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NUCLEAR ENERGY AGENCY
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FORSMARK 1 & 2 BWR STABILITY BENCHMARK
Time Series Analysis Methods for Oscillations during BWR Operation

Summary Record of the First Meeting
Consejo de Seguridad Nuclear, Madrid
18th and 19th February 1999

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Introduction

The meeting was opened by the chairman, J.M. Conde Lopez, who welcomed participants to the meeting on behalf of the Consejo de Seguridad Nuclear, who co-sponsored the benchmark and was hosting the workshop. E. Sartori welcomed participants on behalf of the OECD/NEA.

In all, seventeen participants from eight countries and thirteen organisations attended. The interest in the benchmark and in the meeting was somewhat larger: some interested parties were unable to attend because of other commitments (see Annex 1, for the list of participants)

The agenda was reviewed; the details including presentations are provided as Annex 2. The list of papers distributed at the meeting is provided as Annex 3.

Objectives

G. Verdú, co-ordinator of the benchmark study, recalled the objectives of the benchmark and the meeting: the purpose of this benchmark is the intercomparison of the different time series analysis methods that can be applied to the study of BWR stability, and is a follow-up activity of the Ringhals 1 Stability Benchmark organised by the NSC in 1996.

While the Ringhals 1 Stability Benchmark included both time domain and frequency domain calculation models to predict stability parameters, the new activity is focused in the analysis of time series data by means of noise analysis techniques in the time domain.

The first goal is to determine, if possible, the main stability parameters from the neutronic signals time series with enough reliability and accuracy. Typically, the main stability parameters are assumed to be the decay ratio (DR) and the frequency of the oscillation. However, there is also the possibility of considering other parameters that can provide valuable information of the stability of the neutronic time series.

For the purpose of analysing the effects of all these parameters, the participants in this benchmark were asked to provide a short description of the methodology used for the analysis of the time series, to provide information on the codes used with enough detail to identify the sources of discrepancies. In addition participants were asked to describe their experience with the data and other information to help the analysis of the results globally and to draw conclusions.

The data used in this benchmark were obtained during several stability tests performed at the Swedish BWR reactors Forsmark 1 and 2, in the period 1989 to 1997. And were released by Pär Lansaker of Forsmarks Kraftgrupp AB.

Test Problems Considered

Two kinds of power oscillations have been observed in BWRs: in-phase (core-wide) oscillations, where all the core oscillations are in phase, and out-of-phase, where one half of the core oscillates out of phase of the other part. The oscillations are studied using LPRM and APRM signals. Thus, the oscillation detection algorithms are important to detect and classify the instabilities of the neutronic power signal.

The database is divided into six cases, the sampling rate of all the time series being 25 Hz, decimated to 12.5 Hz. No filter was applied to the signals and the DC-component has not been subtracted.

- **CASE 1**

This case contains the neutron flux signals measured during several tests. The objective of the case is to study several signals ranging from stable to quasi-unstable conditions. The signals are standard measurements with no distortions, and should be fairly easy to evaluate. Data contains measured APRM (Average Power Range Monitor) signals from stability tests.

The results for this case will be the DRs and oscillation frequencies associated with the APRM signals taken during 14 different tests.

Each time series has about 4000 points, the range of DR being from 0.4 till 0.8. The objective of this case is the comparison among the different methods applied to obtain the stability parameters.

The preliminary results provided for the DR and the fundamental frequency for this case are shown in tables 2 and 3. Taken as a reference the mean values, the following conclusions can be obtained

- The UPV-AR methodology is dependent on the model order. AR methodologies based on an average among different orders or the plateau methodology are more stable.
- The UPV-Dynamics reconstruction method generally overestimates the DR.
- For the methods based on a fit for the impulse response it was found that JAERI’s group method has a stable behaviour and the method used by TU DELFT gives deviating DRs for some of the cases.
- The PSU group and the Tsukuba University group use AR methods that generally underestimate the DR.
- The Reduced-order Method, based on the LAPUR code, provides different results from the other contributors. This could be due to the lack of an accurate input model for the Forsmark reactor.

- As the main conclusion for this case we have that case 1 corresponds to a stable configuration of the reactor. The results for the fundamental frequency are quite uniform, and there is a large dispersion for the DR values.

- **CASE 2**

This case addresses the importance of the time duration of measured data.

The objective of this case is to study the variability of the DR and the oscillation frequency with the measurement time duration. There are two long time series to analyse, l1 and l2. Each one has about 14000 points, and will be divided into blocks of approximately 4000 and 2000 points. The results for the short time series will be compared with the original long series results.

The preliminary results provided for this case are shown in tables 5 and 6. From these results the following conclusions can be drawn:

- For Signals l1 and l2 the frequency is approximately constant for the different segments.
- For Signal l1 the DR depends on the segment of the signal analysed. The first part of the signal (s1) corresponds to a more stable configuration than the other segments (s2, s3, s4).
- For Signal 12 the DR remains approximately constant along all the segments.
- Signal 11 presents a slow transient and the results provided for this signal have larger dispersion than the ones provided for Signal l2, which is practically stationary.
- It is clear that at least for Signal l1 the DR is time dependent.

- **CASE 3**

APRM data for this case contain more than one natural frequency of the core. The data also contain peaks of other frequencies due to the actuation of the pressure controller. One case has two frequencies close to each other. Cases with more than one natural frequency make the analysis much more difficult.

This case contains five measurements contaminated with influences from the plant control systems. In this case, the time series have a bad behaviour, and consequently the standard stability parameters are not clear.

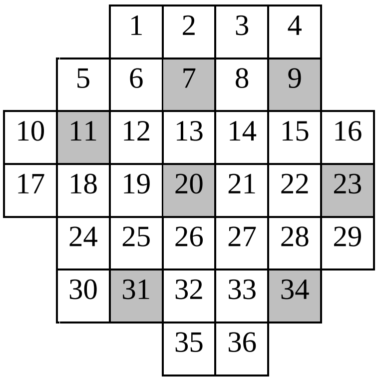
The preliminary results provided for this case are shown in tables 7 and 8. From these results the following conclusions can be obtained:

- For this case the UPV group has found some problems to determine the fundamental harmonic of the oscillation.
- The other contributors give homogenous results for the frequency of the neutronic signals.
- The typical dispersion for the values of the DR appear. For example, the values provided for the DR in test 3 range from 0.1 to 0.6.
- The signal conditions can play an important role to resolve the stability information.

- **CASE 4**

  This case contains a mixture between a global oscillation mode and a regional (half core) oscillation. The case consists of APRM and LPRM (Local PRM) signals coming from one test.

