c.)				EXCITER ROTOR			EXCIT. STATOR
Armature	Field	Exciter		Phase 1-2	Phase 1-3	Phase 2-3	ohm
2000	1500	1500		160,15	160,04	160,12	9,153
INSULATION RESISTANCE (Mohm)				Purchaser Order			
Armature	Field	Exciter		Project			
> 100	> 100	> 100					

RADIO DISTURBS SOPRESSION		PROTECTION CONTROL		REMARKS
Standards	Degree			
VDE 0875	N	Thermoresistances	Heaters O.K.	
		Diagram		

Generator complete with EMC filter in compliance to directive EMC 89/336/EEC and standards EN50081-2 EN50082-2

test bench B4C TEST ROOM MARELLI MOTORI S.p.A. Inspecting engineer



SYNCHRONOUS GENERATOR TEST CERTIFICATE

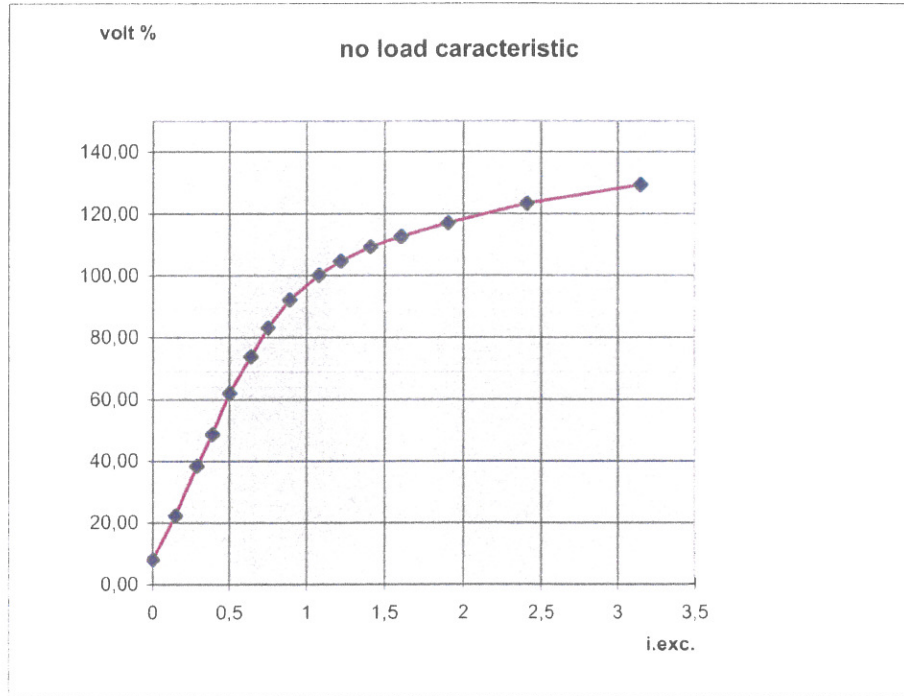
DATE..... 21/07/2011

