



WCB ENGINEERING BULLETIN

Vol.29 No2



The Institution of Certificated Mechanical and Electrical Engineers South Africa
Western Cape Branch (WCB)

JUNE 2020

MISSION STATEMENT: 1. To uphold the image and status of the Certificated Engineer. 2. To represent the Certificated Engineer at ECSA and other decision-making bodies concerning legislation, safety & health standards, the environment and the machinery regulations. 3. To promote continued education and training of its members and future engineers. 4. To promote fellowship in the engineering profession.

EDITORIAL

Welcome to the latest edition of the Western Cape News Bulletin

We trust that all members and families are enduring the current COVID pandemic and lockdown safely. It really is a tough time for the Country and Industry, where most of us are employed or contracted to, and all we can really do is to endure and take all precautions to ensure our Safety and Health.

In this Bulletin, we have the normal Questions and Answers for Factories and Mining GCC examinations. The continuation of the "Lighting up the fairest Cape 1895 to 1995" with part 44 of the series, which is noted as the conclusion. The book has an Appendix which describes all the generation plants and machinery, which we will place in this Bulletin in future editions.

Part two of the discussion held at our recent AGM, by John Davidson, is included. The subject line is Small Scale Electricity Generators Using PV.

Please find the latest ECSA E-Bulletin [here](#).

Any contributions to future editions of this Bulletin from members would be welcome.

I trust that you will find the content of this news bulletin interesting enough to pass on to your colleagues and friends.

Chris Schnehage
chris@icmeewc.co.za

LOCAL BRANCH NEWS

Activities of the Western Cape Branch since the last Bulletin were as follows:

Due to the current Lock Down situation there has been no activity of the branch.
Hopefully we will be able to arrange meetings or visits soon again.

We appeal to members who have an interest to please suggest something and assist with arrangements.

Until next time, Ciao for now!

Chris Schnehage
Tel: 083 326 8023
Email: chris@icmeewc.co.za

OHSAct, Nov. 2010 (6) (HCSR)

[6.1] Define the following terms as given in the Hazardous Chemical Substance Regulations (HCSR).

6.1.1 Exposed [1]

6.1.2 Intake [1]

Answer: HCSR See definitions

6.2 When are the HCS Regulations not applicable? [1]

Answer: HCSR 2(3)

6.3 Name THREE types of records you have to keep when employees are exposed to an HCS during a production process. [3]

Answer: HCSR 9

6.4 Persons who are or may be exposed to an HCS shall obey a lawful instruction given by or on behalf of the employer regarding certain specific aspects such as the prevention of HCS from being released.

Name FOUR other aspects for which lawful instructions may also be given which persons must obey. [4]

Answer: HCSR 4

Jorge Pereira GCC Preparation Classes (Pty) Ltd.

GCC Part-time classes in Cape Town

For details contact Jorge Pereira at

082 896 8489 or jorgepereira43@yahoo.co.za

Plant Eng. Nov. 2003 (7.1)

A new 4.2 : 1 ratio gearbox has a pair of single helical gears with a 20° pressure angle, helix angle of 30° and a normal module of 3 mm. The shaft centre lines must be approximately 400 mm apart. The gearbox must transmit 75 kW at a pinion speed of 1 000 rev/min. Assume that the end-thrust is carried by a separate thrust bearing and that the centre line of the pinion coincides with the midpoint between its supporting bearings.

Determine:

7.2.1 The number of teeth on each wheel [3]

7.2.2 The exact centre distance (to the nearest 0,01 mm) [1]

7.2.3 The end thrust on the pinion shaft [3]

7.2.4 The load on each bearing [4]

Helical gears are used in place of spur gears to give a smoother drive between parallel shafts, since engagement between helical teeth is gradual. The transverse section of a tooth is identical with that of an involute spur tooth but the teeth are inclined to the axis of the wheel.

