GeoSIG

The Swiss manufacturer of seismic NPP instrumentation solutions

presents

Measuring Solutions for the Nuclear Industry

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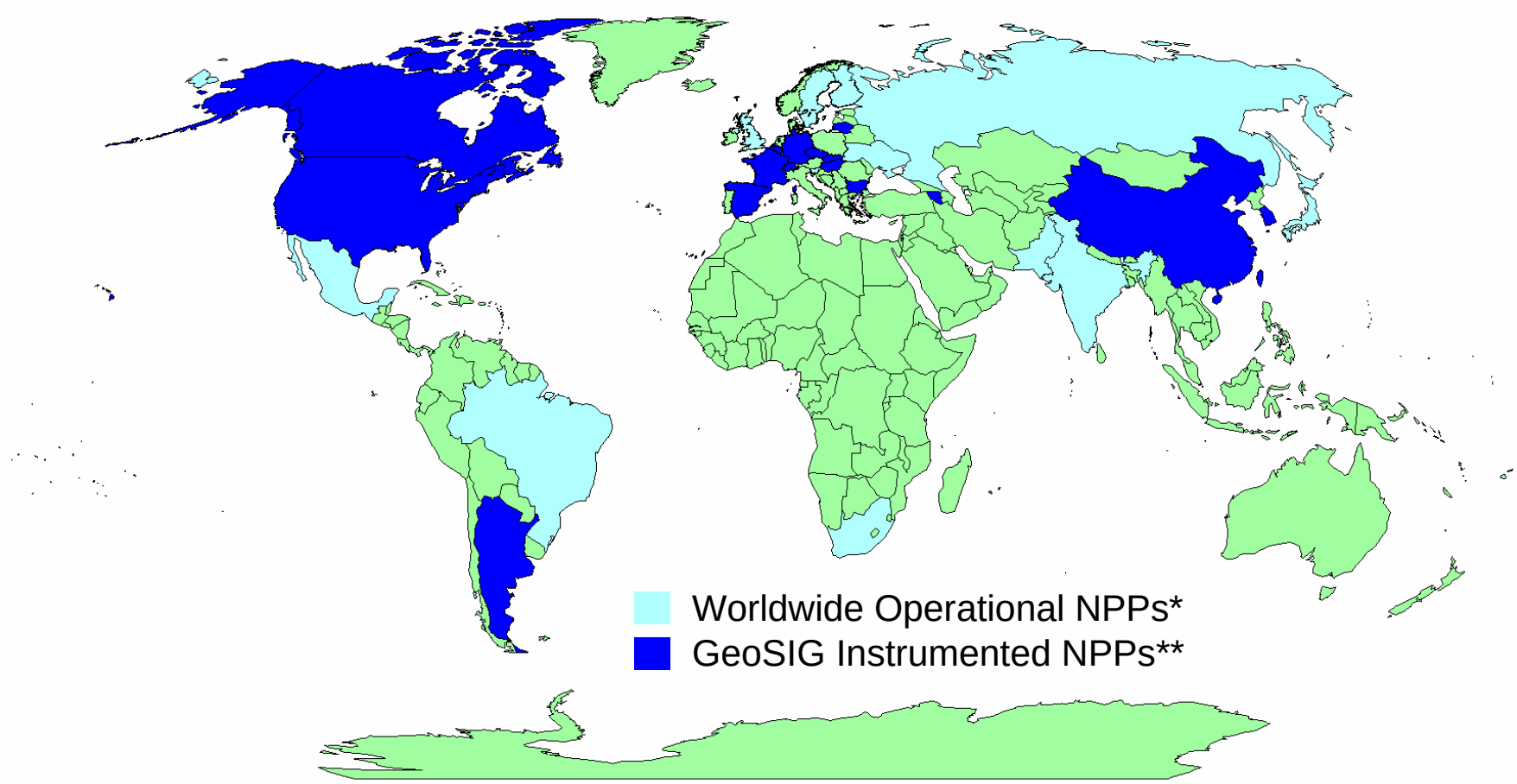
GeoSIG NPP Instrumentation in the World



*: data from PRIS database, 06.05.2009 (http://www.iaea.org/cgi-bin/db.page.pl/pris.db57.htm)
**: incl. GeoSys, SIG & Terra Technology Instruments

Key NPP Project References

NUCLEAR STATION	CUSTOMER
Beznau NPP, Unit 1 and 2, Switzerland	NOK, KKW Beznau, Switzerland
Bohunice NPP, administrative Building, Slovak Rep.	PPA, Slovak Republic
Doel NPP, Belgium	Electrabel S.A., Belgium
Embalse NPP, Argentina	NASA Nucleoelectrica Argentina SA, Argentina
Gösgen NPP, Switzerland	KKW Gösgen-Däniken AG, Switzerland
Ignalina NPP, Lithuania	INPP/PMU, Visaginas, Lithuania
Kozloduy NPP, Bulgaria	IAEA, Vienna, Austria
Leibstadt NPP, Switzerland	NOK, KKW Leistadt, Switzerland
Mochovce NPP, Unit 1 and 2, Slovak Republic	PPA, Slovak Republic
Marcoule Research Center, France	CEA / Cogema, France
Metsamor NPP, Armenia	IAEA, Vienna, Austria
PAKS NPP, Hungary	PAKSI Atomerómú RT., Hungary
PAKS NPP, Waste Disposal, Hungary	PAKSI Atomerómú RT., Hungary
Shin-Kori Unit 1-2	KEPCO, Seoul, South Korea
Temelin NPP, Czech Republic	Westinghouse Energy System, Pittsburg USA
Tianwan NPP, Unit 1 and 2, China	SNIIP Systematom, Russia
Tihange NPP, Belgium	Electrabel S.A.. Belgium
Wolsong Unit 1, original delivery + full upgrade in 2005	KEPCO, Seoul, South Korea
Wolsong Unit 2, original delivery + full upgrade in 2005	KEPCO, Seoul, South Korea
Ulchin NPP, Unit 5 and 6	KHNP, Seoul, South Korea
Zorita NPP, Spain	IIC / Spain