ORDER // PURCHASER MWM

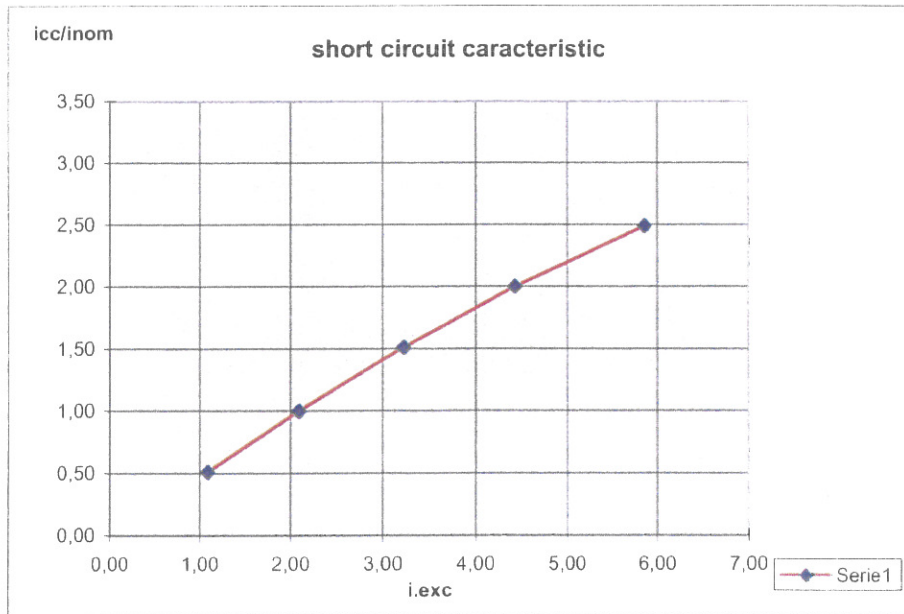
sheet ...4. of..... 9

3 Phase synchronous generator **TYPE** MJB 400 LC4 **CODE** MJB4082K2U1580 **N°** MY 22868
KVA 1500 **Power Factor** 0,8 **Stator volt.** 480 **Con** STAR **Stator curr.** 1805
Cycles 60 **RPM** 1800 **Excitation: V.** 34 **d.c.** A. 3,6 **d.c.**
Duty S 1 **Amb. Temp. (°C)** 40 **Standards** IEC 34-1

i.exc	volt %
3,15	129,30
2,41	123,30
1,9	116,99
1,6	112,50
1,41	109,26
1,22	104,60
1,08	100,10
0,89	92,20
0,75	83,08
0,64	73,80
0,50	61,97
0,39	48,69
0,29	38,46
0,15	22,30
	8,10



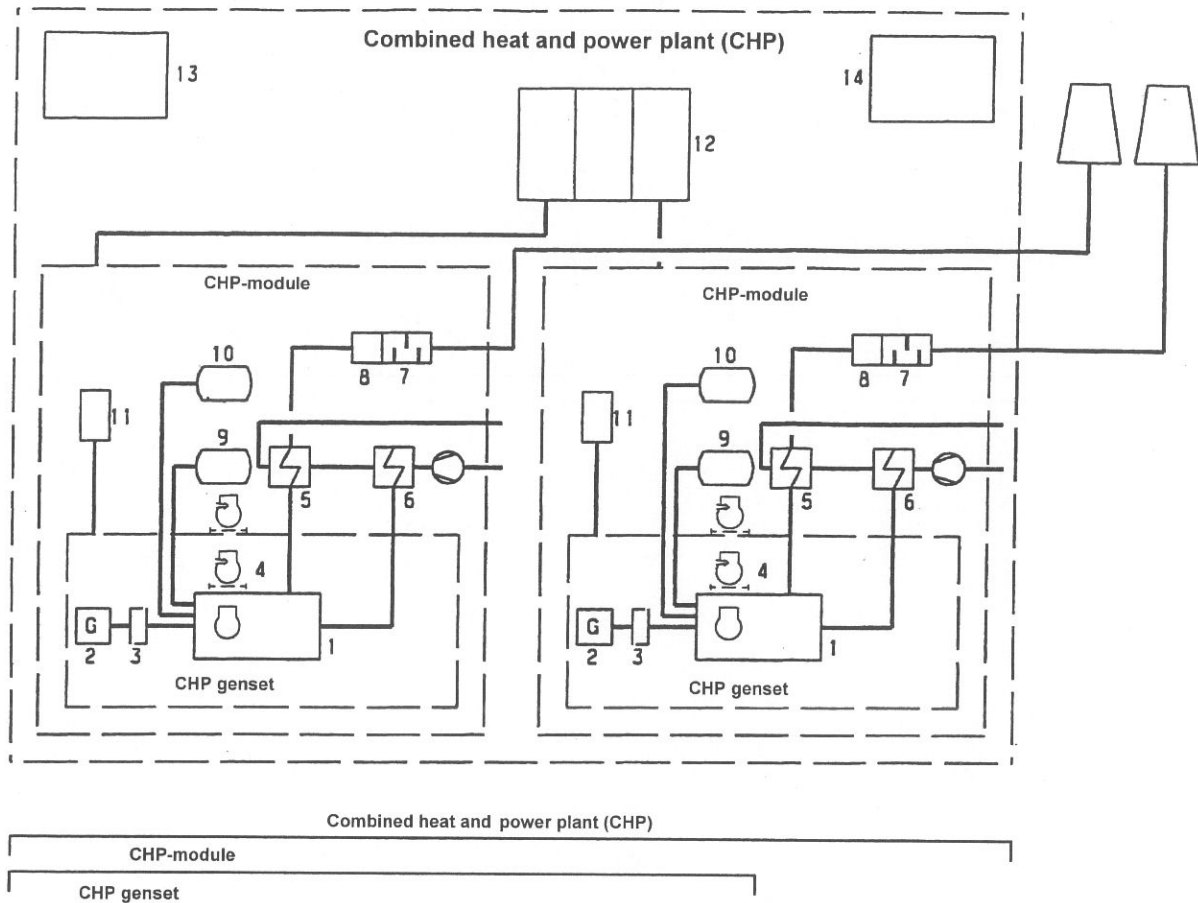
i.exc	icc/in.
1,09	0,51
2,09	1,00
3,22	1,51
4,43	2,00
5,86	2,49