Suggested answer:

7.2.1

Suffix 1 is for the pinion, 2 is for the wheel.

$$\frac{D_2}{D_1} = \frac{T_2}{T_1} = 4.2 \text{ and } \frac{D_1 + D_2}{2} \cong 400 \text{ mm}$$

Hence $D_1 = 154 \text{ mm}$ and $D_2 = 646 \text{ mm}$

$$\text{Module (m)} = m_n \sec 30^\circ = 3 \times 1.155 = 3.465 \text{ mm}$$

$$T_1 = \frac{D_1}{m} = \frac{154}{3.465} = 44 \text{ (nearest whole number)}$$

$$T_2 = 4.2 \times 44 = 185$$

7.2.2

$$\text{Exact centre distance} = \frac{44 + 185}{2} \times 3.465 = 396.5 \text{ mm}$$

7.2.3

$$\text{Torque on pinion} = \frac{75 \times 10^3 \times 60}{2\pi \times 1\,000} = 716 \text{ Nm}$$

$$\text{Driving force on pinion, } F_d = \frac{716}{\frac{44}{2} \times \frac{3.465}{10^3}} = 9\,400 \text{ N}$$

$$\text{Axial thrust, } F_a = F_d \tan \sigma$$

$$F_a = 9\,400 \times \tan 30^\circ = 5\,425 \text{ N}$$

7.2.4

$$\text{Total force on tooth, normal to shaft axis} = F_d \sec \psi = \text{pressure angle}$$

$$= 9\,400 \times \sec 20^\circ = \frac{10\,000}{2} = 5\,000 \text{ N}$$

But, if the normal pressure angle is 20° , then:

$$\Psi_n = \tan^{-1} (\sec 30^\circ \tan 20^\circ) = 22.8^\circ$$

$$\text{Hence, load on each bearing} = 5\,100 \text{ N}$$

Jorge Pereira GCC Preparation Classes (Pty) Ltd.

GCC Part-time classes in Cape Town

For details contact Jorge Pereira at

082 896 8489 or jorgepereira43@yahoo.co.za

Plant Engineering: MINES mechanical question

Question (June 2006)

4.1 The following information was obtained for an underground mining area that is to be cooled by chilled service water and air heat exchangers:

- | | |
|--|----------------------|
| • Mass of rock mined | 85 000 t/month |
| • Mass ratio of service water to mined rock | 2,5:1 |
| • Temperature difference of the chilled water across the refrigeration plant | 19° C |
| • Temperature difference of the chilled water across the heat exchangers | 17° C |

- Quantity of refrigeration to cool the air 12 200 kW
- Quantity of refrigeration to cool the mined rock 6 280 kW

Determine:

- 4.1.1 The quantity of chilled service water (3)
 - 4.1.2 The quantity of chilled water to cool the air (3)
 - 4.1.3 The total quantity of chilled water to be provided (3)
 - 4.1.4 The capacity of the refrigeration plant (3)
- [12]

Proposed Solution:

Let M_{CSW} = Mass of chilled service water
 M_1 = Mass of chilled water supplied to cool air
 M_2 = Mass of chilled water supplied to cool chilled service water
 M_{total} = Mass of chilled water supplied to system
 24 days production per month
 24 hours per day cooling

4.1.1 Quantity of chilled service water

$$M_{\text{CSW}} = \text{Mass ratio of service water/ton of rock mined} \times \text{mass of rock mined}$$

$$= \frac{2.5 \times 85000 \times 1000}{24 \times 24 \times 60 \times 60} = 102.476 \text{ kg/s} = 6148.7 \text{ kg/min}$$

or $2.5 \times 85000 = \mathbf{212500 \text{ m}^3/\text{month}}$

4.1.2 Quantity of chilled water to cool the air

Energy flow = mass of chilled water $\times$ specific heat capacity $\times$ temperature change

$$\therefore 12000 = M_1 \times 4.187 \times 17$$

$$\therefore M_1 = \mathbf{171.4 \text{ kg/s}}$$

4.1.3 The capacity of the refrigeration plant

$$M_2 = \frac{\text{energy to cool mine rock}}{\text{specific heat capacity} \times \text{temperature change}} = \frac{6280}{4.187 \times 19} = \mathbf{79.07 \text{ kg/s}}$$

4.1.4 The capacity of the refrigeration plant

$$\text{Capacity of refrigeration plant} = Q_{\text{air}} + Q_{\text{CSW}} = 1200 + 6280 = \mathbf{18480 \text{ kW}}$$