Supplied Equipment

GeoSIG provides the following equipment for NPPs

- **Units for integration into the monitoring and protection systems of NPPs**
- **Sensors and standalone seismic recorders**
- **Complete seismic alarm and monitoring systems**

AC-23 Accelerometer

Full Scale Range

± 2 g (options down to ± 0.1 g)

Bandwidth

0.1 Hz to 50 or 100 Hz

Dynamic Range

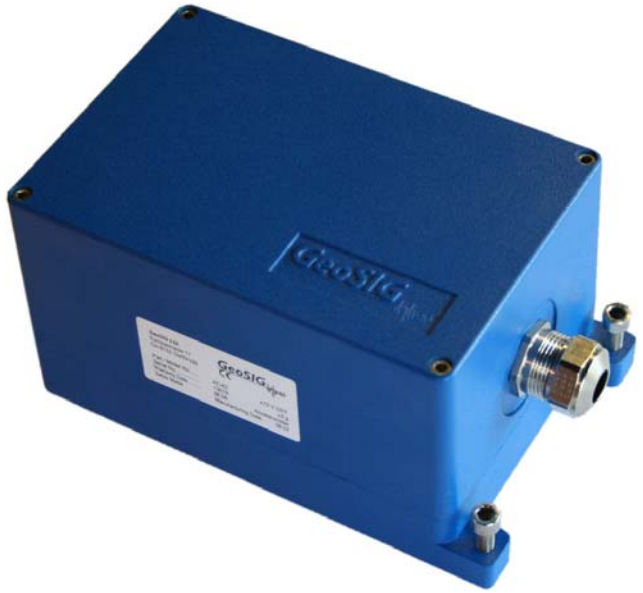
> 125 dB

Axes

triaxial, biaxial, uniaxial

Downhole Version

AC-23DH



Stainless steel protection housing is available for this sensor

Recorder

GSR-18 Strong Motion Recorder

Input Range

+/- 5 V differential (default)

Bandwidth

DC - 80 Hz @ 200 SPS

Dynamic Range

> 108 dB @ 200 SPS

Power Supply

12 or 24 VDC with internal Battery (> 3 days)

Memory

512 MB standard (2 GB ~ 2 weeks recording)

Communication (serial ports)

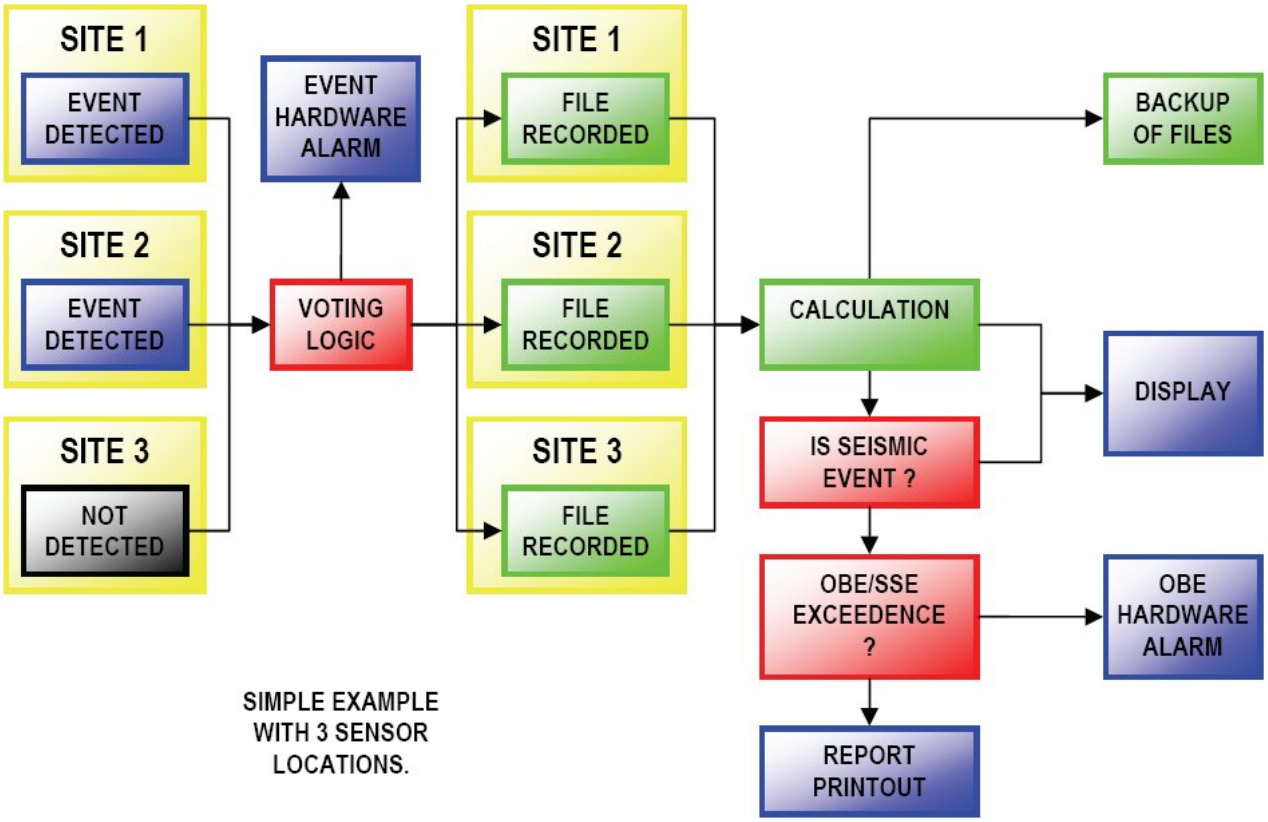
RS-232 or RS-422

NPP Seismic Monitoring System

Summary of Features

- Use of new or existing infrastructure
- Recording, advanced analysis and annunciation according to latest or custom regulations
- Automatic RSA, RSV, CAV calculations and OBE, SSE exceedance evaluation
- Up to 48 remote stations or sensors
- 18 or 24-bit event based and/or continuous recording
- Common timing and triggering within the system
- Completely over-voltage protected
- Continuous system-wide SOH monitoring
- Reporting and alerting via visual and audible tools as well as printed matter
- Seismically and EMC proven design
- Comprehensive configuration of the whole system via the enhanced computer interface

System Functionality Diagram



Voting Logic: Automatic event alarm

Is Seismic Event: Automatic event detection (seismic yes/no)

OBE/SSE Exceedance: Automatic check for OBE and/or SSE criteria

Report Printout: Automatic printout of earthquake report

Two Types of the System Architecture

Decentralized Recording

Sensors and Recorders

at measuring locations

Centralized Recording

Sensors only

at measuring locations

System implementation: Decentralized Recording

Advantages:

Independent recording units increase redundancy and reliability.

