

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP (1)

<p><b>WG* N° A1.34</b></p>	<p><b>Name of Convenor : Osamu Nagura (Japan)</b>  <b>E-mail address: osamu.nagura.sc@hitachi.com</b></p>
<p><b>Technical Issues (2): -----</b></p>	<p><b>Strategic Directions (3): 2</b></p>
<p><b>Title of the Group: Testing Voltage of Doubly-Fed Asynchronous Generator-Motor Rotor Windings for Pumped Storage System</b></p>	
<p><b>Scope, deliverables and proposed time schedule of the Group :</b></p> <p><b>Background :</b></p> <p>Recently, many adjustable (variable) speed pumped storage power stations are constructed in the world. The adjustable (variable) speed pumped storage system can change the input power at pumping operation, which cannot be realized with the conventional pumped storage system. And it can control the active power very quickly by using its flywheel energy for both generation (energy discharge) and pumping (energy storage) operation. This function is very effective to compensate the generation power fluctuation of the renewable energy source. Doubly-fed asynchronous generator-motors are applied to these power stations. The construction of the doubly-fed asynchronous generator-motor is similar to conventional wound type rotor induction motor. However, operation condition is quite difference from the conventional induction machine. So, it is difficult to apply the standards of induction machine. Although, it is difficult to apply the standards of synchronous machine too.</p> <p>The rotor winding is one of the important parts of this machine. And the design concept is different from the induction machine. In this situation, there is no standard or guideline for the rotor winding testing voltage.</p> <p>Detail of the background is shown on Attachment 1.</p> <p><b>Scope :</b></p> <ol style="list-style-type: none"> <li>1. The purpose of this study is to investigate the rotor winding testing voltage of the doubly-fed asynchronous generator-motor for adjustable speed pumped storage system and the background of the definitions of the voltage.</li> <li>2. This study limit only for asynchronous generator-motor for pumped storage and more over 30MVA stator capacity.</li> <li>3. In the world, only 14 units of 9 power stations are put into the commercial operation. However, more over 19 units of 7 power stations are under construction. List of published project list is shown on Attachment 2.</li> </ol> <p><b>Clients:</b>  Users of doubly-fed asynchronous generator-motor for pumped storage system.  Manufactures of doubly-fed asynchronous generator-motor for pumped storage system.</p> <p><b>Deliverables :</b>  Technical brochure and Tutorial with summary in Electra</p>	

<p><b>Time Schedule:</b></p> <p>Start: October 2011  Draft questionnaire: January 2012  Final questionnaire: April 2012  Draft report: August 2012 (Paris meeting)  Final report: December 2013  Electra publication: March 2014  Tutorial: April 2014</p>
<p><b>Comments from Chairmen of SCs concerned :</b></p>
<p><b>Approval by Technical Committee Chairman :</b> Klaus Fröhlich  <b>Date :</b> 20/10/2011</p>

(1) Joint Working Group (JWG) - (2) See attached table 1 – (3) See attached table 2

**Table 1: Technical Issues of the TC project “Network of the Future” (cf. Electra 256 June 2011)**

<b>1</b>	Active Distribution Networks resulting in bidirectional flows within distribution level and to the upstream network.
<b>2</b>	The application of advanced metering and resulting massive need for exchange of information.
<b>3</b>	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
<b>4</b>	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
<b>5</b>	New concepts for system operation and control to take account of active customer interactions and different generation types.
<b>6</b>	New concepts for protection to respond to the developing grid and different characteristics of generation.
<b>7</b>	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
<b>8</b>	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
<b>9</b>	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
<b>10</b>	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

**Table 2: Strategic directions of the TC (cf. Electra 249 April 2010)**

<b>1</b>	The electrical power system of the future
<b>2</b>	Making the best use of the existing system

<b>3</b>	Focus on the environment and sustainability
<b>4</b>	Interactive communication with the public and with political decision maker

### Attachment 1:

Detail explanation of the background.

The construction of the Doubly-fed Asynchronous Generator-Motor for the Adjustable Speed Pumped Storage System is similar to wound rotor type induction machine. Generally the rotor winding induced voltage on slip 1.0 is designed at the same level of the stator winding rated voltage. In this case Turn Ratio is designed to near 1.0. Turn Ratio means the ratio of the effective number of stator turns for the effective number of rotor turns. Turn Ratio is a kind of the transformer ratio. The induced voltage of the rotor winding is in proportion to the slip. The Doubly-fed Asynchronous Generator-Motor is used to operate near the synchronous speed. In order to adjust the frequency converter output voltage, the Doubly-fed Asynchronous Generator-Motor is designed with small Turn Ratio. It means that the induced voltage at slip 1.0 rises very high in comparison with stator winding rated voltage. So, it is difficult to apply the standard of Induction Machine.

We have had some experiences to make contracts of the Doubly-fed Asynchronous Generator-Motor. But every time the definitions of the test voltage of the rotor winding had been depend on discussion with customers.

Currently, in Europe and in Japan, new adjustable speed pumped storage power stations have been constructing and planning. In order to facilitate the definition of the test voltage, I propose to investigate the testing voltage of the rotor winding for existing power station.

Photograph shows doubly-fed asynchronous generator-motor of Ookawachi pumped storage power station. (Ookawachi is the world largest capacity at the present moment.)



Photograph: Rotor of 400 MW, 330-390 min-1, 700 tons, 6000 mm, asynchronous generator-motor

**Attachment 2 :**

List of published adjustable (variable) speed pumped storage project.

No.	Name of power station	Country	Year of operation (First unit)	Specification	No. of units (Adjustable/All)	Remarks
1.	Yagisawa	Japan	1990	85 MVA/82 MW	1/3	Renewed project (Semi basement power house)
2.	Takami	Japan	1993	105 MVA/140 MW	1/2	
3.	Ookawachi	Japan	1993	337 MVA/400 MW	2/4	
4.	Shiobara	Japan	1995	333.3 MVA/341 MW	1/3	
5.	Okukiyotsu No.2	Japan	1996	341 MVA/340 MW	1/2	
6.	Yanbaru sea water	Japan	1999	33.3 MVA/31.8 MW	1/1	Sea water pumped storage pilot plant
7.	Goldisthal	Germany	2003	316 MVA/300 MW	2/4	
8.	Omarugawa	Japan	2007	304 MVA/340 MW	4/4	
9.	Avce	Slovenia	2010	195 MVA/190 MW	1/1	
10.	Okutataragi	Japan	Under construction	319 MVA/320 MW	2/4	Renewed project (Underground power house)
11.	Kyogoku	Japan	Under construction	222 MVA/230 MW	1/3	
13.	Nante de Drance	Switzerland	Under construction	-	4/4	
14.	Linth Limmern	Switzerland	Under construction	-	4/4	
15.	Venda Nova III	Portugal	Under construction	-	2/2	
16.	Kazunogawa	Japan	Under construction	-	2/4	
17.	Tehri	India	Under construction	-	4/4	