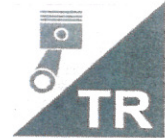
Test bench B4C Test room Inspecting engineer

Fig. 1.1

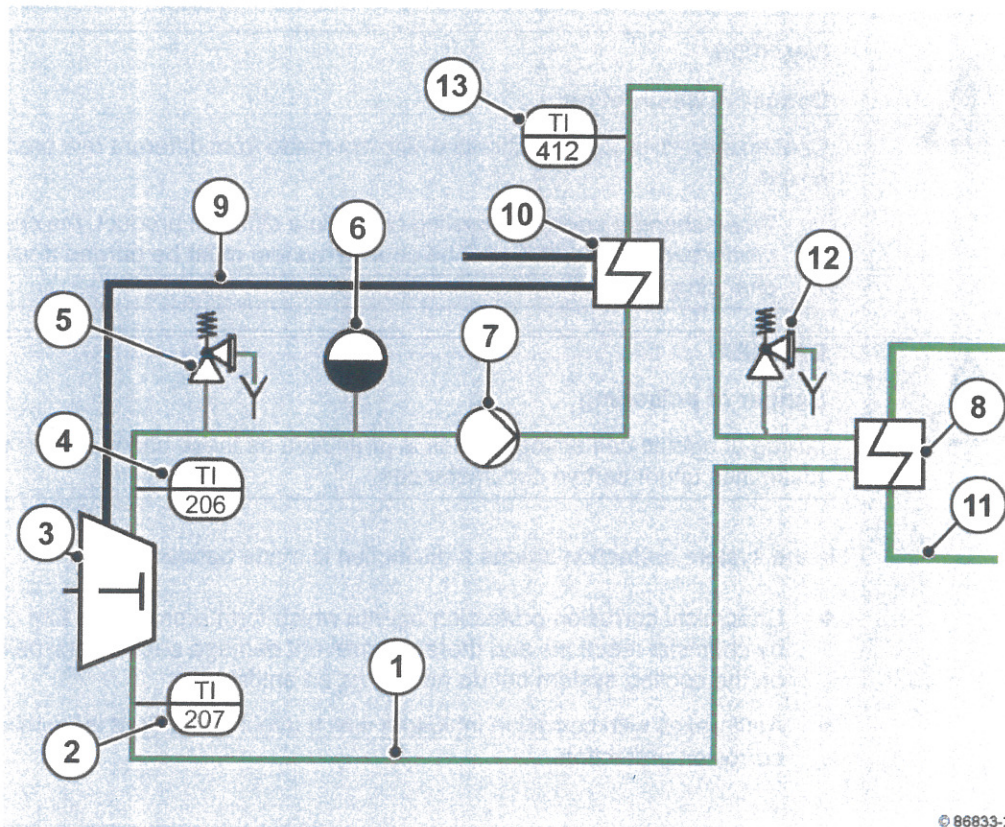
Definition and demarcation of CHP components as per DIN 6280-14