Digital transmission between remote and central locations

Link from remote to central can use Fiber Optics (improved EM noise immunity)

System Implementation / Centralized Recording

Advantages:

Simple devices in controlled area (analog sensors).

Simplified diagnostics and maintenance.

Higher compatibility for upgrades on existing systems based on central recording topology

System Type Selection

The selection of an implementation type is usually cost driven:

For a system upgrade, the reuse of the existing cable would be a major cost reduction and would define the type of implementation.
→ Centralized in most cases

For a new system, both implementations are possible
→ Centralized or Decentralized

Decision is based on a particular site and infrastructure characteristics and conditions (specific for every plant)

Expected level of radiation at sensor site must be considered
(In Centralized implementation only the sensors are exposed in the controlled area)

EMC Qualification of SMS

Example of Decentralized System

Nuclear Power Plants in Switzerland utilize GeoSIG seismic systems with decentralized topology: Beznau, Leibstadt and Goesgen NPPs

Example of Centralized System: Susquehanna NPP

The project is done in cooperation with Nuclear Logistics – strategic partner of GeoSIG in USA for NPP market

Replacement of the old system and possibility to use existing cabling made a choice for centralized monitoring system

Equipment supplied in May 2009

Susquehanna NPP: scope of supply

Three similar systems were supplied:

- Main system: control room replacement (6 sensors)
- Training system (2 sensors)
- Simulator system

Susquehanna NPP: main functionality of SMS

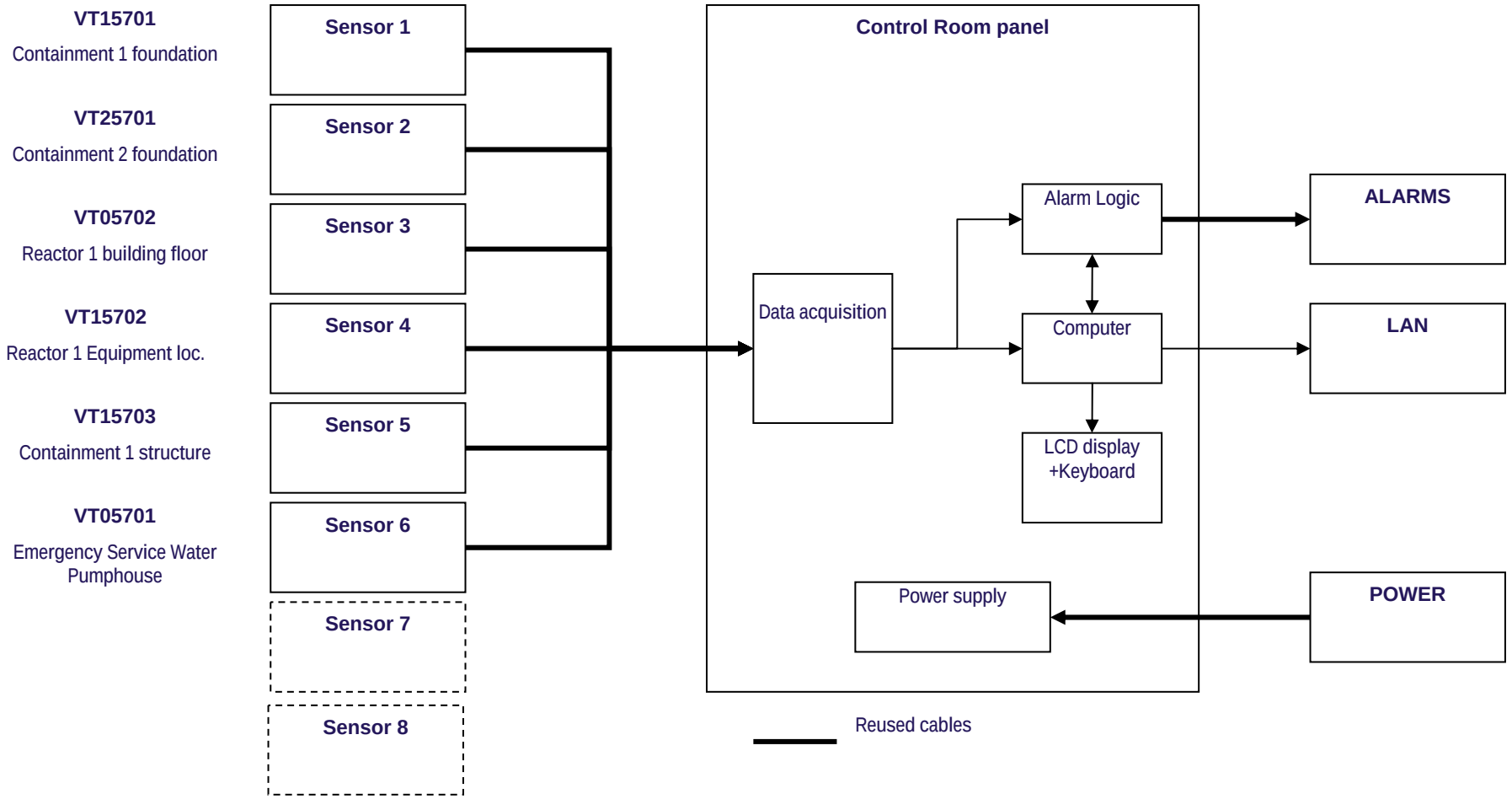
The system performs the following action and data processing during normal operation:

- Monitor correct basic operation of the system.
- Activate the COMMON ALARM in case of failure detection.
- Activate the COMMON ALARM in case of AC power loss.
- Activate the EVENT DETECTED in case of an earthquake.
- Record acceleration time history at each sensor location

