1 annex

Generators models update and verification for the isolated operation test.

Terms of reference

INTRODUCTION

On the 15th March 2016 the Baltic States TSOs agreed on a joint position regarding the Baltic Isolated Operation Test (hereinafter - Test). In order to prepare for the Test the Study of the Isolated Operation of the Baltic Power system was performed.
As an outcome of this study was to perform Model validation and power system stabilizers (PSS) tuning, based on real individual tests data for synchro machines, Wind farms and HVDC.
To ensure the sufficient power oscillation damping during the Test, PSS's should be properly tuned.
In order an ensure the main outcomes of the Isolated Operation of the Baltic Power system Study an additional Power Plants Dynamic model update and verification Study is starting. (hereinafter - Study).

OBJECTIVE AND SCOPE

The main objective of the Study is to perform generating units tests and based on test results to update dynamic Models of Lithuanian power system in the Baltic model. The main scope of the Study are:

- To prepare the individual units test programs for models verification;
- To install (if necessary) a temporary instrumentation to measure the response (tested parameters) of the power plant components for various tests;

To perform steps response tests for the frequency containment reserves' activation monitoring for different operation conditions following Commission regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation requirements.

- To perform the individual unit tests and associated measurements;
- Based on the Test measurements and plant documentation to select (update) the appropriate models structure for different power plant components and parameters. Should be created user written model for non standard units;
- To perform the simulations to validate that the models matches the actual unit response.
- to provide the methodology applied for the units testing, model parameters identification and models validation;
- to verify common Baltic dynamic model behavior;
- to define for PSS (power system stabilizer) the proper damping parameters for the Isolated operation Test. (in accordance with requirements set in Annex No1).
- To provide dynamic model of the individual power plants (synchronous machines prime movers, governors with complete turbine models, AVRs, PSSs, and corresponding limiters such as the under excitation limiter, etc.) available in PSS/E format. (Protection models of each unit shall be included).
- To model and validate proper behavior of validate of Continuously Controlled Shunt Reactor (Transductor) in Ignalina AE substation.

DATA WILL BE PROVIDED BY THE CUSTOMER

The PSS/E (Power System Simulation for Engineering) software version 33 are in use. The Service provide shall use the same PSS/E version 33.

For the dynamic parameter validation Customer will provide Baltic region PS model in PSS/E *.sav (raw) and *.dyr format.

Power flow model includes 110-400 kV Baltic control area transmission power systems network elements, HVDC interconnections and Kaliningrad control area equivalent model.
Baltic Power system dynamic model will be provided, however it requires a thorough verification.

REQUIREMENTS FOR UNITS TETS AND MODEL VERIFICATION

The detail information on Units which models shall be validated is provided in Table No1.

For the dynamic model validation the Service provide shall at least:

- Gather real data information from the generating companies owners (with support of the TSO);
- To prepare the individual units test programs for defining (updating) Generator, AVR, PSS, Governor, Prime mover, Boiler etc. parameters, necessary for dynamic models update and validation;
- Validate the Generators, AVR's, PSS's, Governors, Prime movers, Boilers models based on unit test measurements (if dynamic models parameters update and validations can be performed based on available commissioning test measurement, respective units test can be avoided);
- If standard PSS/E models response did not correspond tests measured results the custom written models shall be prepared, validated and added to Baltic PSS/E Model;

The tests shall be performed on the generating units to capture the dynamic behavior of the units and its controls. It is required that the units being tested should be on-line and have performed no maintenance works: capable to change loading and perform voltage control according the test programs.

The Service Provider will not be responsible for the balance energy compensation and unit start up and shutdown cost during the tests. These costs shall not be included into the Tender offer.

The test programs shall be prepared and coordinated with the Customer and generating company owner considering need to validate parameters. The amount of tests shall be sufficient to validate dynamic parameters.

Frequency containment performance shall be tested performing step response tests by adding artificial input signal to the rated 50 Hz frequency for at least 15 minutes. The step response tests for active power actual response, regulation quality, insensitivity, droop and dead band control shall be performed.

Units with the same types of equipment's shall not be tested twice. The Service Provider in coordination with the Customer shall decide to test only selected machines considering generator and turbine type, manufacturer, commissioning/refurbishing time.