Legal Knowledge: MINES question

Question (June 2019):

4. In terms of Regulation 16.6 (2) of the MHSA the employer must take reasonably practicable measures, that having regard to the number of persons likely to be present in the area served by the refuge bay, every refuge bay has to comply on certain requirements. Mention ten minimum requirements that every rescue bay must comply to. [10]

Proposed answer:

1. is of **sufficient size**;
2. is equipped with means for the **sufficient supply of respirable air**;
3. is equipped with a **sufficient supply of potable water**;
4. is equipped with **sufficient ablution facilities**;
5. is equipped with **sufficient illumination**;
6. is equipped with **sufficient first aid equipment**;
7. is equipped with efficient **means to communicate verbally to surface**;
8. is situated, where practicable, in an area **not being used for storage of combustable material** or close to such an area;
9. is constructed in such a way **that air containing noxious smoke, fumes or gases will not enter the refuge bay**;
10. a **plan of the escape route is displayed** in the refuge bay, indicating the position of the refuge bay in relation to the shaft or any other egress or access way to the surface;
11. a **sign is displayed in the refuge bay, setting out the emergency procedures followed** in the refuge bay and relevant emergency phone numbers; and
12. has a means to facilitate **clear identification of the location of the refuge bay from the outside in poor visibility**.



If you think Veasey's Engineering College can assist you in your studies towards your GCC, visit our site at

www.veaseys.co.za or contact

Caitlyn Jones at info@veaseys.co.za.

We also have a social media presence on:





SSEG (Small Scale Electricity Generators) Using PV (“Photo Voltaic” Solar Power): An Introductory Discussion:

PART 2

by John Davidson Pr. Cert Eng.

Introduction: What are the requirements when considering the installation of SSEG and ESS (energy storage systems)?

The City of Cape Town Municipality supports a green energy policy and, as such commissioned a few pilot SSEG PV domestic projects about eight years ago in partnership with private residents who had made application to install their own SSEG PV systems at that time.

There was very little to nothing available nationally, regarding regulations and standards required of SSEG for residential or business installations. Consequently, the City Electricity Department has developed their own and introduced a City By Law to regulate the installation of SSEG in their area of jurisdiction. Apparently, several smaller municipalities in the Western Cape have followed this lead. A link was provided in Part 1 of this SSEG presentation:

The City of Cape Town’s requirements:

Full access to all of these are available at: <http://www.capetown.gov.za/City-Connect/Apply/Municipal-services/Electricity/apply-for-authorisation-to-install-a-small-scale-embedded-generation-system>

For continuity of the discussion, the link above and the relevant list of documents available on this website are repeated in Figure 1.

They apply to Domestic, Commercial and Industrial SSEG.

Document downloads



- [PDF] Application for the Connection of Small-Scale Embedded Generation (GEN/EMB)**
01/02/2018, Application form - 405.3 KB
- [PDF] Approved Photovoltaic (PV) Inverter List**
26/03/2020, List - 293.8 KB
- [PDF] Declaration for Off-Grid Small-scale Embedded Generation Form**
01/07/2019, Form - 309.8 KB
- [PDF] Electricity Distribution Licence and Area Boundaries Map**
14/11/2016, Map - 2.2 MB
- [PDF] PV Registration letter to customers**
10/07/2018, Notice - 310.3 KB
- [PDF] Requirements for Small-scale Embedded Generation**
21/08/2017, Guideline - 886.9 KB
- [PDF] Rooftop PV Safe and Legal Installations Guidelines Pamphlet**
09/06/2018, Pamphlet, Guideline - 2 MB

For Grid Tied SSEG installations, the first download Application form is required and must be filled in and submitted before even purchasing your SSEG equipment. If going for the off-grid option, then the third download for the relevant “Declaration” is required. It is advised to fill this in before installation, but it only must be submitted immediately after installation and provide for all the relevant safety regulations and standards implemented in the installation.

Important extracts of the sixth document listed above are provided in Figure 2. to Figure 8. Inclusive. (It's suggested that for anyone considering the installation of an SSEG carefully read the full original document available per the link provided):



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

REQUIREMENTS FOR SMALL- SCALE EMBEDDED GENERATION

Application process to become a
small-scale embedded generator in
the City of Cape Town

2017-08-21

Important Notices

Compliance with the Law

Paragraph 39 of the City of Cape Town Electricity Supply By-Law 2010 states that no generation equipment may be connected to the grid without the express consent of the Director of the Electricity Services Department.