- | | | |
|---|--------------------------------|-------------------------------|
| 1 Reciprocating internal combustion engine | 5 Exhaust gas heat exchanger | 12 Switch board with controls |
| 2 Generator | 6 Cooling water heat exchanger | 13 Ventilation inlet |
| 3 Coupling and flexible mounting | 7 Exhaust gas silencer | 14 Ventilation outlet |
| 4 Combustion air filter | 8 Exhaust gas cleaning system | |
| (optionally installed separately from the engine) | 9 Fuel tank or gas supply | |
| | 10 Lubricating oil supply | |
| | 11 Monitoring system | |



C) Cooling system with exhaust heat exchanger in the engine cooling circuit:



© 86833-2

- 1 Engine cooling circuit
- 2 Temperature sensor engine inlet
- 3 Engine
- 4 Temperature sensor engine outlet
- 5 Safety valve (3 bar)
- 6 Diaphragm expansion vessel
- 7 Coolant pump
- 8 Heat exchanger
- 9 Exhaust gas
- 10 Exhaust gas heat exchanger
- 11 Heating circuit
- 12 Safety valve (10 bar)
- 13 Temperature sensor exhaust heat exchanger outlet

Abb. 15.2. Isolated operation without public grid

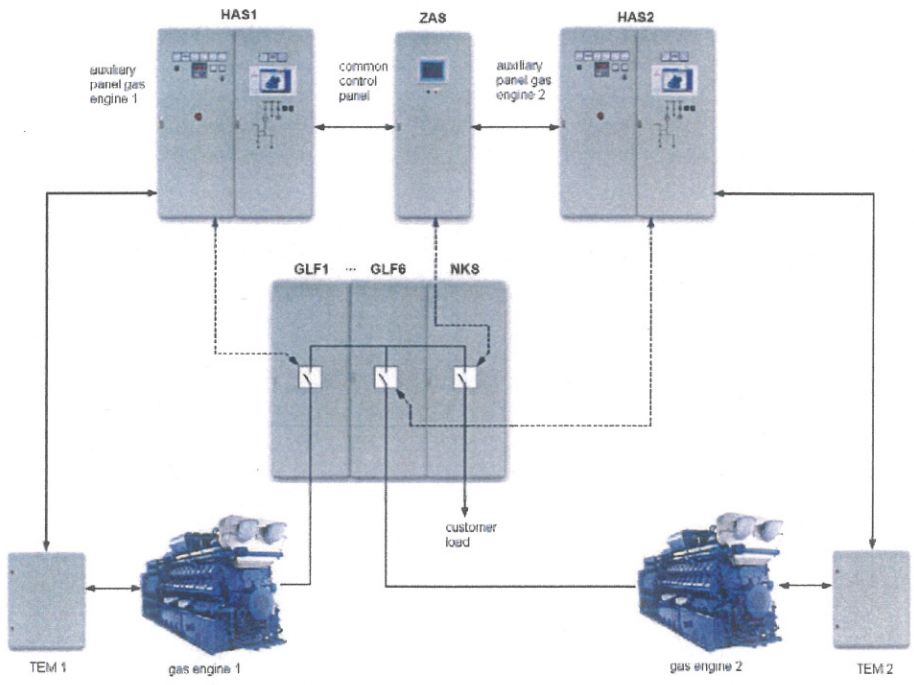
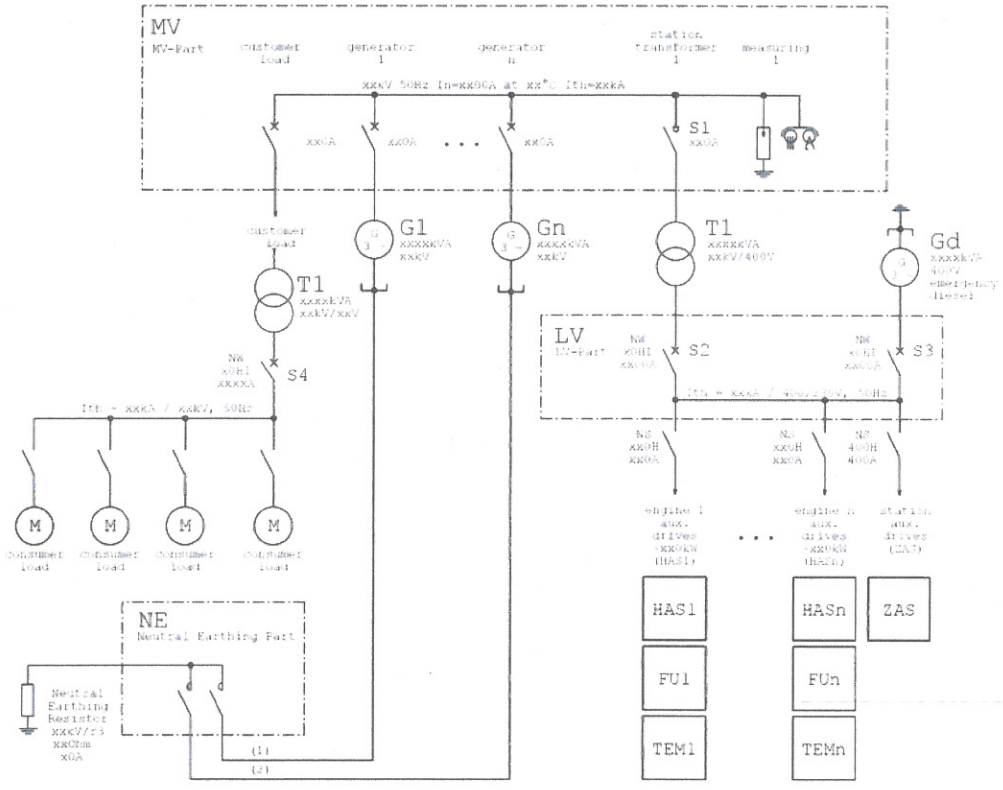
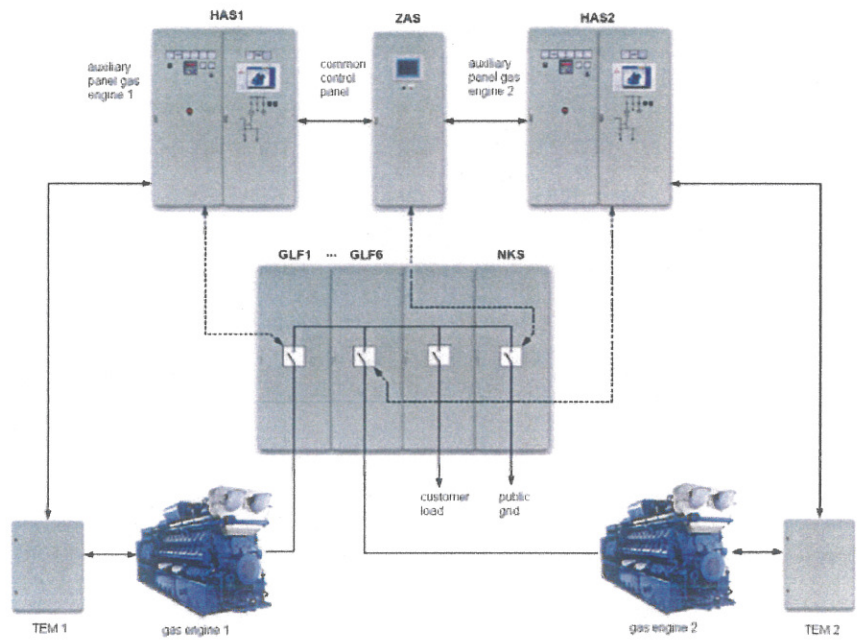
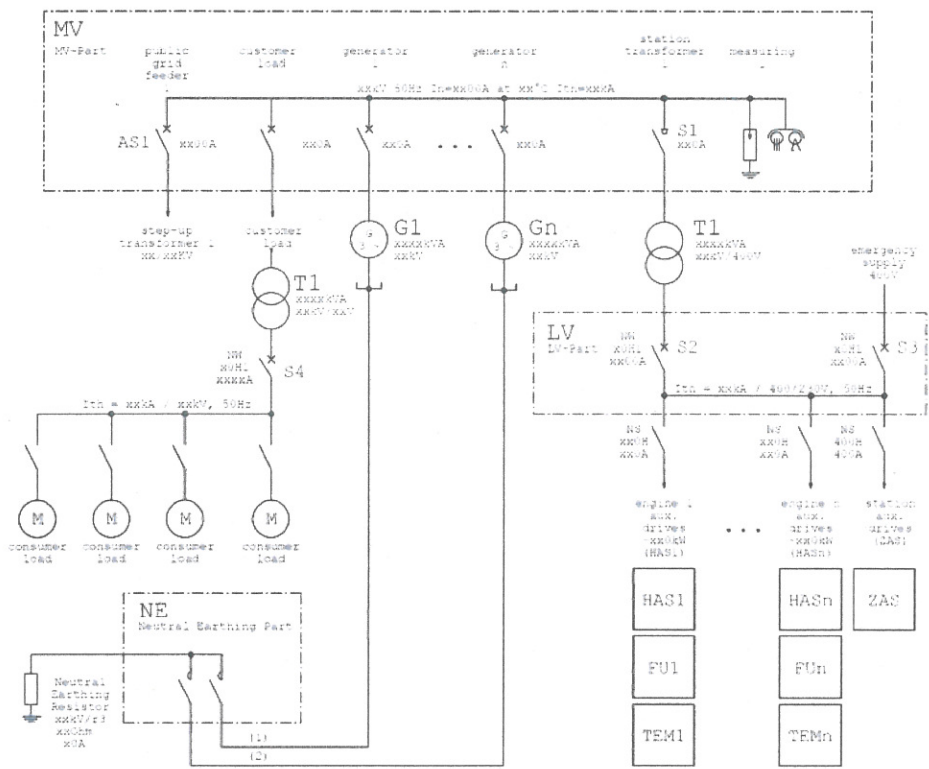