The appropriate model structure should be selected based on the generating company documentation. Models shall be selected in such manner that the performance of the equipment and controls can accurately be modeled.

With an appropriate model the proper parameters should be identified based on the testing results and data collected from the plant.

Each unit of Kruonis HPSPP shall consist of three different models: for generator mode, pump mode and synchronous compensator mode. Kruonis HPSP dynamic parameters shall be validated for all operation modes.

Updated model shall be suitable for transient-, angle-, voltage stability as well as for frequency stability both for containment and restoration processes studies.

INSTRUMENTATION AND TEST EQUIPMENT

Considering the list of Units provided in Table No1, the Service provider shall prepare the main requirements (for example sampling rate, accuracy) for additional portable instrumentation and test equipment to be installed.

Installation of the test equipment and any temporary instrumentation places shall be coordinated with the generating company owner, and shall be capable to capture the response of the power plant components for various tests.

The list of available instrumentation and test equipment with the main technical capabilities is provided in Annex No2.

Based on the information provided in Annex No2 the Service provider shall estimate an additional need of installation of portable instrumentation and install it.

The Service provider is responsible for all costs related to additional installation/reinstallation of the measurement devices. The Service provide shall coordinate installation with generating companies owners and the Customer. These costs shall be included into the Tender offer.

Installation of the test equipment (connection places, human safety and etc.) shall be coordinated with the generation companies owners. If will be needed to install any instrumentation on high voltage side of step up transformer (110-330 kV voltage level) installation shall be coordinated with the Customer.

REQUIREMENTS FOR MODEL VERIFICATION

Based on the information collected from the generating companies' owners, provided by the Customer, performed unit tests results, the Service Provider:

- shall compose and validate single unit dynamic models,
- check the consistency of common Baltic TSO's dynamic model.

The performed simulations shall match the actual unit response for all tested conditions. The selection of the unit control parameters shall be finished if correlation between tested and simulated values are less predefined in the proposed methodology shall be used for the parameter validation. The comparison shall be done on amplitudes, oscillations and damping.

If not possible to reach acceptable correlation between tested and simulated values less in the proposed methodology, the Service provide shall provide reasonable explanation with the main reasons for deviation and elaborate possible deviations for the model usage.

The validation on the common Baltic TSO's dynamic model (with the updated dynamic parameters) shall be based on a reproduction of significant incidents close to the generator unit bus. The Customer will provide prepared static (initial conditions) model for the selected (no more than two) disturbances. According this the Service provider shall additionally verify the model.

REQUIREMENTS FOR RESULTS PROVISION

Plant information collected from the generating companies owners, tests results and captured parameters should be provided to the Customer.

Frequency containment performance compliance with the Continental Europe Synchronous area requirements shall be provided in the separate report.

All Units tested in accordance the Annex No1 should be included into report. Unit test results and PSS/E performed simulations, corresponding the same unit test conditions, shall be compared graphically on the same chart.

The structure of the *.dyr files of the dynamic models of the individual power plants (synchronous machines, prime mover, governor, AVR, PSS, limiters) should be the same as provided in Annex No 3.

The separate tables of all dynamic parameters for the generating units used in the Model shall be provided. If there are differences between initial parameters and updated short explanation is needed.

REQUIREMENTS FOR METHODOLOGY

Within the scope of this Study, the Service Provide shall prepare methodology for the selection of the unit dynamic parameters based on the plant documentation and Grid Code acceptance tests performed during the Power plant commissioning tests.

The prepared methodology shall:

- Set quality requirements to compare the correlation between tested and simulated values;
- Include requirements for the plant documentation to be provided from the generating company owner, requirements for testing;
- Additional tests to validate dynamic parameters if needed;
- Provide recommendations for the tests instrumentation installation requirements;
- Shall elaborate the main principles of dynamic model calibration based on the test results, taking into account the best engineering practice used by different TSO's.
- Shall include the continuous monitoring principles using disturbances data by comparing modeled response of grid disturbances versus actual response, and requirements for the dynamic model set up;
- Include explanation of the dynamic parameters sensitivity for the dynamic studies.
- An practical examples (illustrative cases) for parameter selection for different types of units. (Thermal (steam, gas turbines) Hydro, Wind parks).