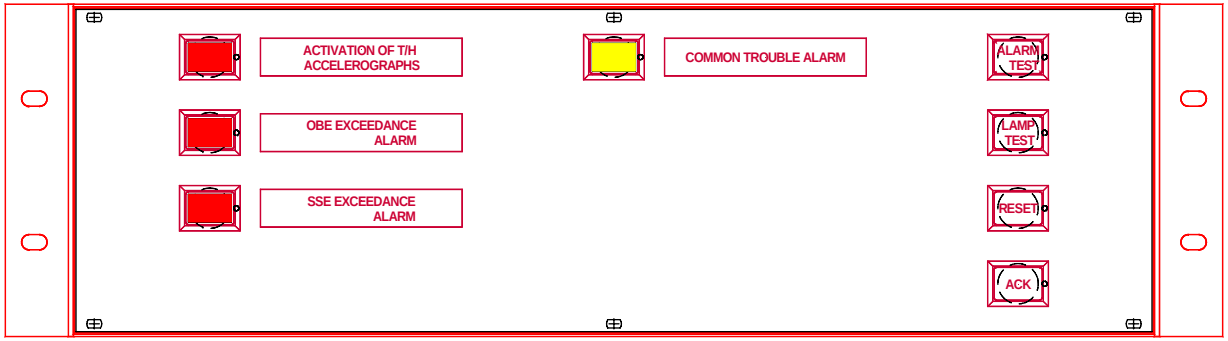
The following action and data processing are done under operator control:

- Detailed periodic test of the system.
- Calculation of Response Spectra for each channel.
- Operating Basis Earthquake (OBE) exceedance check.
- Event report generation and printing

Susquehanna NPP: SMS Block Diagram



Susquehanna NPP: SMS output signals



The available alarm outputs of the systems are:

- **AL1, seismic level 1, activation of the seismic recorder**
- **OBE Exceeded**
- **SSE Exceeded**
- **COMMON ALARM, Selftest error, self test failure, power fault, AC power is lost**

Susquehanna NPP: OBE and SSE calculations

Compliance with the Regulatory Guides:

NRC Regulatory Guide 1.12, 'Nuclear Power Plant Instrumentation For Earthquakes', Rev. 2, March 1997

NRC Regulatory Guide 1.166, 'Pre-earthquake Planning and Immediate Nuclear Power Plant Operator Post earthquake Actions', March 1997

EPRI TR-100082-T2, 'Standardization of the Cumulative Absolute Velocity', December 1991

$$OBE = (RSA_{OBE} \text{ or } RSV_{OBE}) \text{ and } CAV_{OBE}$$

$$SSE = (RSA_{SSE} \text{ or } RSV_{SSE}) \text{ and } CAV_{SSE}$$

The following parameters are used during the OBE exceedance check:

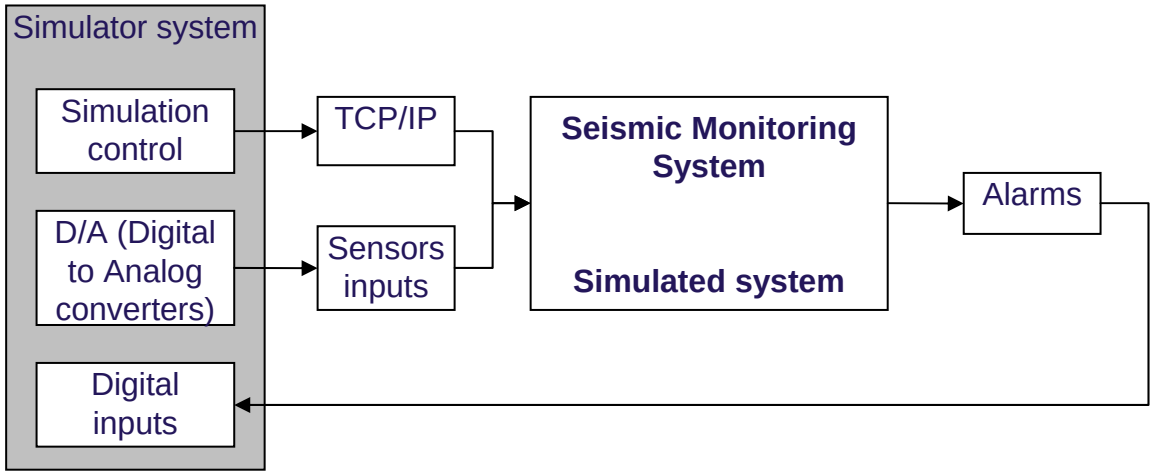
Acceleration Time History, Peak Acceleration Value.