It is explicitly emphasised that a grid-connected SSEG installation which has been issued only with a Certificate of Compliance (CoC) **has not been authorised** to connect to the City's electricity grid.

Clause 2 of the Electricity Installation Regulations of the Occupational Health and Safety Act states that it is the property owner who carries the responsibility for the safety of the electrical installation on the property. This includes everything related to SSEG installations on the property.

Failure to obtain this consent constitutes an offence which could lead to a fine and/or imprisonment in terms of the City of Cape Town Electricity Supply By-Law 2010.

Furthermore, the installation may be in contravention of the Occupational Health and Safety Act, for which punitive sanctions apply.

Figure 3.

1. General Requirements: Residential

1.1. Generation size limitations

The generation size limits for residential customers wishing to install an SSEG are detailed below:

Service connection		
No. of Phases*	Service Circuit Breaker Size (A)	Maximum Total Generation Capacity** of SSEG (kVA***)
1	40	2,3
1	60	3,5
1	80	4,6
3	40	6,9
3	60	10,4
3	80	13,9
3	100	17,3

Table 1. Residential SSEG size limitations as derived from NRS 097-2-3

* To determine if you have a single-phase or three-phase connection, check the main circuit-breaker on the distribution board. A single-phase supply will generally have a single main circuit-breaker, and a three-phase a triple main circuit-breaker. If in doubt consult an electrician.

** Generation Capacity refers to the total output capacity of the generator. For PV systems in particular, this refers to the maximum output of the inverter as limited either by hardware, or by software settings. The system designer/installer will provide guidance here.

*** kVA and kW ratings for SSEGs are similar in most cases and can be used interchangeably for estimation purposes.

Figure 4.

So, contents of Figure 4. will beg the question: Why these power rating limitations for SSEG? First, they are contained within the national “Grid Code” NRS 097-2-1. Second, consider that the size or rating of the Service Circuit Breaker installed for the electricity supply to any premises by an electricity supply authority or utility is part of the contract for the supply of electricity to those premises. The circuit breaker rating is determined by the “Notified Maximum Demand” of the premises. For a 60Amp breaker it is 60A X 230V=13.8kW. See Figure 6.

The electrical infrastructure of conductors, transformers and electrical protection built into such a distribution network must be designed subject to relevant engineering standards, regulations and economic considerations. These criteria are potentially impacted by the installation of SSEG within such a network. The extract in Figure 5. explains some of the detail:

- e) The individual customer limit of 25 % of NMD on shared LV feeders is informed by an analysis of typical LV feeder designs whereby the individual generator size was scaled as a function of the design ADMD and the generation penetration level (percentage of customers that install a generator).
 - a) The voltage rise and change in voltage were calculated assuming that the installed generation is reasonably balanced.
 - b) An individual limit of 25 % of NMD will typically support a penetration level of 30 % to 50 %, which is considered a reasonable and acceptable compromise between restricting individual generator sizes versus restricting penetration levels.

Figure 5.

What is ADMD? “After diversity maximum demand” is used in the design of electricity distribution networks where demand is aggregated over many customers. After diversity maximum demand (ADMD) accounts for the coincident peak load a network is likely to experience over its lifetime and as such is an overestimation of typical demand.

South African Renewable Power Plants Grid Code (SARPPGC)

This document sets out the technical and design grid connection requirements for renewable power plants (RPP) to connect to the transmission or distribution network in South Africa. This guideline is of concern to embedded generators of Category A that are connected to a low-voltage (LV) network.

i) **Category A: 0 – 1MVA (Only LV connected RPPs)**

This category includes RPPs with rated power of less than 1 MVA and connected to the LV voltage (typically called 'small or micro turbines'). This category shall further be divided into 3 sub-categories:

ii) **Category A1: 0 – 13,8kVA**

This sub-category includes RPPs of Category A with rated power in the range of 0 to 13,8kVA.

iii) **Category A2: 13,8kVA – 100kVA**

This sub-category includes RPPs of Category A with rated power in the range greater than 13,8kVA but less than 100kVA.

iv) **Category A3: 100kVA – 1MVA**

This sub-category includes RPPs of Category A with rated power in the range 100kVA but less than 1MVA. This category also includes RPPs of Category A1 and A2 with a rated power less than 100kVA that are directly connected to a MV-LV transformer.