The methodology shall be provided in the separate report.

REQUIREMENS FOR POWER SYSTEM STABILIZER RETUNING

Power system stabilizes (PSS) must be tuned:

- with the goal of damping local modes from 1 to 2 Hz.
- with the goal of damping inter-area modes from 0.25 to 0.8 Hz.

PSS gain tests, step response tests, frequency response tests, output limiter tests shall be performed.

The PSS tests should be carried out by applying a step and sinusoids signals to the AVR summing point to evaluate the performance of the PSS in local and inter-area modes.
Step signals resulting active or reactive power amplitude increase approx. 2 - 3 percent of the nominal value shall be used. Sinusoidal signals with a frequency step of 0.1 Hz for the full frequency range shall be fed into the test input of the AVR. Each test shall be initially performed with the PSS OFF and the repeated with the PSS ON.

The Service Provider in cooperation of generation companies' owners, PSSs manufactures, should prepare PSS test and retuning requirements, test and retune.

Existing PSS need to be correctly tuned to ensuring the proper damping. This has to be done in cooperation with the manufacturer of the PSS.

Witnesses of the Customer during the PSS tests is needed. The tests reports and protocols with the retuning parameters should be provided to the Customer.

The List on units for the PSS testing and retuning is provided in Annex No1

Table No1. List of Units parameters to be validated (AVR and PSS not included)

Plant name	Generator name *	Fuel Type	Generator type	Turbine type	Boiler type	FCR test **
Lietuvos E	TG7	Gas/Fuel Oil	TVV-320-2	Steam turbine K-300-240	ТГМП-114	yes
	TG8	Gas/Fuel Oil	TVV-320-2	Steam turbine K-300-240	ТГМП-114	yes
	KCB	Gas	450H (General Electric)	Manufactory: General Electric: Gas turbine type - 9FB.02, steam turbine type - D12		yes
Vilnius E2 (Combined Heat Power Plant) connected to DSO network	TG4	Biomass/ Biogas or fuel oil	T-12-2U3		BKZ-75-39FB	yes
	TG5		JISALT DECA 419	MAN Turbo MARC4-C01	BKZ-75-39FB	yes
Kaunas CHP	TG2	Gas/Fuel Oil	TVF-120-2	Steam turbine T 100/120-130	BKZ-420-140NGM-4	yes
Panevėžys CHP	TG1	Gas	AMS 1120 LC (ABB)	Gas turbine SGT-600 (Siemens)		yes
	TG2		A13274, (Manufactory Converteam Ltd, Electrical Machines)	Steam turbine MARC 2-H01 (manufactory MAN Diesel &Turbo SE)	Steam boiler type: IEG a.s Capacity 40t/h Pressure 6,52 MPa temperature 482 C	yes
Mažeikių CHP	TG1	Fuel Oil/Gas	TVF-120-2U3	Steam turbine PT80/100-130/13	TGME-464	yes
	TG2		TVF-120-2U4	Steam turbine PT80/100-130/13	TGME-464	yes
Lifosa (Industrial CHP)	TG-1		TPS-6-2EU3	K-6,1-0,68		
	TG-2		T-6-U3	P-6-35/5		
	TG-3		T-25-2U3	P-25-3,4/0,6)		
Achema (Industrial CHP)	T-2	Gas	AMS 1250 A LF (ABB)	Siemens, SGT-800		yes
Kaunas Hydro Power Plant (HPP)	G-1	Hydro	VGS-700/100-48	KAPLAN		yes
	G-2		VGS-700/100-48	KAPLAN		yes
	G-3		VGS-700/100-48	KAPLAN		yes
	G-4		VGS-700/100-48	KAPLAN		yes

Kruonis Hydro Pump Storage Plant (HPSP)	G-1	Hydro	VGDS-1025/245	RONT-115/812/V-630		yes
	G-2		VGDS-1025/245	RONT-115/812/V-630		yes
	G-3		VGDS-1025/245	RONT-115/812/V-630		yes
	G-4		VGDS-1025/245	RONT-115/812/V-630		yes
Fortum E (connected to DSO)		Waste	Siemens AMS 1120SF	Steam turbine Siemens Type SST-300		yes
Šiaulių CHP (connected to DSO)		Biomass	HTM 110C 04			
Putinų CHP (connected to DSO)		Biomass	HTM 171E04			