Seismic response spectra

Cumulative Absolute Velocity

Susquehanna NPP: Simulation System

Block diagram of the Simulation System



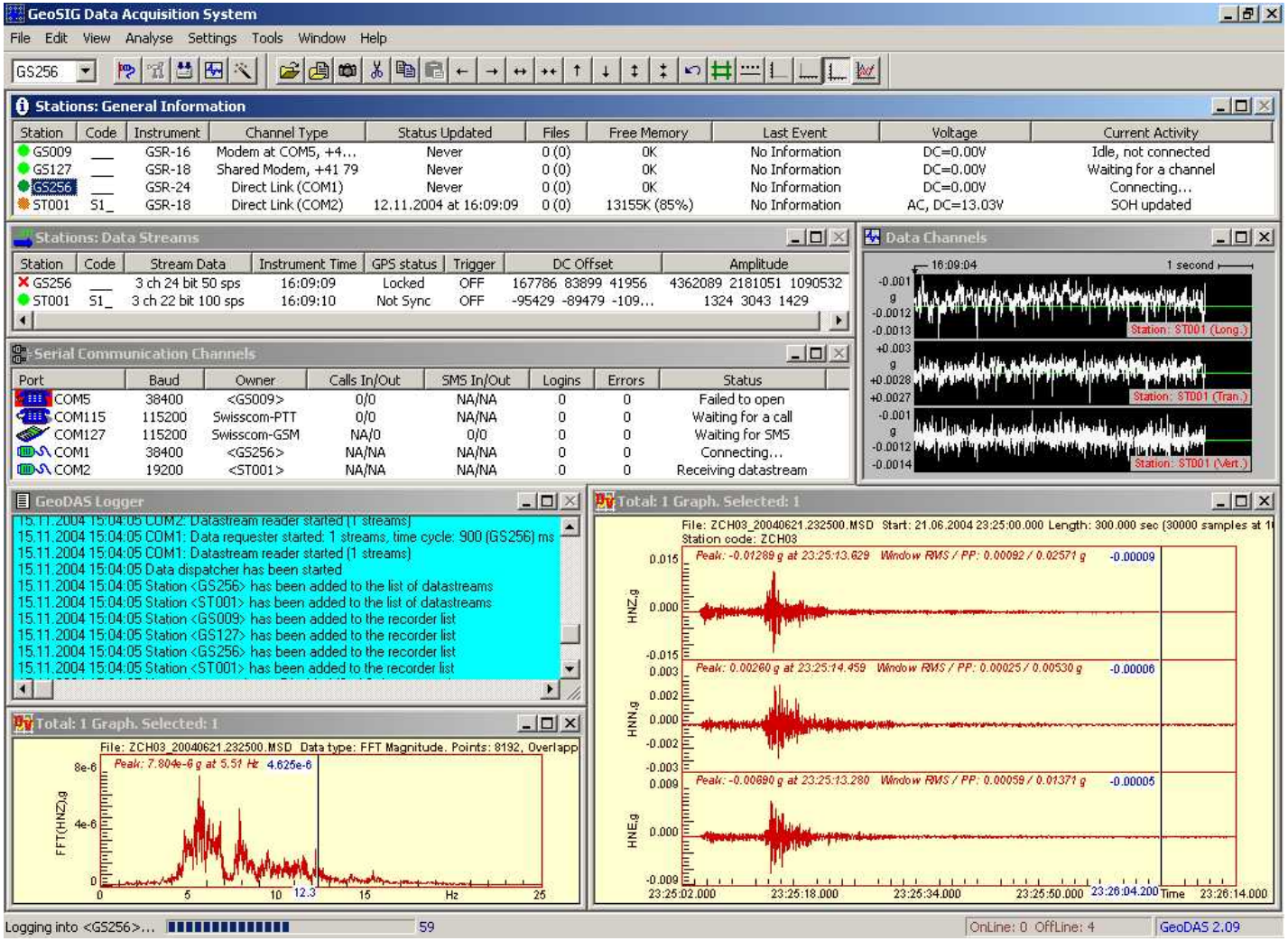
Commands of the Simulation System

FREEZE - allow operators to observe current status of the system and to discuss it

RUN - the simulation continues at the point where it was paused or at the time defined by a RESET command.

RESET - clears the system. Any data in process will be stopped and input files cleared. The processing software on the Seismic Monitoring System is restarted and the system will be ready for processing. In addition, the RESET command can define a time that will be set to the recorder and computer when the next RUN command is issued.

GeoSIG Data Acquisition System



GeoDAS Software for NPP Seismic System

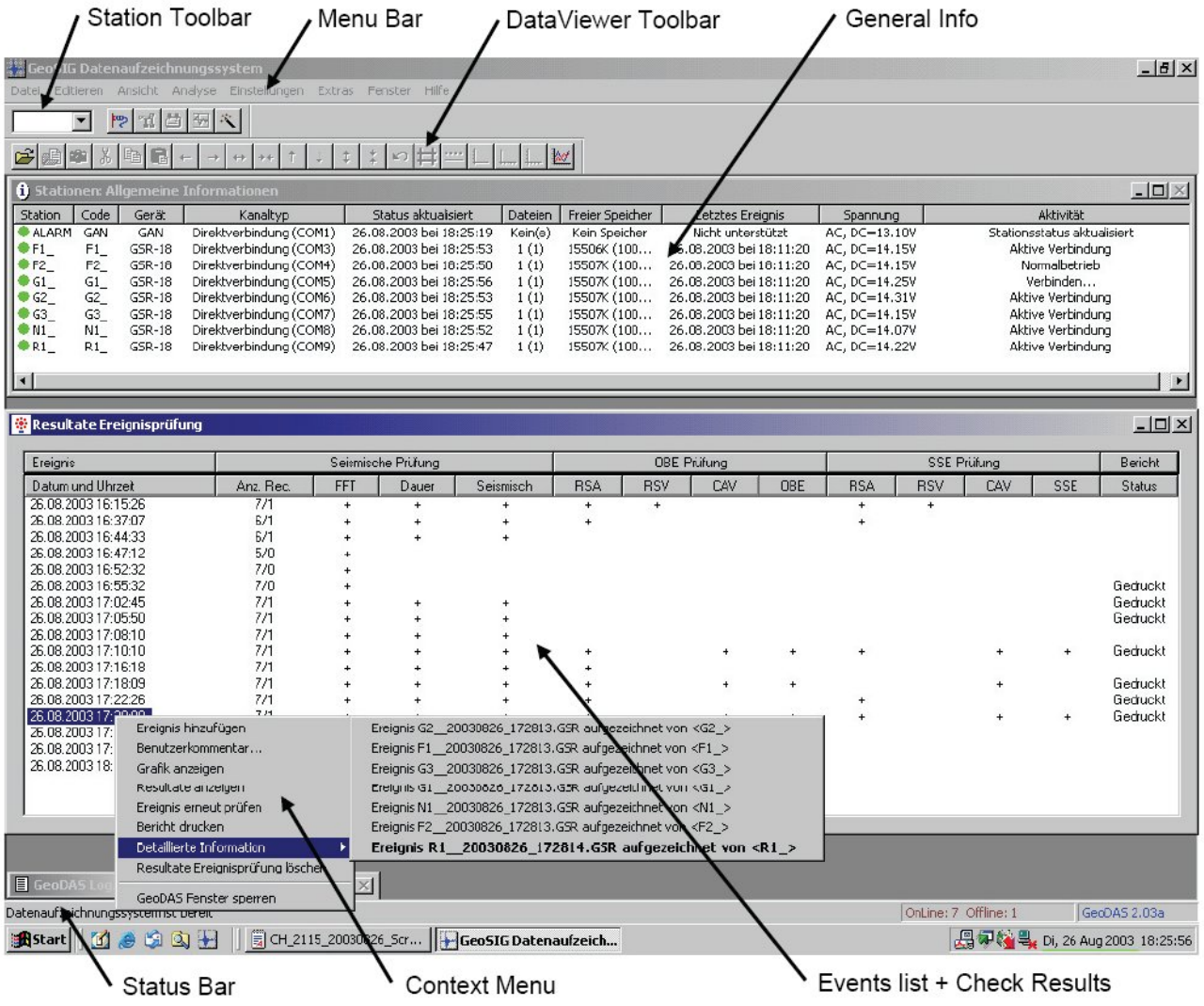
GeoDAS – GeoSIG Data Acquisition System

- Graphical Windows based application running under Windows NT4/2000/XP/Vista
- Primary GeoSIG software supporting all types of seismic instruments
- Designed to meet specific requirements of different applications
- Easy extendable and upgradeable