  The LPRM positions in the core are as follows:



		1	2	3	4	
	5	6	7	8	9	
10	11	12	13	14	15	16
17	18	19	20	21	22	23
	24	25	26	27	28	29
	30	31	32	33	34	
			35	36		

The locations corresponding to the different numbers used to label the tables are the following:

Number	**Position**	**Level**
1	23	1
2	23	2
3	23	3
4	23	4
5	34	1
6	34	2
7	34	3
8	34	4
9	7	1
10	7	4
11	11	1
12	11	4
13	20	1
14	20	2
15	20	3
16	20	4
17	9	1
18	9	2
19	9	3
20	9	4
21	31	1
22	31	4

The time series have a good behaviour. In this case, it is interesting to study the interrelations between APRM and LPRM signals.

The preliminary results for this case are shown in tables 9 and 10. From these tables the following conclusions are obtained:

- There is not a large dispersion for the values of the DR in this case because the configuration of the reactor is more unstable, that is the DR is high (≅ 0.8).
- There is a half of the reactor (locations 23 and 9) where the DR is high and the other half (locations 31 and 11) where the DR is lower. The upper part of the reactor seems to be more stable than the lower part.
- Spectral analysis of the signals indicates that there is a phase shift between the LPRM at radial locations 23 and 11, and locations 23 and 31, but the out-of-phase oscillation is not totally developed.
- To make a more accurate regional analysis more information is needed, e.g. more LPRM signals, the operating conditions for this case and nuclear cross-sections. Nevertheless, for this case the Siemens group provides regional decay ratio calculations obtained from diagonal LPRMs.

- **CASE 5**

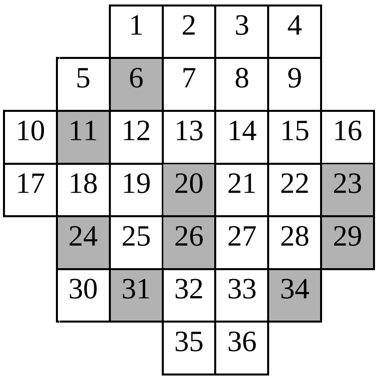
This case is focused on the analysis of two APRM-signals obtained during a small plant transient that resulted in a bad behaviour of the signals. In this case, it is important to analyse the first dominant poles of the transfer function obtained from the time series. Note that this is a non-stationary case and the auto-regressive methods have a limited validity.

The preliminary results for this case are shown in tables 11 and 12. For this case the following conclusions can be obtained:

- For APRM 1 signal considered as a whole, the results are quite uniform, the DR is near 1, and the results for the frequency are near 0.5 Hz.
- If the signal is divided in two or three records, the first part corresponds to a limit cycle, and the second part is more stable.
- For the APRM 2 the results of all the contributors are quite similar. The signal can also be divided in two or three parts, the first part of the signal being more stable than the second.
- We can surmise that when the DR is high the methodology seems to work even for small power transients.
- For cases with mild transient, the transient portion of the signal, which must correspond to a time-varying decay ratio, was shown to have an averaged decay ratio bounded by the steady state points before and after the transient portion. This gives confidence that some methods retained importance for monitoring purposes.

- **CASE 6**

The LPRM positions in the core for case 6 are the following:



		1	2	3	4	
	5	6	7	8	9	
10	11	12	13	14	15	16
17	18	19	20	21	22	23
	24	25	26	27	28	29
	30	31	32	33	34	
			35	36		

The locations corresponding to the different numbers used to label the tables are:

Number	Position	Level
1	23	1
2	23	4
3	26	1
4	26	4
5	11	1
6	11	4
7	6	1
8	6	4
9	34	1
10	34	4
11	20	1
12	20	4
13	31	1
14	31	4
15	24	1
16	24	4
17	29	1
18	29	4

This test case shows local (channel) oscillations.

The data contains APRM and LPRM signals from two tests that were performed close to each other, both in time and in the operating conditions.

Test 1 (case 6.1) is the same as Case 1.8, and the measurement is taken from Forsmark 1. The second test (case 6.2) clearly shows local oscillations.

The preliminary results for this case are shown in tables 13, 14, 15 and 16. The following conclusions can be obtained:

Case 6.1

- This is a stable case where the typical dispersion for the values provided for the DR are observed while the results for the frequency are more accurate.
- The LPRM signal at location 11 has a higher DR than the one corresponding to the APRM signal.

Case 6.2

- The APRM signal corresponds to an almost unstable situation (DR>0.9) and the results for the contributors are quite similar.
- It is observed that half of the reactor is oscillating and the other half is stable.
- The channels with radial locations 26, 11, 6, 24 are almost unstable. It seems that half of the reactor is oscillating and the other half is stable.
- There is a kind of local oscillation but there is no phase shift between the LPRMs signals. Clearly this case is not an out-of-phase oscillation
- Case 6.2 corresponds to a ‘strange’ oscillation where some channels oscillate and other channels are stable. Dr. Hennig has proposed a possible explanation of this case based on the assumption of unseated channels in the core.

Presentation by Participants

Participants presented their results. The corresponding papers and copies of viewgraphs containing the relevant details are listed in Annex 3. Table 1, summarises the methods used by participants.

Table 1. The methods used in the solutions provided

Method	Country	Organisation
Auto-Regressive methods & Dominant Poles	PSI UPV/CSN SIEMENS	Switzerland Spain Germany/USA
Auto-Regressive methods & Impulse Response	TOSHIBA JAERI IRI/TU-Delft PSU	Japan Japan The Netherlands USA
Auto-correlation	TOSHIBA	Japan
Recursive Autocorrelation	SIEMENS	Germany/USA
ARMA (plateau method)	PSI	Switzerland
Power Spectrum Estimation	CSNNS	Mexico

LAPUR (frequency domain)	PSU	USA

A general discussion followed. The conclusions for the different cases are summarised in a previous paragraph.

Review of Summary Conclusions

Lessons learned on the performance of different approaches and determination of uncertainties were debated. The questions raised were summarised by G. Verdú and discussed. The answers provided by participants were summarised by D. Ginestar. The expert views are as follows:

Questions Raised / Answers

1. **Which is the best definition of Decay Ratio (DR)?**
   For Noise Analysis it is the decay ratio associated with the least stable or dominant pole. The definition is clear for a second order system.

2. **Which are the best methods for calculating the DR?**
   Several methods were used in this study: AR method, AR method plus Impulse Response, Auto-correlation, Recursive Autocorrelation methods, ARMA, LAPUR, Power Spectrum Estimation. At the Forsmark NPP stability monitors have been used for over 10 years and the uncertainty in the DR

range 0.5 – 0.6 is smaller than 0.1. Obviously experience of the operator in using such a monitor at the plant is required. In other ranges the uncertainty can be higher. Measurements in a steady state condition, extracting signals for a given time interval and analysing them, leads to small uncertainties. The methodology for determining the uncertainty has to be defined and the model order should be known (but this is not always certain). What really matters is the DR after manoeuvring and the amplitude of the oscillation. Often oscillations are not stationary, the 'decay ratio' for these signals is not well defined but the determination of frequency (Fourier analysis) is quite accurate. For the determination of decay ratios the asymptotic part of the transformation function should be used. This is a suggested pragmatic approach.