Remarks: ** Units with the same types of equipment's shall not be tested twice. The Service Provider in coordination with the Customer shall decide to test only selected machines.*

*** primary control response shall be tested*

TIME SCHEDULE

The Service Provide should undertake to perform the Study within the following time schedule and forms:

Milestone	Action	Deadline (latest)*
1	Signing of the contract for the Study	D+0
2	Kick-off meeting / coordination of the time line of the project	D+5, (exact date to be agreed in the time schedule)
3	Providing information for the Study (Customer owned information)	D+10 (exact date to be agreed in the time schedule)
4	Collection of plant documentation, identification of needed test.	D+40 (exact date to be agreed in the time schedule)
5	Preparation of the tests programs	D+60 (exact date to be agreed in the time schedule)
6	Meeting to discuss on tests amounts, instrumentation needed for installation (generating companies owners participation is needed)	D+70 (exact date to be agreed in the time schedule)
7	Units tests/measurements collection/dynamic model validation	D+160 (exact date to be agreed in the time schedule)
8	Intermediate report/test results/*.dyr files	D+200 (exact date to be agreed in the time schedule)
9	Meeting to discuss intermediate results	D+210 (exact date to be agreed in the time schedule)
9	Remarks from the Customer	D+220 (exact date to be agreed in the time schedule)
10	Final report/plant documentation/test results provided to the Customer	D+230 (exact date to be agreed in the time schedule)
11	Accepted final report (all the scope accepted by the Client)	D+240 (exact date to be agreed in the time schedule)

* Calendar days (all weekends and holidays included)

Regular catch up Telco's between the Service provide and Customer should take place during the performance of the study.

At least 2 physical meetings/workshops should be held during the performance of the study. The meetings/workshops should take place in Lithuania

Annex No1 Requirements for PSS (power system stabilizer) retuning

No	Power Plan	Generator
1.	Kruonis Hydro Pump Storage Plant (HPSP)	G1
2.	Kruonis Hydro Pump Storage Plant (HPSP)	G2
3.	Lietuvos Power Plant unit 9	G9
4.	Mažeikių CHP	TG1
5.	Mažeikių CHP	TG2
6.	Lietuvos Power Plant unit 7	G7
7.	Lietuvos Power Plant unit 8	G8

Annex No2 Available measurement systems owned by the Customer and generating companies owners.