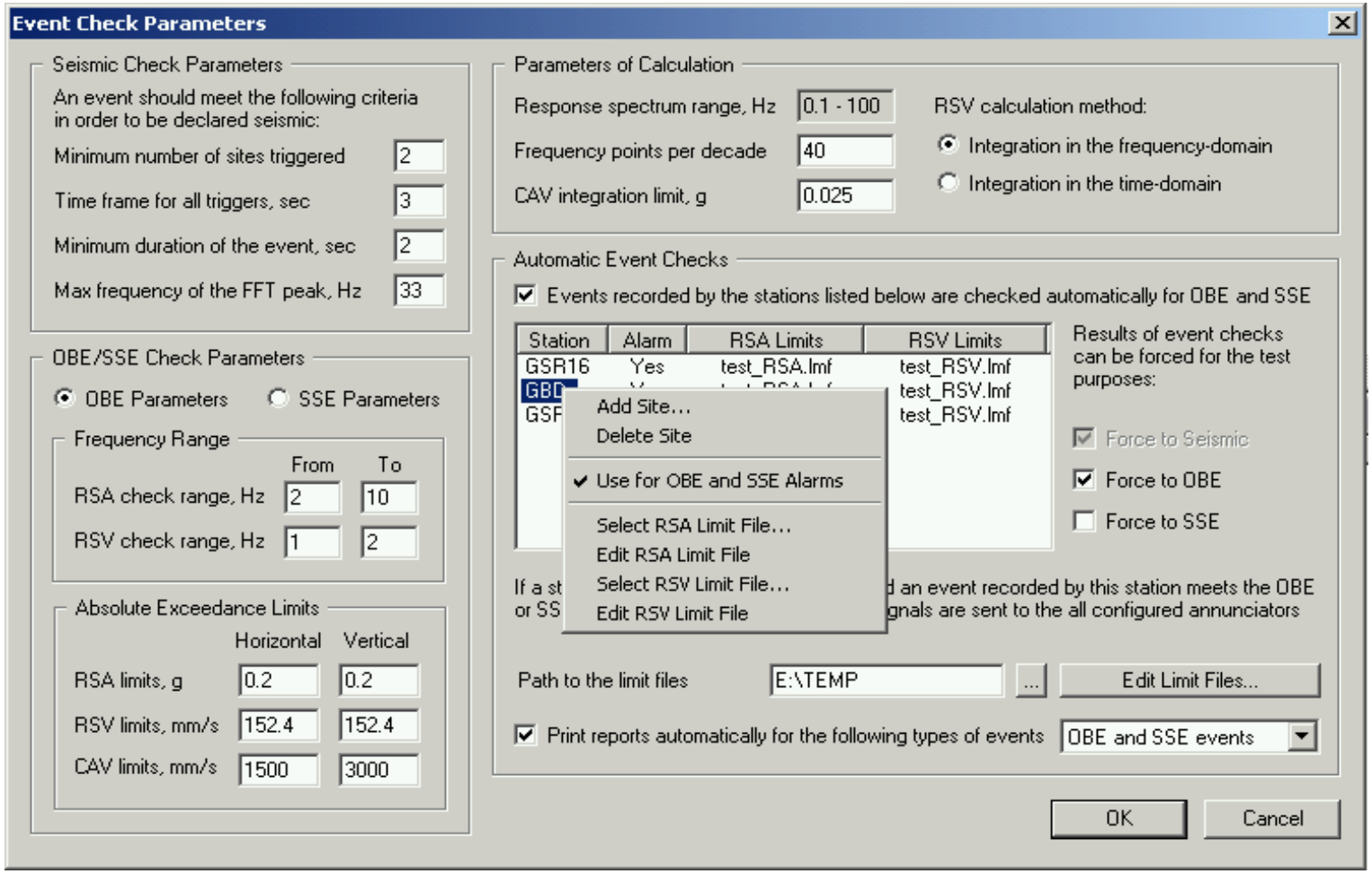
Main Functionality of GeoDAS in NPP applications

- Setup of instruments. One can change any parameters of an instrument with GeoDAS
- SOH monitoring. GeoDAS performs permanent or periodical monitoring of the instrument status
- Downloading of event files from the recorders
- Off-line event data view and data analysis
- Logger features. GeoDAS keeps important messages in a log file
- Analysis of the event recording files for seismic and OBE/SSE criteria
- Event check report generation, including automatic printout