3. **Is it possible to have reliable methods for determining DR automatically, independently of the analyst?**
It is possible. This has been demonstrated at Forsmark where the same method is used and compared in the monitoring and off-line. Also the Siemens experience affirms this answer. No filtering is required and once experience has been gained it works well. Signal conditioning has to be plant dependent. The experts tune it to the plant, then it can be run automatically.

4. **What is the influence of the time duration in the estimation of DR?**
An accurate auto-correlation function is required first based on the AR model. A heuristic type of algorithm is normally used. The duration depends on the value of DR (about inversely proportional to it). For power spectral density between 4000 and 10000 points are required).

5. **Is it of interest to determine the DR in a transient? Is the calculation reliable?**
It is of interest - because the method follows the trend and makes the DR derived acceptable.

6. **What happens if the signal contains more than one natural frequency? Which DR is the true one?**
The interesting information for the operator is: oscillations driven by a noise source, disturbances in the system. Oscillations by themselves do not imply instability if driven by an external source. The stability characteristics of the reactor need to be known; the amplitudes are easy to extract.

7. **Is it possible to determine DR of an out of phase oscillation?**
This is possible for DR up to 0.7 ± 0.1 and if enough LPRM signals per plane are provided. Because there are many ways of doing it wrong and only a few to do it right, it depends on the expertise of the analyst, or the sophistication of the monitoring algorithm.

8. **Can we provide an accurate limit to the stable behaviour of the reactor core?**
This depends on the uncertainty. The real margin should be determined on power. Frequency domain codes can determine it; they are efficient but not sufficient. The 'decay ratio' is a measure of linear stability and should therefore not be used as the only indicator of BWR stability. The Siemens group disagrees with this affirmation, and the say that there is no need for non-linear consideration whatsoever.

The Next Phase

The possibility to add an additional phase was debated. The possibilities would be to;

- revisit the solutions in the light of what was presented and discussed at the meeting
- repeat some precise cases with more data

It was agreed that the major objective, namely the verification as to what extent different methods give the same answer was met. The applicability and reliability of the different methods were investigated. Additional data would not be more helpful for the signal analysis. In practice analysts have only a small set of data available and not the full picture. The six cases chosen to be studied are relatively difficult and are really addressing the limits of the methods. Use of a full set of data could be the subject of a different study involving reactor physics. It has therefore been agreed that new solutions would be accepted, but those submitted would not be revised.

The schedule for submission of new results, the publication of results, the presentation at conferences and reporting to CSNI PWG2 was agreed on. This summary will form the basis for the report to the NEA NSC.

The proposed outline of the final report is provided as Table 2.

Table 2. Proposed Outline of Forsmark 1 & 2 Benchmark Report

Foreword
Executive Summary
Contributions & Acknowledgements (Chair, Co-ordination, Participation, Editing)
(a) Introduction
(b) Objectives
(c) Description of Cases
(d) Summary Table on Participants and Methods Used
(e) Comparison of Results (sorted by method and case)
(f) Discussion of Results
(g) Conclusions – Recommendations
Annex 1: Full Address of Participants
Other Annexes: Special Analyses Made by Participants; Details about Methods Used
References

The agreed actions and timetable are provided as Annex 4.

The NEA Secretariat expresses thanks to the Consejo de Seguridad Nuclear for hosting the workshop, for the hospitality provided, and for the competent expertise made available.

Table 3. Preliminary results for the DR. Case 1.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	Mean	S D
Aprm.1	0.460	0.423	0.576	0.640	0.42	0.580	0.330	0.500	0.420	0.422	0.460	0.420	0.512	0.57	0.566	0.487	0.09
Aprm.2	0.656	0.654	0.702	0.824	0.52	0.500	0.420	0.510	0.510	0.523	0.613	0.650	0.577	0.46	0.454	0.572	0.11
Aprm.3	0.576	0.582	0.558	0.735	0.30	0.250	0.300	0.500	0.630	0.511	0.537	0.520	0.499	0.60	0.516	0.508	0.13
Aprm.4	0.515	0.514	0.525	0.634	0.39	0.260	0.230	0.530	0.420	0.549	0.528	0.510	0.558	0.78	0.516	0.497	0.14
aprm.5	0.581	0.573	0.523	0.702	0.49	0.700	0.200	0.510	0.510	0.534	0.517	0.470	0.532	0.36	0.523	0.515	0.12
aprm.6	0.540	0.549	0.521	0.659	0.44	0.100	0.420	0.550	0.510	0.559	0.526	0.550	0.587	0.53	0.764	0.520	0.14
aprm.7	0.695	0.700	0.694	0.624	0.51	0.370	0.150	0.590	0.680	0.657	0.669	0.660	0.630	0.66	0.572	0.591	0.15
aprm.8	0.533	0.542	0.503	0.577	0.27	0.220	0.370	0.450	0.460	0.495	0.483	0.440	0.445	0.57	0.519	0.458	0.10
aprm.9	0.573	0.547	0.458	0.503	0.55	0.340	0.430	0.500	0.530	0.487	0.530	0.470	0.561	0.50	0.642	0.508	0.07
aprm.10	0.611	0.635	0.631	0.545	0.45	0.520	0.300	0.450	0.490	0.482	0.585	0.470	0.537	0.32	0.764	0.519	0.12
aprm.11	0.599	0.601	0.598	0.644	0.36	0.230	0.180	0.500	0.560	0.440	0.551	0.390	0.469	0.29	0.772	0.479	0.17
aprm.12	0.812	0.809	0.828	0.751	0.68	0.430	0.560	0.780	0.780	0.757	0.792	0.780	0.740	0.66	0.559	0.715	0.12
aprm.13	0.535	0.562	0.556	0.777	0.43	0.260	0.370	0.450	0.460	0.383	0.532	0.590	0.610	0.51	0.445	0.498	0.12
aprm.14	0.722	0.715	0.704	0.782	0.56	0.270	0.380	0.650	0.710	0.658	0.698	0.660	0.662	0.71	0.130	0.600	0.19