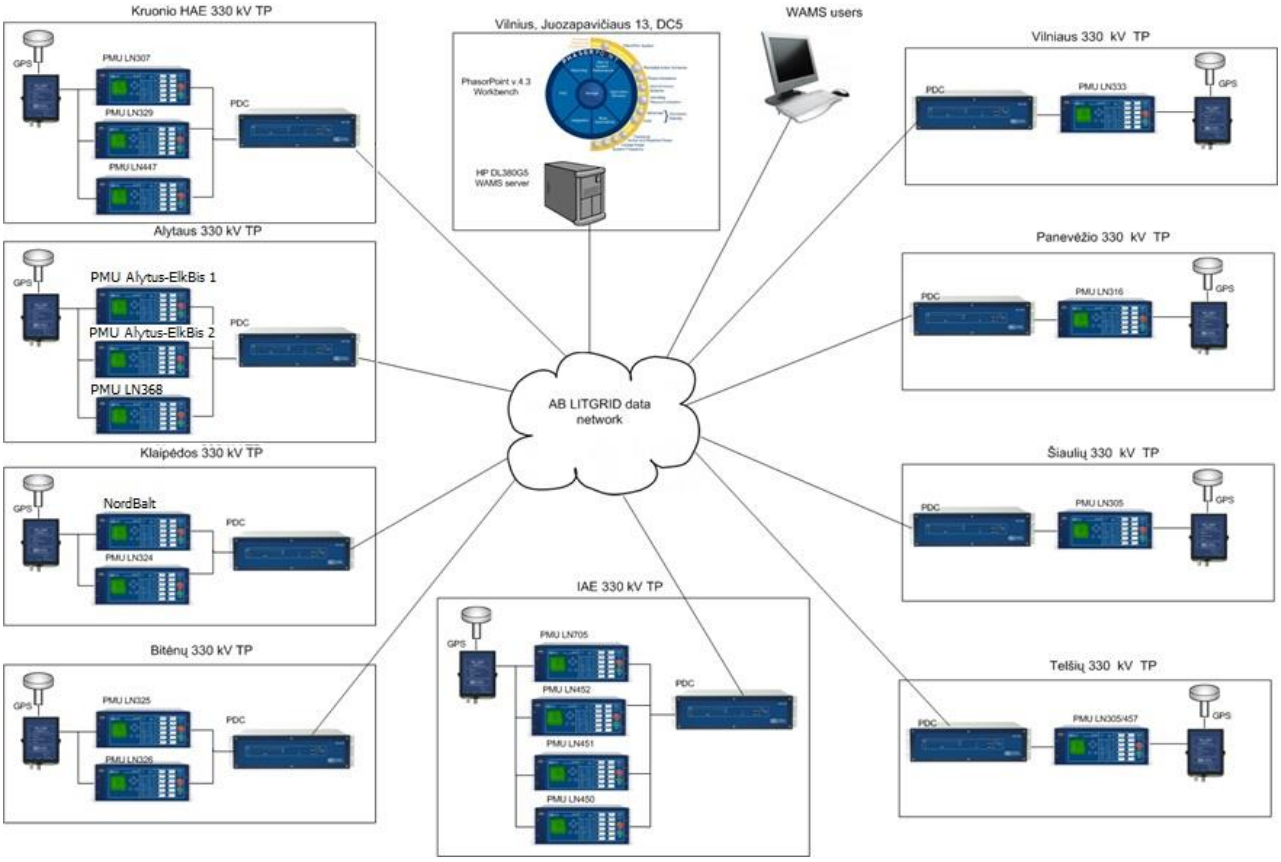
SCADA system

	U, kV	P, MW	Q, MVar	f, Hz	Generation		Load	
					P, MW	Q, MVar	P, MW	Q,MVar
Recording time	> 1 year	>1 year	>1 year	>1 year	> 1 year	> 1 year	> 1 year	> 1 year
Discretion	2 sec	2 sec	2 sec	2 sec	2 sec	2 sec	2 sec	2 sec

WAMS: Allocation of PMU devices

	Substation name	330 kV OHL, No
1	330 kV Kruonio HAE	LN 307, LN 329, LN 447
2	330 kV TP Vilnius	LN 333
3	330 kV TP Alytus	LN 368
4	330 kV TP Klaipėda	LN 324, NordBalt
5	330 kV TP Panevėžys	LN 316
6	330 kV TP Šiauliai	LN 305
7	330 kV TP Telšiai	LN 457
8	330 kV TP Bitėnai	LN 325, LN 326
9	330 kV Ignalinos AE	LN 450, LN 451, LN 452, LN 705
10	400 kV Alytus	Alytus-Elk Bis1, Alytus-Elk Bis 2

WAMS structure



Technical data of WAMS system

PMU device	Manufacture	Software	Communication	Real time date base	Data archiving sample per cycle
SEL-451	Schweitzer Engineering Laboratories, Inc. (SEL)	PHASORPOINT	Stream synchrophasor data with IEEE C37.118 standard format	available	1

Functionality of WAMS system

Functionality	Available yes/no	Comments
Complex phasor data concentrator	yes	SEL-1102 Substations PDCs and Central PDC
Real-time data analysis	yes	
Historical data analysis	yes	
Detection of abnormal power system operation states	yes	
Phase angle difference detection	yes	
Low frequency oscillation detection	yes	By 7 types of ranges
Over/under value detection (U, f, P, Q)	yes	
Data visualization	yes	

Possibility for connections with other WAMS systems	yes	by IEEE C37.118 standard format