Note: RPPs with a rated power greater than 4,6kVA must be balanced three-phase.

Figure 6.

The City has published list as updated from time to time, of Approved PV Inverters for Grid Tied SSEG. (Second document in the list of available document downloads provided above). The motivation for this list is explained in Figure 7. The Electricity Department requires certain minimum technical standards to be met by inverters that will be tied to their grid.

Appendix 3: Inverter Type Testing Requirements

The City's requirements for grid tied inverter (GTIs) and ancillary equipment type test certification are as follows:

1. A 3rd party accredited body must perform the inverter type test certification in terms of NRS 097-2-1. The accredited body must be SANAS accredited or by a member of the recognition arrangements of the International Laboratory Accreditation Co-operation (ILAC) or the International Accreditation Forum (IAF) in terms of ISO/IEC 17025:2005 for photovoltaic systems. The accreditation bodies must provide accreditation documentation for the specific test location.

Figure 7.

Further to the above requirements, the National Occupational Health and Safety Act and Regulations shall be complied with. This is where the NRS 10142 Standards for wiring of premises comes in. Relevant installed equipment must be compliant for a valid COC (Certificate of Compliance) to be issued for the modifications required of the wiring of the premises to which an SSEG is installed, including the changeover switch. Approved Inverters for Grid Tied installations are, by the very nature of their design and operation,

continuously varying the grid supplied portion of electrical energy being consumed on the premises. This is dependent on the rating of the SSEG PV system, prevailing load, weather conditions and time of day, inverter rating and ESS storage capacity. The norm is to supply electricity directly from the Grid to “non-essential loads” on the premises. These could be air conditioners, stoves, water heaters etc. “Essential loads” would normally be most SSOs (switched socket outlets, particularly those supplying burglar alarms, computer and internet routers, home entertainment systems lighting and so forth). In the case of an “off grid” inverter supplying the “essential loads” a compliant, automatic “changeover” switch is required. Alternatively, a manual, NRS 10142 compliant change over switch is required. Such a manual change over switch is recommended for grid tied systems too, in the unlikely case of inverter failure, so that supply to the inverter fed loads can be restored to grid supply, until the SSEG system is repaired. See figure 8. For relevant details.

Appendix 4: Suitably interlocked change-over switch for grid-tied hybrid SSEG and a passive standby UPS utilised as off-grid hybrid SSEG