Table 4. Preliminary results for the fundamental frequency. Case 1.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	Mean	S. D
aprm.1	0.483	0.452	0.487	0.467	0.45	0.350	0.450	0.460	0.460	0.464	0.459	0.459	0.448	0.47	0.458	0.455	0.03
aprm.2	0.473	0.476	0.470	0.464	0.45	0.330	0.450	0.460	0.460	0.458	0.470	0.470	0.456	0.48	0.459	0.455	0.04
aprm.3	0.483	0.482	0.481	0.480	0.46	0.270	0.450	0.480	0.490	0.497	0.483	0.483	0.482	0.51	0.476	0.467	0.06
aprm.4	0.489	0.490	0.487	0.481	0.48	0.280	0.470	0.490	0.460	0.480	0.490	0.490	0.518	0.51	0.490	0.474	0.06
aprm.5	0.509	0.509	0.507	0.492	0.47	0.370	0.480	0.490	0.490	0.479	0.501	0.501	0.496	0.51	0.494	0.487	0.03
aprm.6	0.484	0.483	0.471	0.487	0.51	0.320	0.470	0.490	0.490	0.477	0.477	0.477	0.477	0.48	0.486	0.472	0.04
aprm.7	0.535	0.535	0.535	0.510	0.50	0.290	0.510	0.520	0.530	0.524	0.530	0.530	0.517	0.55	0.521	0.509	0.06
aprm.8	0.525	0.527	0.531	0.506	0.40	0.270	0.500	0.520	0.530	0.537	0.526	0.526	0.518	0.53	0.479	0.495	0.07
aprm.9	0.430	0.429	0.385	0.409	0.43	0.290	0.490	0.400	0.400	0.403	0.422	0.422	0.401	0.41	0.402	0.408	0.04
aprm.10	0.460	0.460	0.462	0.424	0.43	0.330	0.440	0.440	0.440	0.455	0.454	0.454	0.433	0.45	0.424	0.437	0.03
aprm.11	0.473	0.472	0.476	0.454	0.43	0.270	0.470	0.460	0.460	0.484	0.472	0.472	0.443	0.47	0.424	0.449	0.05
aprm.12	0.466	0.466	0.467	0.400	0.45	0.300	0.450	0.460	0.460	0.467	0.465	0.465	0.459	0.47	0.452	0.446	0.04
aprm.13	0.405	0.405	0.404	0.478	0.40	0.270	0.400	0.400	0.400	0.416	0.403	0.403	0.401	0.42	0.408	0.401	0.04
aprm.14	0.489	0.490	0.487	0.489	0.48	0.280	0.480	0.480	0.490	0.492	0.493	0.493	0.496	0.49	0.469	0.473	0.05

Table 5. Preliminary results for the DR. Case 2.

	M1	M2	M3	M4	M5	M7	M8	M9	M10	M11	M12	M13	M14	M15	Mean	S D
test.l1	0.395	0.394	0.469	0.432	0.350	0.160	0.350	0.550	0.339	0.360	0.270	0.386	0.23	0.393	0.363	0.10
test.s11	0.287	0.268	0.312	0.355	0.360	0.100	0.200	0.200	0.113	0.168	0.150	0.416	0.34	0.580	0.275	0.13
test.s21	0.431	0.460	0.457	0.649	0.490	0.210	0.450	0.410	0.476	0.479	0.400	0.525	0.40	0.444	0.449	0.09
test.s31	0.338	0.384	0.475	0.646	0.360	0.190	0.400	0.470	0.323	0.359	0.270	0.416	0.27	0.243	0.367	0.12
test.s41	0.457	0.467	0.469	0.368	0.370	0.180	0.400	0.390	0.263	0.416	0.390	0.406	0.14	0.311	0.359	0.10
test.l2	0.640	0.640	0.634	0.620	0.570	0.340	0.630	0.600	0.622	0.576	0.570	0.576	0.54	0.534	0.578	0.08
test.s12	0.680	0.688	0.654	0.617	0.610	0.320	0.600	0.640	0.625	0.523	0.640	0.523	0.52	0.493	0.581	0.10
test.s22	0.675	0.676	0.690	0.656	0.590	0.330	0.600	0.550	0.656	0.601	0.620	0.601	0.56	0.594	0.600	0.09
test.s32	0.599	0.598	0.597	0.641	0.540	0.220	0.530	0.450	0.539	0.523	0.520	0.523	0.44	0.502	0.516	0.10
test.s42	0.577	0.542	0.516	0.564	0.420	0.330	0.580	0.420	0.500	0.537	0.510	0.537	0.49	0.506	0.502	0.07

Table 6. Preliminary results for the fundamental frequency. Case 2.

	M1	M2	M3	M4	M5	M7	M8	M9	M10	M11	M12	M13	M14	M15	Mean	S D
test.l1	0.454	0.453	0.453	0.472	0.440	0.430	0.450	0.460	0.457	0.444	0.444	0.441	0.45	0.442	0.449	0.010
test.s11	0.442	0.440	0.435	0.471	0.410	0.490	0.440	0.420	0.361	0.424	0.424	0.478	0.45	0.444	0.438	0.03
test.s21	0.467	0.468	0.438	0.439	0.410	0.430	0.460	0.430	0.451	0.449	0.449	0.510	0.45	0.448	0.450	0.02
test.s31	0.443	0.440	0.437	0.427	0.430	0.410	0.460	0.480	0.482	0.453	0.453	0.478	0.45	0.441	0.449	0.02
test.s41	0.443	0.461	0.419	0.409	0.430	0.380	0.460	0.410	0.442	0.433	0.433	0.430	0.45	0.428	0.431	0.02
test.l2	0.533	0.533	0.519	0.534	0.500	0.520	0.530	0.510	0.537	0.516	0.516	0.516	0.54	0.516	0.523	0.012
test.s12	0.539	0.539	0.537	0.529	0.520	0.530	0.540	0.530	0.529	0.510	0.510	0.510	0.54	0.520	0.527	0.012
test.s22	0.529	0.533	0.534	0.530	0.490	0.510	0.520	0.510	0.524	0.517	0.517	0.517	0.54	0.516	0.520	0.013
test.s32	0.532	0.532	0.532	0.523	0.510	0.520	0.530	0.510	0.512	0.510	0.510	0.510	0.55	0.516	0.521	0.012
test.s42	0.507	0.505	0.515	0.527	0.480	0.480	0.510	0.500	0.502	0.515	0.515	0.515	0.50	0.509	0.506	0.013

Table 7. Preliminary results for the DR. Case 3

	M1			M2			M3		
test.1	0.382	0.291	0.488	0.376	0.273	0.506	0.370	0.310	0.514
test.2	0.236	0.372-0.441	0.442-0.584	0.249	0.316-0.422	0.446-0.581	0.453	0.318	0.453
test.3	0.414	0.587	0.320-0.613	0.424	0.592	0.619	0.388	0.363	0.489
test.4	0.514	0.614	0.707	0.528	0.629	0.720	0.516	0.580	0.748

	M4	M5	M7	M8	M10	M11	M12	M13	M14	M15
test.1	0.552	0.27	0.17	0.400	0.287	0.409	0.360	0.435	0.30	0.600
test.2	0.621	0.29	0.21	0.310	0.345	0.330	0.370	0.495	0.39	0.882
test.3	0.516	0.23	0.10	0.400	0.177	0.395	0.330	0.373	0.20	0.632
test.4	0.676	0.34	0.24	0.420	0.744	0.517	0.550	0.520	0.36	0.551

Table 8. Preliminary results for the fundamental frequency. Case 3.