Measurement devices/equipment owned by generating companies	Availability
Transient fault recorders	Lithuanian PP: Standard fault recorders. Recording 1 sec before event and 1 sec after event. Synchronization 0,01 s. Panevezio PP: Siemens 7UM621 SIPROTEC Lifosa PP: REMI 12/16 Sudėnai, Kreivėnai, Lauksargiai, Čiuteliai, Didšiliai, Strepeikiai, Geišiai Wind parks: 1 event recording time 20 sec. available 100 events recording
Portable measurement devices	
Energy quality analyzers	Lithuanian PP: Portable Elspec G4500: U, I, P, Q, f, registration of transient processes, harmonic spectrum, accuracy 0,15 %. Synchronization 1 μs, recording time 12 month Lifosa PP: Portable METREL Čiuteliai, Didšiliai, Strepeikiai wind parks: IMC iMEAX B-1100-1 Šyša wind park: EPM9450 Šiauduva wind park: ION7650 Geišių wind park: G4K

Wind parks

Wind parks	**P, MW** **$a^1/b^2/c^3$**	**Q, MVar** **$a^1/b^2/c^3$**	**F, Hz** **$a^1/b^2/c^3$**	**Export format**
DIDŠILIAI	1sec//24h/-	1sec//24h/-	1sec//24h/-	Excel
ŠIAUDUVA				
KREIVĖNAI	1min/24h/-	1min/24h/-	1min/24h/-	Excel
ČIUTELIAI	1sec//24h/-	1sec//24h/-	1sec//24h/-	Excel
LAUKSARGIAI	1min/24h/-	1min/24h/-	1min/24h/-	Excel
SUDĖNAI	1min/24h/-	1min/24h/-	1min/24h/-	Excel
STREPEIKIAI	1sec//24h/-	1sec//24h/-	1sec//24h/-	Excel
GEIŠIAI	1sec//24h/-	1sec//24h/-	1sec//24h/-	Excel

[1]-Data archiving sample per sec./ [2]- Recording time / [3]- Accuracy

Hydro plants

Hydro generators	**P, MW** **$a^1/b^2/c^3$**	**Q, MVar** **$a^1/b^2/c^3$**	**F, Hz** **$a^1/b^2/c^3$**	**Export format**

KHAE G1	10/>100 h/0,5	10/>100 h/0,5	10/>100 h/0,5	Excel
KHAE G2	10/>100 h/0,5	10/>100 h/0,5	10/>100 h/0,5	Excel
KHAE G3	10/>100 h/0,5	10/>100 h/0,5	10/>100 h/0,5	Excel
KHAE G4	10/>100 h/0,5	10/>100 h/0,5	10/>100 h/0,5	Excel
KHE G2	15 min*/>24 h/-	15 min*/>24 h/-	15 min*/>24 h/-	txt
KHE G2	15 min*/>24 h/-	15 min*/>24 h/-	15 min*/>24 h/-	txt
KHE G4	15 min*/>24 h/-	15 min*/>24 h/-	15 min*/>24 h/-	txt
KHE G4	15 min*/>24 h/-	15 min*/>24 h/-	15 min*/>24 h/-	txt

[1]-Data archiving sample per sec./ [2]- Recording time / [3]- Accuracy
*-registration if no signal change

Thermal plants

Turbo generator	**P, MW a[1]/b[2]/c[3]**	**Q, MVar a[1]/b[2]/c[3]**	**F, Hz a[1]/b[2]/c[3]**	**Export format**
LE B9	1-10 />12month./-	1-10 />12month./-	1-10 />12month./-	txt
LE B7	1-10 />12month./-	1-10 />12month./-	1-10 />12month./-	txt
LE B8	1-10 />12month./-	1-10 />12month./-	1-10 />12month./-	txt
LIFOSA G1	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	Program CITECT
LIFOSA G2	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	Program CITECT
LIFOSA G3	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	2/1440h/ 0,5-0,2%	Program CITECT
PAN.E G1(gas turbine)	1/720h/0,5%	1/720h/0,5%	1/720h/0,5%	csv
PAN.E G2(steam turbine)	1/720h/0,5%	1/720h/0,5%	1/720h/0,5%	csv
VE2 G-4	1/360h/1-5%	1/360h/1-5%	1/360h/1-5%	Excel
VE2 G-5	1/360h/1-5%	1/360h/1-5%	1/360h/1-5%	Excel
Achema G-2	1/72h/0,5	1/72h/0,5	1/72h/0,5	csv