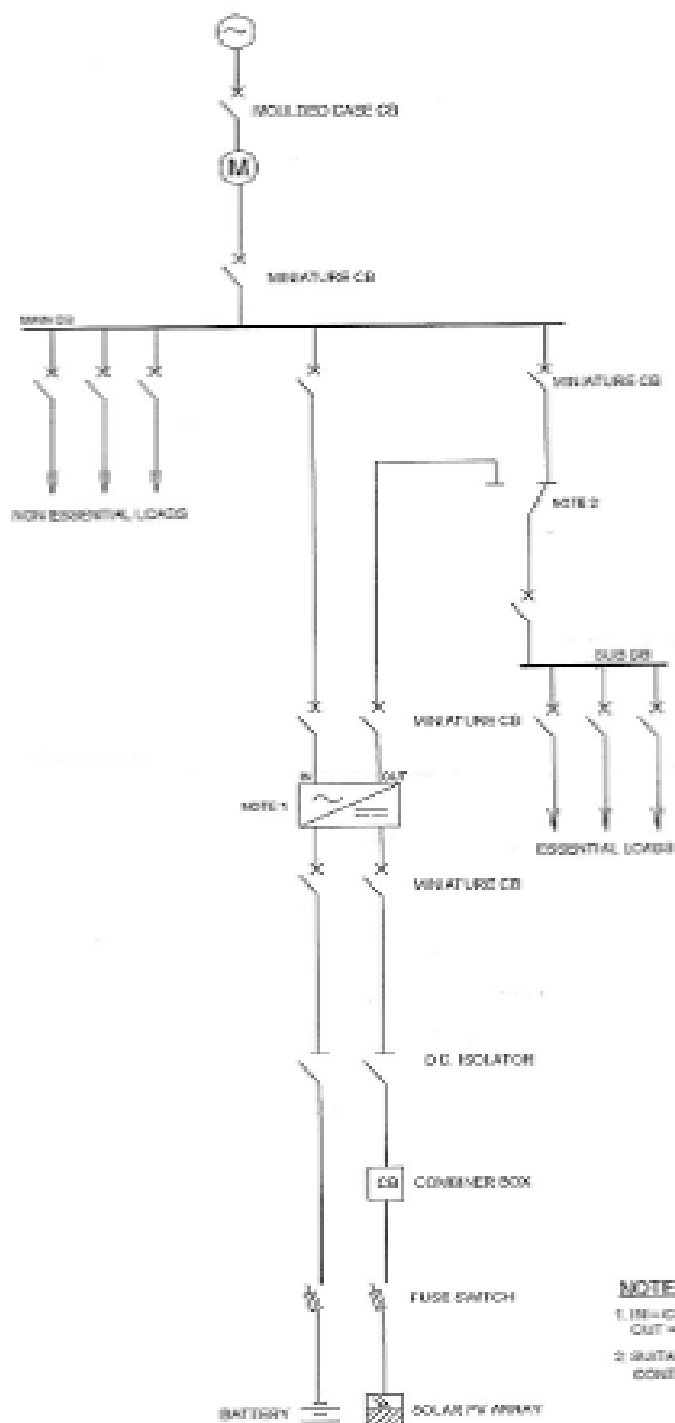
- a. This includes interrupters, transfer switches, bypass switches, isolation switches and tie switches.
- b. The switch shall provide feedback of its position to the inverter/charger so that if the contacts fail to operate or malfunction [e.g. fused-closed contacts, inadvertent energising of the change-over switch coil, etc.], use of the inverter mode will be impossible.
- c. The requirements of SANS 10142-1 Section 7.12.2.5 are applicable.
- d. It shall be a separate, controllable switch, compatible with the applicable electrical service conditions and to the performance requirements of the passive standby UPS, in accordance with SANS / IEC 60947-6-1 and the following product specifications:
 - Static transfer systems (STS): SANS / IEC 62310-3.
 - Automatic transfer systems (ATS): SANS / IEC 60947-6-1.
 - Manual isolation, tie and transfer switches (MTS): SANS / IEC 60947-3.
- e. The switch shall have a rated lightning impulse withstand voltage (BIL) of 4 kV at 1,2/50 μ s in accordance with SANS / IEC 60947-1 (Tables H.1 and 12).

Figure 8.

Figure 9. is a typical single line Wiring Diagram for an SSEG Installation. A diagram similar this, drawn up per the actual installation being applied for, is required as part of the submission documents for the SSEG application.

CONCLUSION

This discussion is intended merely as a “primer”. For a more informed consideration of what needs to be done prior to installing an SSEG it’s advisable to ensure that all these technical and regulatory issues be incorporated with the installation, even where the City of Cape Town’s By-Law is not enforceable. This would alleviate possible future problems with Regulations that will be rolled out nationally in future. Owners of SSEG systems would not want to find they have problems with their installations, either due to poor performance for poor technical design for the application, but for regulatory and safety compliance as well.



NOTES

1. IN = CHARGER/RECTIFIER MODE
OUT = INVERTER MODE
2. SUITABLE INTERLOCKED CHARGE-OVER SWITCH
CONTROLLED BY PASSING OF BATTERY

APPROVALS	DATE	CITY OF CAPE TOWN ELECTRICITY SERVICES	DESIGN PROJECT	DESIGN DRAWING NO.	CHECKED DATE	THESE DESIGNS WILL BE USED FOR SOLAR PV CHARGER/RECTIFIER MODE	REVISIONS
APPROVED	11/08/2018		ENGINEER	DATE	SCALE		IN 8 SH5X
				1:1000000	1:1		

Figure 9.