

# The Impact of changing from G59 to G99 for hydropower

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## Background information

One of the existing European Network Codes is called Requirements for Generators (RfG.) This sets out requirements which new generators will need to meet. The RfG became a binding EU regulation in May 2016. The EU Network Codes aim to harmonise technical and market rules to help to minimise barriers to energy trading. They also aim to prevent wide scale technical events, such as cascade tripping if generation is lost, and to help recover the system if there is such an event in the future. Due to the huge increase in Distributed Generation (DG) in GB and across Europe, it has been recognised that DG needs to do more to provide support to power systems, so that generation supports frequency, remains connected if possible and rides through faults, rather than tripping off, and potentially exacerbating any problems. It is a legally binding document.

Within GB, a Distribution Code Review Panel and Grid Code Review Panel were charged with implementing RfG. This includes setting parameters that RfG leaves to national interpretation. The Panels proposed changes to the Grid Code, Distribution Code and supporting Engineering Recommendations and their work resulted in the publication of G98 and G99 by the ENA.

(Note that Ofgem have stated that if there is a no - agreement Brexit, the Government will replace RfG by an equivalent UK statute. The implication is that the RfG accommodation in the Grid and Distribution Codes should remain and G98 and G99 will still stand.)

G98 replaces G83 and provides guidance on the GB technical requirements for the connection of fully type tested Micro- generators in parallel with Low Voltage (LV) distribution networks. The Registered Capacity of which is no greater than 16A (3.68kw) per phase or 11.04kw on a 3-phase supply.

G99 replaces G59 and was introduced in May 2018. Generators connecting after 27 April 2019 must connect under G99. There was a grace period and you may be able to connect under G59 if you meet the following requirements:

- You have concluded a signed final and binding contract by 17 May 2018 for the main plant items, and
- You submit evidence of the above to the DNO before 17 November 2018.

This grace period has now ended but it may be worthwhile discussing this with your DNO and trying to get it extended. Some of the DNOs have been poor in communicating these requirements to their customers, especially those with signed Offers, and may be open to negotiation for an exemption.

RfG introduces new classifications for generators called Types. The generation Type increases with capacity (or connection voltage.) There are more requirements for larger generation and there are also different compliance requirements, forms and notifications for different Types.

The Types are split into 4 parts; A, B, C and D. G99 lists these between 800W and 1MW, between 1MW and 10MW, between 10MW and 50MW and over 50MW respectively. There are also additional requirements for grid connections above 110kv.

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### Application process

Most hydro generators will be Type A or Type B, between 800W and 10MW. Many of the larger hydro generators are synchronous machines. Some of the smaller, < 250kW, machines may be asynchronous or induction machines. Under G99, Power Generating Modules (PGM) are classified as Power Park Modules (PPM) i.e. induction machines or Synchronous Power Generating Modules (SPGM). There are different compliance requirements for PPMs and SPGMs.

There is a Standard Application Form for G99 applications. A lot of the fields are the same as the G59 Common Application Form. Some new fields have been added to reflect new technical requirements in G99. The form has been restructured into 5 parts. Parts 1 – 3 of the Standard Application Form are the minimum information required when you submit the application to the DNO.

In some cases, this information may be sufficient for the DNO complete the connection design and make a connection Offer. However, for some of the larger generator applications (> 150kw), this initial information may not be sufficient and Parts 4 and 5 will have to be completed. The DNO will advise if Parts 4 and 5 are required. Part 4 asks for specific information on each generating unit (and transformer information for HV connections.) Part 5 is for additional data which may be required by the DNO before the Final Operation Notification (FON) is issued. A FON is only required for Type B generators and above.

RfG has introduced several Notifications for Type B and above generators. For Type B, a FON is issued by the DNO when they are satisfied that you have demonstrated compliance with G99. Some DNOs may not let you operate your generator until you have received your FON. However, some may let you generate without a FON for the purposes of compliance testing and commissioning but bear in mind that you have no permanent rights until the FON is issued.

Type A generators do not have permanent rights to operate the generators until the commissioning tests have been successfully completed (and witnessed by the DNO if required) and the Installation Document has been fully completed and sent to the DNO.

A Power Generating Module Document (PGMD) is required for all Type B and above generators. It is used by the customer to show the DNO that their PGM meets the requirements of G99. It is likely to be completed and updated through the connection process. You must submit the PGMD to the DNO at least 28 days before synchronising, although ideally a first draft will be submitted shortly after accepting the connection Offer. A final version with all the correct data must be submitted to the DNO in order to obtain a FON from the DNO.

For generators connecting after 27 April 2019 with signed Offers, they will now need to complete the new G99 Standard Application Form. This will result in additional work for the DNOs and their customers, but it will mean that the energisation plan is agreed at an early stage and there should be no last-minute surprises about the DNO requirements.