	M1			M2			M3		
test.1	0.397	0.344	0.439	0.400	0.342	0.440	0.385	0.331	0.434
test.2	0.406	0.331-0.475	0.307-0.447	0.416	0.334-0.471	0.307-0.447	0.430	0.360	0.313
test.3	0.461	0.477	0.301-0.470	0.461	0.476	0.470	0.474	0.304	0.467
test.4	0.481	0.483	0.475	0.480	0.483	0.474	0.484	0.485	0.478

	M4	M5	M7	M8	M10	M11	M12	M13	M14	M15
test.1	0.420	0.391	0.380	0.420	0.417	0.408	0.408	0.392	0.45	0.404
test.2	0.431	0.391	0.330	0.430	0.422	0.411	0.411	0.397	0.40	0.312
test.3	0.465	0.422	0.450	0.460	0.434	0.455	0.455	0.450	0.46	0.263
test.4	0.437	0.467	0.470	0.480	0.489	0.480	0.480	0.473	0.48	0.260

Table 9. Preliminary results for the DR. Case 4.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
aprm	0.797	0.788	0.699	0.806	0.813	0.900	0.850	0.850	0.850	0.768	0.763	0.710	0.450	0.78	0.459
lprm.1	0.877	0.877	0.874	0.889	0.906	0.900	0.890	0.900	0.900	0.834	0.876	0.830	0.918		0.527
lprm.2	0.899	0.901	0.901	0.918	0.907	0.900	0.900	0.900	0.900	0.829	0.898	0.860	0.919		0.567
lprm.3	0.910	0.910	0.910	0.914	0.916	0.910	0.900	0.900	0.950	0.845	0.901	0.880	0.917		0.514
lprm.4	0.901	0.901	0.898	0.854	0.868	0.910	0.850	0.880	0.880	0.859	0.894	0.900	0.903		0.502
lprm.5	0.814	0.818	0.814	0.830	0.852	0.910	0.820	0.860	0.850	0.774	0.811	0.750	0.860		0.546
lprm.6	0.808	0.800	0.803	0.869	0.852	0.890	0.810	0.850	0.850	0.768	0.803	0.750	0.846		0.464
lprm.7	0.782	0.786	0.786	0.826	0.782	0.860	0.770	0.800	0.760	0.765	0.787	0.740	0.805		0.518
lprm.8	0.703	0.705	0.694	0.733	0.688	0.740	0.620	0.760	0.710	0.729	0.760	0.700	0.733		0.403
lprm.9	0.744	0.749	0.761	0.848	0.808	0.850	0.780	0.800	0.810	0.703	0.758	0.690	0.792		0.465
lprm.10	0.703	0.707	0.711	0.757	0.712	0.500	0.670	0.750	0.730	0.749	0.751	0.710	0.756		0.565
lprm.11	0.634	0.635	0.650	0.749	0.767	0.880	0.710	0.770	0.760	0.714	0.678	0.670	0.788		0.486
lprm.12	0.709	0.709	0.733	0.787	0.517	0.270	0.450	0.580	0.560	0.677	0.677	0.710	0.654		0.530
lprm.13	0.767	0.771	0.771	0.835	0.821	0.870	0.770	0.810	0.830	0.737	0.787	0.700	0.833		0.422
lprm.14	0.739	0.742	0.740	0.817	0.813	0.880	0.750	0.810	0.800	0.728	0.767	0.700	0.823		0.517
lprm.15	0.646	0.657	0.657	0.691	0.788	0.870	0.760	0.800	0.800	0.790	0.740	0.690	0.783		0.552
lprm.16	0.675	0.668	0.670	0.699	0.801	0.880	0.800	0.800	0.810	0.796	0.690	0.680	0.771		0.547
lprm.17	0.833	0.834	0.836	0.838	0.861	0.900	0.830	0.850	0.860	0.854	0.838	0.810	0.862		0.478
lprm.18	0.819	0.817	0.821	0.877	0.843	0.880	0.820	0.850	0.850	0.845	0.829	0.810	0.857		0.489
lprm.19	0.813	0.814	0.813	0.886	0.628	0.850	0.450	0.800	0.790	0.785	0.812	0.800	0.787		0.495
lprm.20	0.721	0.720	0.701	0.757	0.695	0.840	0.670	0.750	0.740	0.756	0.767	0.700	0.769		0.500
lprm.21	0.666	0.672	0.661	0.771	0.766	0.880	0.670	0.770	0.760	0.770	0.738	0.670	0.791		0.496
lprm.22	0.583	0.569	0.569	0.702	0.360	0.860	0.380	0.390	0.360	0.422	0.517	0.490	0.447		0.582