[1]-Data archiving sample per sec./ [2]- Recording time / [3]- Accuracy

Available measurements from generation units

Generators	**AVR/PSS control (voltage and current measurements)**	**Turbine Governor steam valve/ (Hydro - pitch position)**
KHAE G1	10 sample per sec	pitch position- 10 sample per sec

KHAE G2		pitch position- 10 sample per sec
KHAE G3		pitch position- 10 sample per sec
KHAE G4		pitch position- 10 sample per sec
LE B9	1-10 sample per sec	Steam valve position, steam pressure and temperature before turbine: 1-10 sample per sec
LE B7	1-10 sample per sec	Steam valve position, steam pressure and temperature before turbine: 1-10 sample per sec
LE B8	1-10 sample per sec	Steam valve position, steam pressure and temperature before turbine: 1-10 sample per sec
LIFOSA G1		Steam pressure and temperature before turbine: 2 samples per sec, recording time1440h, accuracy 0,5-0,2%
LIFOSA G2		Steam pressure and temperature before turbine: 2 samples per sec, recording time1440h, accuracy 0,5-0,2%
LIFOSA G3		Steam pressure and temperature before turbine: 2 samples per sec, recording time1440h, accuracy 0,5-0,2%
PAN.E G1(gas turbine)	1 sample per sec., recording time 720 h, accuracy 0,5 %	Steam valve position, steam pressure and temperature before turbine: 1 sample per sec., recording time 720 h, accuracy 0,5 %
PAN.E G2 (steam turbine)	1 sample per sec., recording time 720 h, accuracy 0,5 %	
VE2 G-4		Steam pressure and temperature before turbine: temperature 1 sample each 5 sec., pressure 1 sample per sec, accuracy 0,4 %
VE2 G-5	4ms-10sec, recording time up 8 events, accuracy 0,25%	2 sample per sec. recording time 8765 h, accuracy 0,4
Achema G-2	1 sample per sec., recording time 72 h, accuracy 0,5 %	