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### **Type testing**

According to G99, type tested equipment is defined as a product which has been tested to ensure that the design meets the relevant requirements of G99 and that all similar products supplied will be constructed to the same standard and will have the same performance.

Under G59, the protection relay (now called Interface Protection relay under G99) was the main piece of equipment that required compliance. G99 includes detailed information on the connection process from the initial design, type testing of equipment, technical requirements and on-site testing and commissioning. The process is a lot more complicated and the “G59” relay is now only a very small part of the connection process.

G99 allows for generators and equipment, such as the Interface Protection relay, to be fully type tested, partially type tested or non – type tested. RfG doesn't mention Type Testing but instead describes a regime of Equipment Certificates (EC). ECs are a type of Type Testing regime where the EC is granted by an Authorised Certifier who is accredited by the national affiliate of the European cooperation for Accreditation (EA).

No formal EC regime exists in GB. The ENA hosts a Type Test Verification Report Register or Type Test database. This allows manufacturers of generating units that have been Type Tested to meet the requirements of G83 or G59 to upload relevant documentation and obtain a Type Test Reference Number (Product ID), which can be quoted on application forms.

The ENA is in the process of developing this facility for G98 and G99 and it is planned that this will be available in 2019. In the meantime, it has been agreed that the DNOs will accept self-certified information from the manufacturers in lieu of equipment certificates, as evidence of compliance. Note that the historic upper limit of 50kw on type testing has been removed.

For equipment that is not Type Tested, the G99 requirements must be demonstrated by the generator by providing alternative information e.g. manufacturer's data, one off test reports, simulation studies or by on - site commissioning. There are various forms for all Types of generator on the requirements for simulation studies, testing of non-Type Tested equipment and commissioning. The DNO may require witnessing some of the on-site testing. Under G59, the testing usually on lasted a few hours. Under G99 it may take a lot longer. Some DNOs may charge for this so it will be beneficial for the generators if compliance can be shown without on-site testing.

### **Technical requirements**

Type A generation systems will be very similar in design and application to G59 requirements, although some of these requirements have been formalised in more detail. Some of the main requirements are: Performance and Control, Frequency Response, Network Falling Frequency, Frequency Response (LFSSM-O), Voltage Limits and Control, Reactive Power Control and Fast Fault Current Injection.

Type B generation system requirements are similar to Type A. Fault Ride Through is an additional requirement, but this shouldn't be a problem for hydro generators.

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The manufacturers' design and specification may need to improve, and additional power system studies will be required to demonstrate compliance. A SCADA interface will be required with the DNO for operational monitoring, but this is an existing requirement with many DNOs, especially for HV connections.

For Type B generating systems, a report detailing the outcome of the simulation studies will be required. This will demonstrate compliance with a number of technical requirements, such as fault ride through and fast fault current injection.

G99 also introduces a number of requirements for a communication interface between the generator and the DNO. For Type A, the generators must be equipped with a logic interface in order to stop power output within 5s following a signal received from the DNO. For Type B, the power output reduction is between 100% and zero. I presume the DNOs will produce a technical standard to define their interface requirements as part of their G99 implementation programme. In some cases, the DNO may not provide this signal.

G99 is still being developed through the monthly ENA DER Technical Forum and there may be future amendments. The next issue is due to be published in May 2019.

### **Financial impact**

There will be a financial impact in implementing G99. It is possible that the price of the generating units could rise as the plant requirements may be more technically demanding. It may not be economic for the turbine/generator manufacturers to Type Test their equipment and they may treat them on an individual basis.

The manufacturers will have to provide simulation studies and the DNOs may require more network power system studies. In saying that, G99 compliance will be a good selling point for the manufacturers.

Data collection and form completion will take much longer, and site testing could be extended to a few days. For example, operating the generator at different portions of power output and power factors for periods of up to 1 hour, when water is available, will take longer and will require a commissioning engineer and DNO witness engineer. Hopefully, the DNOs will be flexible in their approach. Although the ENA have produced G99, DNOs should provide Technical Guides on how they intend to implement G99 within their areas. These Guides should be consistent across GB.

With FITS coming to an end, I estimate that most hydro generators will be connected under G59 and after 2021 only a few will be connected. It was suggested that we could seek a derogation for hydro generators and the BHA approached Mike Kay who represents the ENA. He suggested that derogations are mainly for inescapable technical issues and not issues of excessive cost. Ofgem are usually against granting derogations and he didn't think that there is a precedent for this type of situation. We would have to produce a Cost Benefit Analysis in defining the economic case although the carbon benefits of renewable generation could be to our advantage. Seeking an exemption from the DNOs could take 12 months and there would be a cost without any guarantee of gaining an exemption for hydro.

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