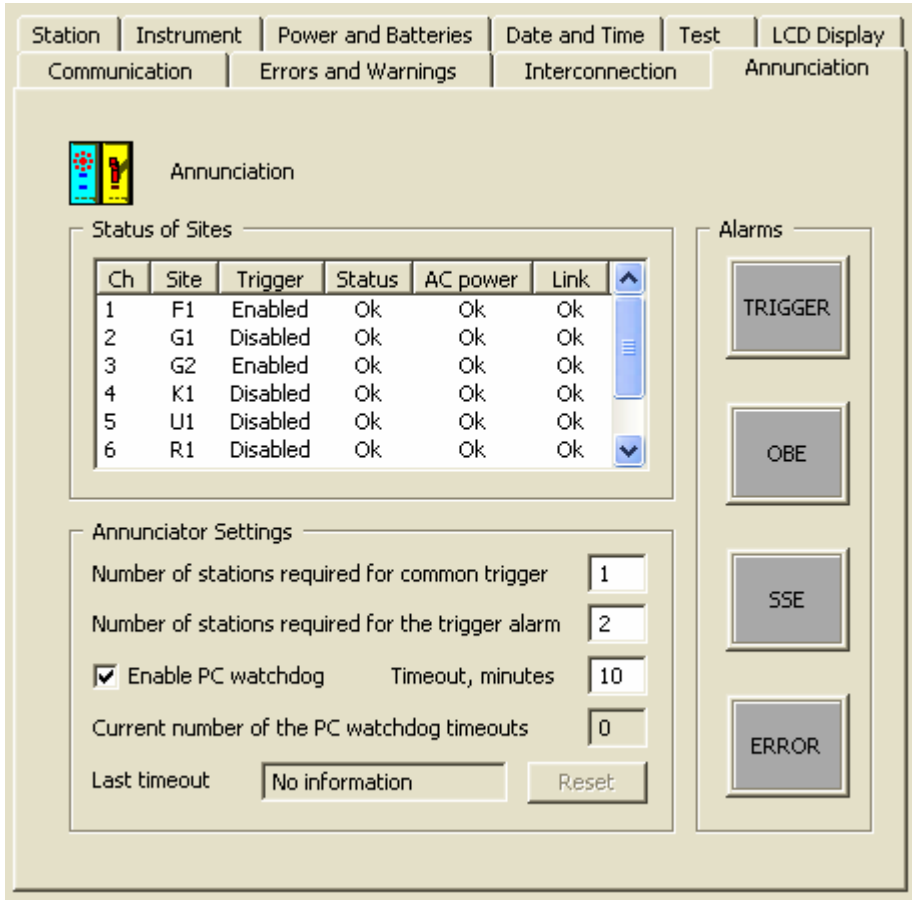
Example of the main GeoDAS screen of SMS