Abb. 15.1. Isolated operation after a changeover from main parallel operation



MWM 2 X800 KW BIOGAS ENGINE GENERATOR SETS PACKING LIST

CASE	DESCRIPTION	CMXCMXCM	M ³	INXINXIN	FT ³	KGS	LBS
1	TCG 2016V16C MWM gas generating set S/N 1278446	420x160x240	16.128	165x63x95	569.8	8000	17637
2	TCG 2016V16C MWM gas generating set S/N 1278445	420x160x240	16.128	165x63x95	569.8	8000	17637
1A	Control cubicle	218x118x90	2.315	86x46x35	81.759	340	750
2A	Control cubicle	218x118x95	2.444	86x47x37	86.301	360	794
1B	Stack plate cooler	138x108x95	1.416	54x42x37	50.001	656	1446
2B	Stack plate cooler	138x108x95	1.416	54x43x37	50.001	656	1446
1C	Accessories box	120x80x133	1.277	47x31x52	45.09	235	518
2C	Accessories box	120x50x112	0.672	47x31x44	23.731	235	518
1D	Three way valve	100x60x73	0.438	39x24x29	15.468	74	163
2D	Three way valve	100x60x73	0.438	39x24x29	15.468	74	163
1E	Gas control system	328x89x137	3.999	129x35x54	141.234	513	1131
2E	Gas control system	328x89x137	3.999	129x35x54	141.234	513	1131
1F	Accessories box	195x95x133	2.464	77x37x52	87.009	515	1135
2F	Accessories box	195x95x133	2.464	77x37x52	87.009	508	1120
1G	Switchboard plant	223x178x255	10.122	88x70x100	357.454	1644	3624
2G	Switchboard plant	223x178x255	10.122	88x71x100	357.454	1850	4079
1H, 2H	Heat exchanger	500x180x220	19.8	197x71x87	699.229	2250	4960
						3378.042	58252
						95.642	26423