Table 10. Preliminary results for the fundamental frequency. Case 4.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
aprm	0.486	0.485	0.492	0.490	0.508	0.480	0.495	0.510	0.480	0.508	0.491	0.491	0.522	0.51	0.512
lprm.1	0.482	0.482	0.481	0.495	0.492	0.480	0.495	0.490	0.490	0.494	0.486	0.486	0.493		0.503
lprm.2	0.482	0.482	0.481	0.491	0.492	0.480	0.495	0.490	0.490	0.495	0.486	0.486	0.491		0.497
lprm.3	0.482	0.481	0.482	0.488	0.489	0.490	0.495	0.490	0.480	0.494	0.485	0.485	0.489		0.494
lprm.4	0.485	0.485	0.485	0.485	0.492	0.490	0.495	0.490	0.490	0.489	0.488	0.488	0.490		0.493
lprm.5	0.486	0.486	0.485	0.515	0.500	0.490	0.495	0.500	0.500	0.498	0.493	0.493	0.500		0.512
lprm.6	0.488	0.491	0.488	0.510	0.500	0.470	0.495	0.500	0.500	0.498	0.495	0.495	0.500		0.512
lprm.7	0.492	0.489	0.492	0.494	0.500	0.450	0.495	0.500	0.500	0.502	0.499	0.499	0.500		0.512
lprm.8	0.509	0.510	0.507	0.478	0.508	0.400	0.495	0.500	0.510	0.504	0.507	0.507	0.507		0.514
lprm.9	0.492	0.492	0.490	0.491	0.508	0.450	0.495	0.510	0.500	0.504	0.499	0.499	0.506		0.520
lprm.10	0.527	0.526	0.520	0.522	0.530	0.360	0.495	0.530	0.530	0.527	0.526	0.526	0.529		0.530
lprm.11	0.524	0.523	0.523	0.518	0.521	0.470	0.520	0.520	0.520	0.522	0.514	0.514	0.519		0.532
lprm.12	0.541	0.540	0.540	0.542	0.534	0.290	0.495	0.530	0.530	0.531	0.536	0.536	0.497		0.542
lprm.13	0.491	0.490	0.490	0.505	0.508	0.460	0.520	0.510	0.510	0.504	0.498	0.498	0.506		0.518
lprm.14	0.492	0.493	0.493	0.506	0.508	0.470	0.495	0.510	0.510	0.505	0.501	0.501	0.508		0.520
lprm.15	0.503	0.502	0.502	0.497	0.513	0.460	0.495	0.510	0.510	0.513	0.506	0.506	0.507		0.518
lprm.16	0.496	0.496	0.501	0.522	0.517	0.470	0.495	0.520	0.520	0.520	0.504	0.504	0.516		0.520
lprm.17	0.485	0.485	0.485	0.500	0.496	0.480	0.495	0.490	0.490	0.494	0.490	0.490	0.494		0.506
lprm.18	0.486	0.486	0.486	0.487	0.492	0.460	0.495	0.490	0.490	0.495	0.490	0.490	0.494		0.505
lprm.19	0.492	0.492	0.492	0.499	0.496	0.450	0.495	0.500	0.500	0.497	0.495	0.495	0.497		0.507
lprm.20	0.497	0.497	0.495	0.478	0.508	0.440	0.495	0.500	0.500	0.500	0.502	0.502	0.516		0.512
lprm.21	0.502	0.501	0.500	0.518	0.513	0.470	0.495	0.510	0.510	0.511	0.507	0.507	0.510		0.533
lprm.22	0.530	0.531	0.530	0.557	0.540	0.450	0.495	0.530	0.550	0.512	0.526	0.526	0.523		0.548

Table 11. Preliminary results for the DR. Case 5.

	M1	M2	M3	M4	M5	M7	M8	M9	M10	M11	M12	M13			M14	M15
aprm.1	0.951	0.949	0.948	0.98	0.98	0.980			1.020			0.918	0.955	0.961	0.85	0.143
	1.000	1.000	1.000				1.000			0.998	0.990					
	0.679	0.811	0.818				0.940			0.699	0.690					
aprm.2	0.650	0.647	0.671	0.717	0.59	0.470			0.823			0.589	0.881	0.933	0.80	0.748
	0.688	0.692	0.764				0.670			0.620	0.660					
	0.574	0.580	0.536				0.470			0.659	0.670					
										0.515	0.550					

Table 12. Preliminary results for the fundamental frequency. Case 5.

	M1	M2	M3	M4	M5	M7	M8	M10	M11	M12	M13			M14	M15
aprm.1	0.534	0.534	0.534	0.53	0.53	0.520		0.526	0.524	0.524	0.529	0.525	0.527	0.53	0.535
	0.569	0.426	0.441				1.000		0.556	0.556					
	0.536	0.553	0.552				0.940								
aprm.2	0.514	0.514	0.510	0.494	0.54	0.500		0.520	0.500	0.500	0.516	0.513	0.509	0.52	0.505
	0.514	0.514	0.514				0.670		0.516	0.516					
	0.513	0.513	0.509				0.470		0.504	0.504					

Table 13. Preliminary results for the DR. Case 6.1.

	M1	M2	M3	M4	M5	M6	M7	M8	M10	M11	M12	M13	M14	M15
aprm.1	0.523	0.523	0.490	0.589	0.290	0.220	0.160	0.35	0.503	0.474	0.520	0.459	0.39	0.563
lprm.11	0.377	0.372	0.405	0.518	0.085	0.410	0.090	0.15	0.382	0.358	0.450	0.267		0.373
lprm.12	0.276	0.297	0.297	0.295	0.080	0.200	0.100	0.22	0.552	0.170	0.240	0.261		0.439
lprm.13	0.547	0.549	0.577	0.689	0.238	0.260	0.120	0.42	0.296	0.473	0.640	0.373		0.556
lprm.14	0.395	0.469	0.402	0.664	0.226	0.150	0.200	0.20	(0.321)	0.405	0.370	0.413		0.506
lprm.15	0.654	0.583	0.663	0.639	0.270	0.270	0.130	0.58	0.589	0.603	0.700	0.449		0.516
lprm.16	0.803	0.804	0.801	0.818	0.559	0.170	0.420	0.80	(.721)	0.758	0.790	0.664		0.441
lprm.17	0.564	0.563	0.583	0.533	0.254	0.240	0.150	0.50	0.477	0.529	0.560	0.421		0.542
lprm.18	0.638	0.635	0.643	0.686	0.499	0.140	0.570	0.50		0.565	0.490	0.517		0.287
lprm.19	0.339	0.340	0.390	0.460	0.100	0.280	0.030	0.32	0.266	0.349	0.330	0.339		0.808
lprm.110	0.241	0.248	0.302	0.491	0.148	0.170	0.130	0.20		0.204	0.160	0.290		0.068
lprm.111	0.392	0.391	0.382	0.461	0.105	0.280	0.110	0.23	0.277	0.361	0.400	0.344		0.907
lprm.112	0.413	0.413	0.439	0.362	**	0.150	0.230	0.20	(.545)	0.333	0.320	0.292		0.071
lprm.113	0.378	0.375	0.361	0.308	0.098	0.290	0.040	0.20	0.239	0.341	0.380	0.330		0.784
lprm.114	0.419	0.423	0.441	0.474	0.275	0.160	0.280	0.35		0.379	0.430	0.408		0.813
lprm.115	0.560	0.562	0.549	0.516	0.241	0.270	0.120	0.44	0.296	0.478	0.660	0.402		0.553
lprm.116	0.565	0.567	0.574	0.703	0.261	0.250	0.130	0.43	0.318	0.482	0.660	0.395		0.531
lprm.117	0.296	0.289	0.319	0.661	0.092	0.330	0.080	0.19	0.733	0.610	0.310	0.306		0.401
lprm.118	0.312	0.304	0.296	0.222	**	0.150	0.210	0.20		0.267	0.160	0.411		0.383

