Verification of the IPS/UPS dynamic model using WAMS recordings

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Power system digital models

The tool allowing to create the adequate power system digital model with detailed power system control has appeared
Verification is used for digital model tuning and model adequacy check

Digital power system model verification

- Power system model verification is done by means of comparison of the transient processes diagrams recorded by WAMS during disturbance in power system and corresponding transient processes received from model simulation
- Verification also includes the excitation regulator, turbine, generator and load characteristic settings and parameters refinement.

Digital power system model verification

- WAMS is the tool allowing to get necessary information for verification. Now it's developing in IPS/UPS
- WAMS allows to record basic power system parameters: frequency, bus voltage and its absolute angle, active and reactive power of any power line number with discrecity 0.02÷0.2 sec
- WAMS recordings are synchronized in time by means of signals PPS (pulse per second) sent by cosmic satellites

Digital power system model verification



Digital power system model verification

The process of verification can be divided into three basic stages:
Power system control model verification
Load model verification and refinement their static and dynamic characteristics
Power system model IPS/UPS verification in general

Verification of Power System Control Models

The excitation regulator models are created on the base of its structural diagrams received from regulator manufacturer The regulator model verification consists in frequency characteristic (Bode diagrams) comparison of regulator model and real regulator

Verification of Power System Control Models

The approach of creating generalized turbine model and turbine control system model is accepted

Generalized models are adapted to concrete power generating unit by means of model settings adjustment: gain coefficients and time constants

This adaptation is done according to results of registration of power generating unit external characteristics

Digital power system model of IPS/UPS

- The base dynamic power system model has been created.
- This model includes the models of all power systems in East Synchronous Zone: Russia, Ukraine, Belorussia, Moldova, Lithuania, Latvia, Estonia, Kazakhstan, Central Asia, Georgia and Azerbaijan power system
- The base dynamic power system model comprises 4250 nodes, 520 nodes of them are generator nodes, 7050 brunches, 5200 brunches of them are power lines, 1850 brunches of them are transformer and autotransformers

Digital power system model of IPS/UPS



- Verification is carried out by comparison of the electromechanical transient processes received from model simulation to the data received by means of WAMS digital recorders
- During verification the unknown values of parameters (static and dynamic load characteristics) and parameters having probabilistic behaviour (dead-zone of turbine speed regulators) are adjusted
- The digital model validation is supervised on coincidence of:
 - Frequencies (the maximum deviation, speed of the decrease, the established value) in particular IPS and in IPS/UPS in general;
 - Character of power variation on particular transmission lines;
 - Character of variation of angels between various points of UPS/IPS situated on considerable distance from each other

- No1 disconnection of power system of Central Asia (01.02.2007)
- No2 Blocks 3 and 4 shutoff on Balakovskaya NPP (04.05.2007)
- No3 Block shutdown on Volgodonskaya NPP (31.08.2007)
- Nº4 disconnection of GEN-2,5,8 on Sayano-Shushenskaya HPP (29.02.2008)
- No5 outage on Lukomlskaya SRPP (25.06.2008)



Configuration	01.02.07	04.05.07	31.08.07	29.02.08	25.06.08			
Nodes	4161	4121	4180	3941	3933			
Lines (total)	6711	6719	6700	6456	6393			
particularly:								
Transmission lines	4954	4886	4952	4754	4738			
Transformers	1756	1833	1728	1702	1655			
Breakers	1	0	20 0		0			
Generators	519	481	510	591	561			

Power system	01.02.2007	04.05.2007	31.08.2007	29.02.2008	25.06.08
	UPS/IPS consumption	UPS/IPS consumption	UPS/IPS UPS/IPS consumption consumption		UPS/IPS consumption
	SCADA	SCADA	SCADA	SCADA	SCADA
Russia w/o Siberia	103141.95	75211.19	77509.61	101202.22	83272.64
Siberia	26564.80	19556.10	20509.13	26377.40	21271.31
Baltic states	4572.38	2881.99	3548.22	4251.98	3529.23
Ukraine + Moldova	27288.44	20741.72	21051.66	24677.48	21808.33
Belorussia	5303.20	3578.40	4141.60	5092	4352.80
Kazakhstan	24245.28	18976.64	20812.32	25234.64	21706.32
Azerbaijan	3514.75	2593.48	2810.03	3510.74	2989.72
Georgia	Non-synchronous operation	992.08	1074.92	1342.96	1143.66
Altogether in Russia	129706.75	94767.29	98018.74	127579.62	104543.95
Consumption of the Synchronous Zone	194630.80	144531.60	151457.49	191689.08	160074.01

	Interconnections power flow, MW					
Cut sets	01.02.07	04.05.07	31.08.07	29.02.08	25.06.08	
IPS of Middle Volga– IPS of Urals	1203	1430	375	215	1200	
Center IPS – PS of Ukraine	-11	-802	296	521	441	
Belorussian PS – IPS of the North West	183	4	114	151	59	
IPS of Middle Volga – South IPS	494	651	220	525	657	
South IPS – Center IPS	405	113	53	-304	115	
IPS of Middle Volga – Center IPS	1632	1312	-800	-1282	-631	
PS of Kazakhstan – IPS of the Siberia	418	657	254	-148	622	
IPS of the North West – Estonia PS	148	-37	17	169	487	