Annex No3 Examples of for PSS/E *.dyr file structure and parameters tables

```
/ ++++++++++++++++++++     XXXXX power plant     |++++++++++++++++++++
/ ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
/
/          Generator data
/
/IBUS,'GENSAL',I, T'do,T"do, T"qo,  H,   D,  Xd,   Xq,  X'd,  X"d,  Xl,  S(1.0),S(1.2)/
0001 'GENSAL' 0  0.0  0.00  0.000  0.0   0  0.00  0.00  0.00  0.00  0.0   0.00  0.00
0002 'GENSAL' 0  0.0  0.00  0.000  0.0   0  0.00  0.00  0.00  0.00  0.0   0.00  0.00
0003 'GENSAL' 0  0.0  0.00  0.000  0.0   0  0.00  0.00  0.00  0.00  0.0   0.00  0.00
0004 'GENSAL' 0  0.0  0.00  0.000  0.0   0  0.00  0.00  0.00  0.00  0.0   0.00  0.00
/
/          AVR models data
/
/IBUS, 'ESAC6A', I,   TR,  KA,   TA,    TK,  TB,  TC,  VAMAX,VAMIN,VRMAX,VRMIN, TE,  VFELIM,KH,VHMAX,TH,TJ,  KC,     KD,    KE, E1, SE(E1), E2, SE(E2)/
0001  'ESAC6A'  0 0.0000 000.0 0.00 0.00000 0.0 0.000  0.0  -0.0   0.0  -0.0   0.000 0     0  0.0   0 0   0.0000 -0.00000  0   0    0      0    0
0002  'ESAC6A'  0 0.0000 000.0 0.00 0.00000 0.0 0.000  0.0  -0.0   0.0  -0.0   0.000 0     0  0.0   0 0   0.0000 -0.00000  0   0    0      0    0
0003  'ESAC6A'  0 0.0000 000.0 0.00 0.00000 0.0 0.000  0.0  -0.0   0.0  -0.0   0.000 0     0  0.0   0 0   0.0000 -0.00000  0   0    0      0    0
0004  'ESAC6A'  0 0.0000 000.0 0.00 0.00000 0.0 0.000  0.0  -0.0   0.0  -0.0   0.000 0     0  0.0   0 0   0.0000 -0.00000  0   0    0      0    0
 /
/BUS, 'ESST1A', I, UEL, VOS, TR, VIMAX, VIMIN,  TC,  TB, TC1, TB1, KA, TA, VAMAX, VAMIN, VRMAX, VRMIN,  KC,  KF, TF, KLR, ILR
0001  'ESST1A'  0   0    0   0     0     -0    0.00   00  0    0   000  0    0      0       0       0    0  0.00   0   0    0
0002  'ESST1A'  0   0    0   0     0     -0    0.00   00  0    0   000  0    0      0       0       0    0  0.00   0   0    0
0003  'ESST1A'  0   0    0   0     0     -0    0.00   00  0    0   000  0    0      0       0       0    0  0.00   0   0    0
0004  'ESST1A'  0   0    0   0     0     -0    0.00   00  0    0   000  0    0      0       0       0    0  0.00   0   0    0
/
/IBUS,'COMP',I,   Xe/
0001 'COMP'  0   0.00
0002 'COMP'  0   0.00
0003 'COMP'  0   0.00
0004 'COMP'  0   0.00
/
IBUS,'PSS2A',I,ICS1,REMBUS1,ICS2,REMBUS2,M,N, Tw1,Tw2, T6, Tw3,Tw4,  T7,  KS2, KS3,  T8,   T9,  KS1,   T1,   T2,   T3,   T4,  VSTMAX, VSTMIN/
0001 'PSS2A' 0   0       0       0       0  0 0   0    0    0    0    0    0    0.00   0   0.0   0.0   0    0.0  0.00  0.00  0.00     0.0   -0.0
0002 'PSS2A' 0   0       0       0       0  0 0   0    0    0    0    0    0    0.00   0   0.0   0.0   0    0.0  0.00  0.00  0.00     0.0   -0.0
0003 'PSS2A' 0   0       0       0       0  0 0   0    0    0    0    0    0    0.00   0   0.0   0.0   0    0.0  0.00  0.00  0.00     0.0   -0.0
0004 'PSS2A' 0   0       0       0       0  0 0   0    0    0    0    0    0    0.00   0   0.0   0.0   0    0.0  0.00  0.00  0.00     0.0   -0.0
/
/          Turbine regulators data
/
/IBUS,'TGOV5',I,Jbus,M,  K,    T1,  T2,   T3,  Uo,   Uc, Vmax,Vmin, T4,     K1, K2, T5, K3, K4,T6,K5,K6,T7,K7,K8,K9,K10,K11,K12,K13,K14, Rmax,  Rmin,  Lmax,Lmin,C1,C2,C3, B,  Cb, Ki, Ti, TR,TR1, Cmax,Cmin, Td, Tf,Tw,Psp,   Tmw, K1,Kmw,Dpe/
0001 'TGOV5' 1   0  0 00.00  00.00  0  0.000 0.07 -0.00  0.0  0   0.000   -0.00  0 0.0 0.00 0  0  0  0  0  0  0  0   0   0   0   1  0.000 -0.000   0.0   0   0  0  0  00 0000 0   0  00   0   0.0 -0.0   0  00  0  0  0000000  0  0   0
0002 'TGOV5' 1   0  0 00.00  00.00  0  0.000 0.07 -0.00  0.0  0   0.000   -0.00  0 0.0 0.00 0  0  0  0  0  0  0  0   0   0   0   1  0.000 -0.000   0.0   0   0  0  0  00 0000 0   0  00   0   0.0 -0.0   0  00  0  0  0000000  0  0   0
0003 'TGOV5' 1   0  0 00.00  00.00  0  0.000 0.07 -0.00  0.0  0   0.000   -0.00  0 0.0 0.00 0  0  0  0  0  0  0  0   0   0   0   1  0.000 -0.000   0.0   0   0  0  0  00 0000 0   0  00   0   0.0 -0.0   0  00  0  0  0000000  0  0   0
0004 'TGOV5' 1   0  0 00.00  00.00  0  0.000 0.07 -0.00  0.0  0   0.000   -0.00  0 0.0 0.00 0  0  0  0  0  0  0  0   0   0   0   1  0.000 -0.000   0.0   0   0  0  0  00 0000 0   0  00   0   0.0 -0.0   0  00  0  0  0000000  0  0   0
```