Table 14. Preliminary results for the fundamental frequency. Case 6.1

	M1	M2	M3	M4	M5	M6	M7	M8	M10	M11	M12	M13	M14	M15
aprm.1	0.522	0.523	0.528	0.505	0.490	0.270	0.520	0.49	0.532	0.523	0.523	0.510	0.51	0.497
lprm.11	0.502	0.503	0.513	0.481	0.427	0.310	0.500	0.46	0.526	0.498	0.498	0.481		0.552
lprm.12	0.517	0.514	0.491	0.512	0.504	0.260	0.500	0.49	0.464	0.472	0.472	0.475		0.516
lprm.13	0.524	0.524	0.526	0.511	0.500	0.270	0.510	0.52	0.489	0.524	0.524	0.525		0.523
lprm.14	0.519	0.523	0.502	0.548	0.510	0.250	0.500	0.51	(.512)	0.522	0.522	0.506		0.476
lprm.15	0.529	0.526	0.530	0.509	0.504	0.280	0.510	0.52	0.525	0.525	0.525	0.519		0.526
lprm.16	0.529	0.529	0.529	0.536	0.517	0.250	0.510	0.52	(.528)	0.528	0.528	0.516		0.519
lprm.17	0.522	0.522	0.556	0.502	0.492	0.270	0.510	0.51	0.522	0.517	0.517	0.514		0.513
lprm.18	0.529	0.529	0.529	0.482	0.528	0.250	0.510	0.50		0.527	0.527	0.517		0.510
lprm.19	0.543	0.543	0.548	0.468	0.463	0.280	0.530	0.52	0.669	0.526	0.526	0.524		0.520
lprm.110	0.520	0.518	0.467	0.502	0.500	0.250	0.520	0.52		0.534	0.534	0.556		0.476
lprm.111	0.505	0.506	0.506	0.457	0.463	0.280	0.510	0.53	0.558	0.504	0.504	0.529		0.529
lprm.112	0.541	0.542	0.545	0.492		0.250	0.520	0.53	(.520)	0.535	0.535	0.517		0.488
lprm.113	0.504	0.504	0.494	0.429	0.463	0.280	0.500	0.51	0.586	0.509	0.509	0.524		0.527
lprm.114	0.495	0.496	0.491	0.467	0.532	0.250	0.490	0.50		0.509	0.509	0.553		0.505
lprm.115	0.522	0.523	0.522	0.525	0.504	0.280	0.510	0.52	0.494	0.525	0.525	0.522		0.530
lprm.116	0.523	0.524	0.524	0.514	0.504	0.270	0.510	0.52	0.492	0.525	0.525	0.524		0.525
lprm.117	0.522	0.489	0.487	0.519	0.435	0.290	0.44-0.53	0.47	0.394	0.496	0.496	0.502		0.523
lprm.118	0.533	0.533	0.484	0.443		0.250	0.480	0.50		0.508	0.508	0.472		0.478

Table 15. Preliminary results for the DR. Case 6.2.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
aprm.2	0.929	0.928	0.926	0.923	0.840	0.720	0.700	0.900		(.965)	0.915	0.960	0.886	0.88	0.379
lprm.21	0.601	0.596	0.601	0.735	0.205	0.680	0.210			0.575	0.546	0.700	0.470		0.533
lprm.22	0.384	0.390	0.397	0.589	0.233	0.710	0.200	0.250	0.250	0.332	0.293	0.400	0.357		0.391
lprm.23	0.959	0.959	0.961	0.966	0.875	0.770	0.800	0.950	0.98	0.986	0.950	0.990	0.928		0.524
lprm.24	0.891	0.888	0.882	0.935	0.701	0.750	0.630	0.950	0.980	(.959)	0.858	0.920	0.807		0.085
lprm.25	0.948	0.971	0.968	0.964	0.904	0.790	0.800	0.980	0.94	0.981	0.961	0.990	0.934		0.515
lprm.26	0.985	0.986	0.986	0.963	0.956	0.920	0.920	0.980		1.006	0.983	1.000	0.960		0.484
lprm.27	0.938	0.938	0.937	0.937	0.828	0.790	0.710	0.970		0.986	0.923	0.980	0.890		0.500
lprm.28	0.960	0.962	0.963	0.981	0.889	0.210	0.870	0.950	0.93	(.981)	0.951	0.970	0.919		0.377
lprm.29	0.719	0.710	0.726	0.752	0.366	0.670	0.300	0.650	0.50	0.300	0.674	0.830	0.560		0.517
lprm.210	0.593	0.594	0.601	0.672	0.302	0.680	0.320	0.510	0.570	(.709)	0.513	0.160	0.535		0.473
lprm.211	0.889	0.889	0.890	0.870	0.611	0.450	0.500	0.980	0.950	0.966	0.858	0.950	0.768		0.456
lprm.212	0.879	0.879	0.874	0.884	0.590	0.200	0.530	0.830	0.900	(.952)	0.837	0.950	0.747		0.398
lprm.213	0.897	0.898	0.906	0.876	0.720	0.760	0.530	0.950	0.940	0.935	0.878	0.950	0.836		0.501
lprm.214	0.894	0.896	0.895	0.919	0.766	0.870	0.680	0.820	0.930	(.965)	0.877	0.950	0.832		0.425
lprm.215	0.963	0.973	0.964	0.966	0.877	0.870	0.780	0.950		0.988	0.954	0.990	0.922		0.495
lprm.216	0.963	0.963	0.963	0.966	0.888	0.860	0.820	0.950		0.983	0.955	0.660	0.928		0.490
lprm.217	0.641	0.640	0.651	0.678	0.282	0.690	0.200	0.580	0.410	0.603	0.591	0.730	0.500		0.478
lprm.218	0.547	0.549	0.550	0.700	0.330	0.190	0.420	0.510		(.507)	0.503	0.470	0.518		0.590

Table 16. Preliminary results for the fundamental frequency. Case 6.2.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
aprm.2	0.521	0.522	0.522	0.518	0.520	0.400	0.510	0.520		(.523)	0.520	0.520	0.519	0.52	0.520
lprm.21	0.510	0.510	0.509	0.519	0.513	0.380	0.500			0.499	0.509	0.509	0.506		0.564
lprm.22	0.519	0.520	0.504	0.528	0.513	0.390	0.510	0.510	0.530	0.471	0.517	0.517	0.513		0.519
lprm.23	0.521	0.521	0.521	0.520	0.521	0.420	0.510	0.520	0.520	0.524	0.521	0.521	0.521		0.525
lprm.24	0.517	0.521	0.521	0.518	0.517	0.410	0.510	0.520	0.520	(.523)	0.520	0.520	0.518		0.516
lprm.25	0.521	0.522	0.522	0.521	0.521	0.430	0.510	0.520	0.520	0.524	0.521	0.521	0.521		0.525
lprm.26	0.522	0.522	0.522	0.521	0.521	0.530	0.510	0.520		0.520	0.522	0.522	0.521		0.522
lprm.27	0.521	0.521	0.521	0.519	0.521	0.430	0.510	0.52		0.524	0.520	0.520	0.521		0.523
lprm.28	0.522	0.522	0.522	0.521	0.521	0.260	0.510	0.520	0.520	(.523)	0.521	0.521	0.521		0.520
lprm.29	0.514	0.514	0.514	0.517	0.521	0.380	0.510	0.510	0.510	0.528	0.511	0.511	0.502		0.539
lprm.210	0.511	0.512	0.513	0.506	0.496	0.380	0.500	0.500	0.510	(.516)	0.501	0.501	0.485		0.494
lprm.211	0.521	0.521	0.521	0.518	0.525	0.310	0.510	0.520	0.520	0.523	0.521	0.521	0.519		0.535
lprm.212	0.521	0.521	0.521	0.516	0.517	0.260	0.510	0.520	0.520	(.521)	0.519	0.519	0.516		0.516
lprm.213	0.521	0.522	0.522	0.519	0.525	0.420	0.510	0.520	0.520	0.524	0.521	0.521	0.520		0.530
lprm.214	0.522	0.522	0.521	0.522	0.511	0.480	0.510	0.520	0.520	(.523)	0.521	0.521	0.521		0.523
lprm.215	0.521	0.521	0.522	0.520	0.521	0.480	0.510	0.520		0.524	0.521	0.521	0.521		0.525
lprm.216	0.521	0.521	0.521	0.520	0.521	0.480	0.510	0.520		0.524	0.521	0.521	0.521		0.525
lprm.217	0.510	0.510	0.514	0.507	0.520	0.390	0.510	0.520	0.510	0.503	0.506	0.506	0.494		0.542
lprm.218	0.513	0.514	0.514	0.511	0.510	0.250	0.500	0.510		(.498)	0.507	0.507	0.454		0.504

In tables 3-16 above, we have used the following notation:

M1: UPV standard AR .
M2: UPV Full SVD AR.
M3: UPV Truncated SVD.
M4: UPV Dynamics reconstruction.
M5: Pennsylvania State University: AR.
M6: Pennsylvania State University: LAPUR code.
M7: University of Tsukuba.
M8: PSI: ARMA model (Plateau method)
M9: PSI: AR-AIC.
M10: JAERI.
M11: SIEMENS AR
M12: SIEMENS RAC
M13: TOSHIBA
M14: TU DELFT
M15: CSNNS Mexico.

Also, we note that the method M6 (LAPUR code) is not a signal analysis method. Furthermore some participants also provided standard deviation estimates. This is an important aspect of the Benchmark; these results will be presented in the final report.

Annex 1

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* regrets for not having been able to attend

Annex 2

Approved Agenda

1. **General Items**
    - 1.1 General Announcements (J.M. Conde)
    - 1.2 Introduction of Participants
    - 1.3 Review and Approval of Agenda (J.M. Conde)
2. **Forsmarks 1 & 2 Benchmarks**
    - 2.1 Summary Introduction to the 6 Test Cases (G. Verdú, P. Lansaker)
    - 2.2 Review of Submitted Results and First Draft Report (G. Verdú, D. Ginestar)
    - 2.3 Presentation by Participants (D. Hennig, Y. Farawila, H. Konno, J. Navarro, W. de Kruijf Y. Takeuchi, M. Ceceñas, A. Nuñez, J. Pohlus)
    - 2.4 General Discussion
3. **Review of Summary Conclusions**
    - 3.1 Lessons learned: performance of different approaches determination of uncertainties (G. Verdú, P. Lansaker, D. Ginestar, and all other participants)
    - 3.2 Conclusions and Recommendations on methods (J. Conde, D. Ginestar …)
4. **Next Phase**
    - 4.1 Schedule for Submission of Revised Results
    - 4.2 Publication of Results, Presentation at Conferences Reporting to CSNI PWG2
    - 4.3 Proposals for Further Work
5. **Reporting to NSC**

Annex 3

List of Distributed Papers

1. Agenda
2. List of Participants
3. Summary Introduction to the 6 Test Cases (G. Verdú)
4. Review of Submitted Results (G. Verdú)
5. Comparison of the Results Provided for the Forsmark Stability Benchmark. Some Comments (D. Ginestar)
6. Graphs Comparing the Results (G. Verdú)
7. Results obtained at Penn State University Using Auto-regressive Models (M. Ceceñas)
8. First Results (A. Nuñez)
9. Preliminary Results (W.J.M. de Kruijf)
10. Time Series Data Analysis Results (Y. Takeuchi, S. Kanemoto, H. Miyamoto)
11. Time Series Analysis for BWR Stability Studies (D. Hennig)
12. The Physical Mechanism of Core-wide and Local Instabilities at the Forsmark-1 BWR (G. Analytis, D. Hennig, J. Karlsson)
13. Application of Noise Analysis for the Study of Core Local Instabilities at Forsmark-1 (R. Oguma – distributed and commented by P. Lansaker)
14. Localisation of a Channel Instability in the Forsmark-1 BWR (J. Karlsson, I. Pazsit – distributed and commented by P. Lansaker)
15. Forsmark Benchmark Report (H. Konno)
16. Parametric Stochastic Stability and Decay Ratio for a Stochastic Non-Linear BWR Model Below the Hopf Bifurcation (H. Konno, S. Kanemoto, Y. Takeuchi)
17. UPVM Methodologies and Results (J. Navarro)
18. The First Results (T. Suzudo)

Annex 4

Agreed Deadlines/Actions

Deadline	Action
10 March 1999:	Prepare draft summary of meeting (E. Sartori, G. Verdú, J.M. Conde)
15 March 1999:	Submit draft paper about status of benchmark for M&C'99 (G. Verdú)
20 March 1999:	Provide comments/amendments to summary. Participants should look at the conclusions and comment so that the consensus view can be extracted (All)
30 March 1999:	Distribute summary to participants, NSC and PWG2 (E. Sartori)
30 April 1999:	Deadline for submitting new, additional results. (All)
5 June 1999:	Report results to NSC (E. Sartori)
15 June 1999:	Prepare first draft of report for circulation to participants (G. Verdú)
15 June 1999:	Submit paper on results of benchmark to M&C'99 (G. Verdú)
30 June 1999:	Provide feedback on draft report (All)
1 September 1999:	Distribute 'Final Draft' of Report for final comments and approval (G. Verdú, E. S.)
September 1999:	Report to CSNI/PWG2 (J.M. Conde)
30 September 1999:	Deadline for comments and approval (All)
30 November 1999:	End of final report editing and formatting submission to printing (E. Sartori)
31 December 1999:	Distribution of report
31 December 1999:	Distribution of report
For September 2000:	Paper preparation and presentation of final benchmark results at Physor'2000
2000:	Submit draft article to NSE or Nuclear Technology