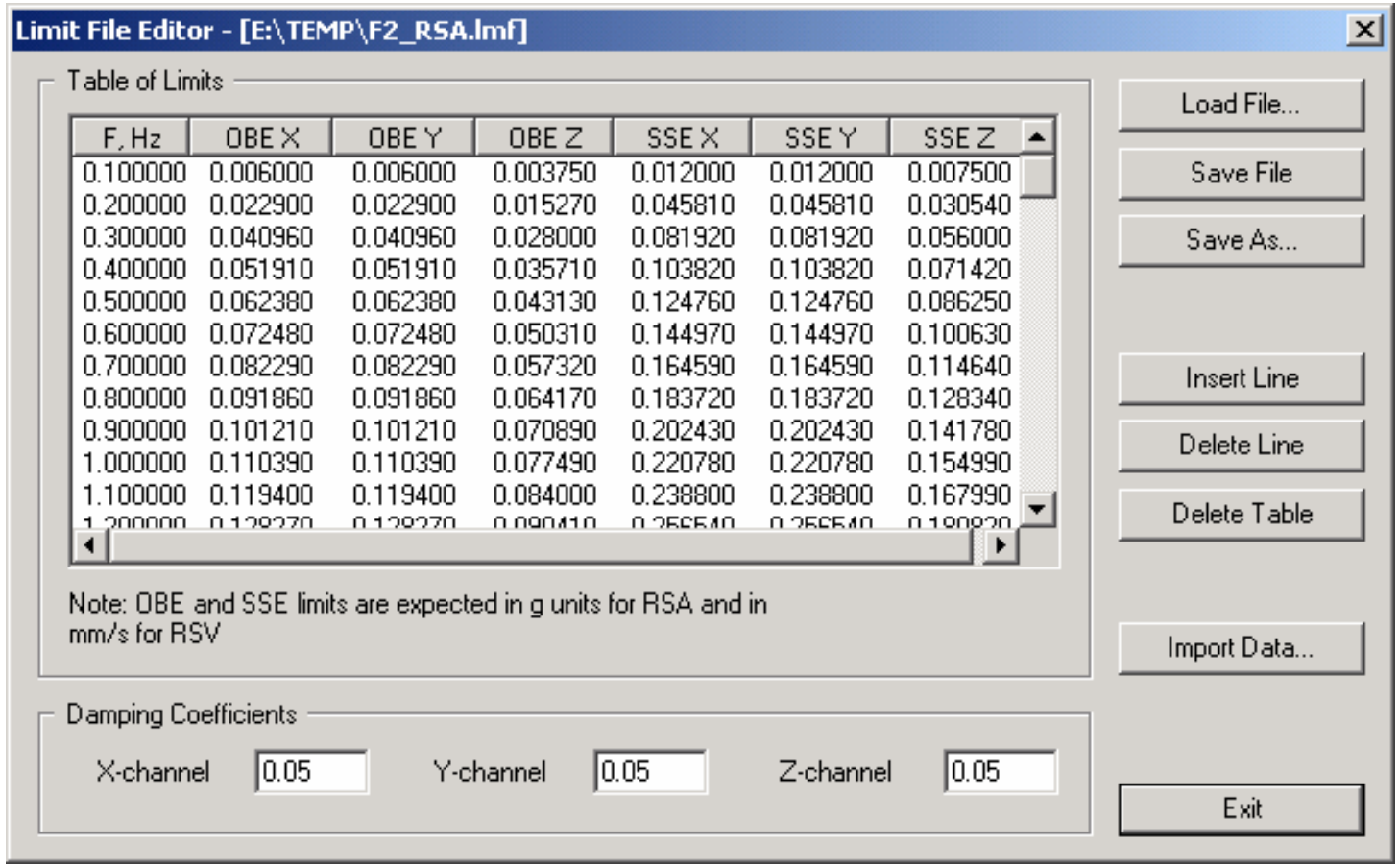
Event Check parameters of GeoDAS



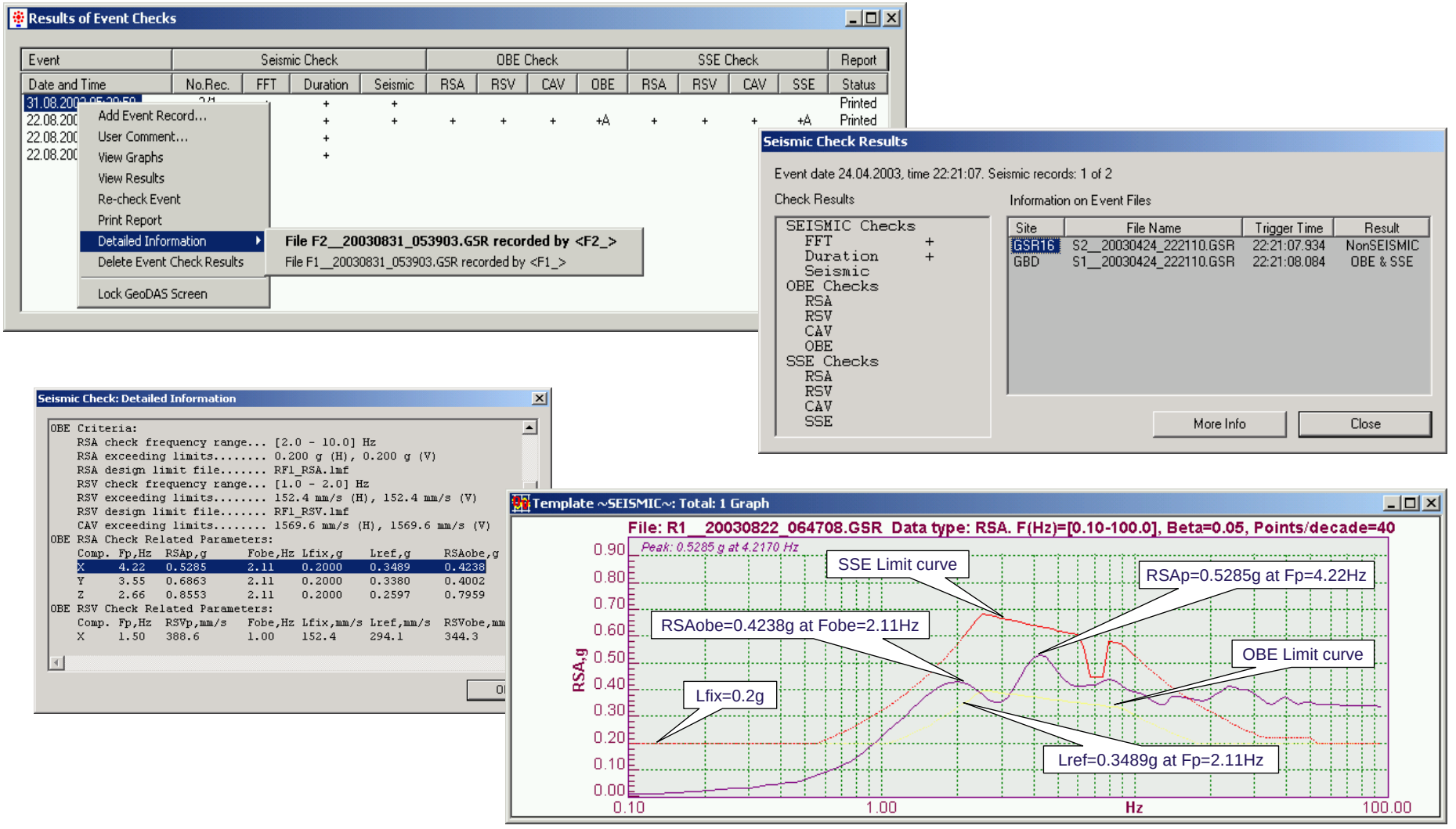
GeoDAS: Annunciation Parameters and Status



GeoDAS: Editor of OBE/SSE Limit Files



GeoDAS: Detailed Event Check



Example of GeoDAS Event Check Report

KKW Beznau
Erdbebeninstrumentierung
Ereignisprüfung (Übersicht)

NOK

Datum Bericht: 31.08.2003
Zeit Bericht: 05:38:58 UTC

Resultat seismisch: Nein
Resultat OBE Alarm: Nein
Resultat SSE Alarm: Nein

Station	Ereignisdatei	Designspektrendatei
F1_	F1__20030831_053903.GSR	RSA:F1_RSA.lmf, RSV:F1_RSV.lmf
F2_	F2__20030831_053903.GSR	RSA:F2_RSA.lmf, RSV:F2_RSV.lmf
G1_	G1__20030831_053903.GSR	RSA:G1_RSA.lmf, RSV:G1_RSV.lmf
G2_	G2__20030831_053903.GSR	RSA:G2_RSA.lmf, RSV:G2_RSV.lmf
G3_	G3__20030831_053903.GSR	RSA:G3_RSA.lmf, RSV:G3_RSV.lmf
N1_	N1__20030831_053903.GSR	RSA:N1_RSA.lmf, RSV:N1_RSV.lmf
R1_	R1__20030831_053903.GSR	RSA:RF1_RSA.lmf, RSV:RF1_RSV.lmf

		Seismische Prüfung			OBE			SSE		
Station		Anz. Rec.	FFT Spitze	Dauer	RSA	RSV	CAV	RSA	RSV	CAV
F1_	X	Nein	14.2 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	12.2 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	13.8 Hz		Nein	Nein	Nein	Nein	Nein	Nein
F2_	X	Nein	9.4 Hz	1.2 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	13.2 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	15.8 Hz		Nein	Nein	Nein	Nein	Nein	Nein
G1_	X	Nein	16.5 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	16.5 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	16.5 Hz		Nein	Nein	Nein	Nein	Nein	Nein
G2_	X	Nein	16.5 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	16.5 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	16.5 Hz		Nein	Nein	Nein	Nein	Nein	Nein
G3_	X	Nein	16.5 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	24.9 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	24.9 Hz		Nein	Nein	Nein	Nein	Nein	Nein
N1_	X	Nein	9.1 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	16.6 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	14.0 Hz		Nein	Nein	Nein	Nein	Nein	Nein
R1_	X	Nein	9.1 Hz	0.0 s	Nein	Nein	Nein	Nein	Nein	Nein
	Y	Nein	21.5 Hz		Nein	Nein	Nein	Nein	Nein	Nein
	Z	Nein	9.0 Hz		Nein	Nein	Nein	Nein	Nein	Nein

Testresultate

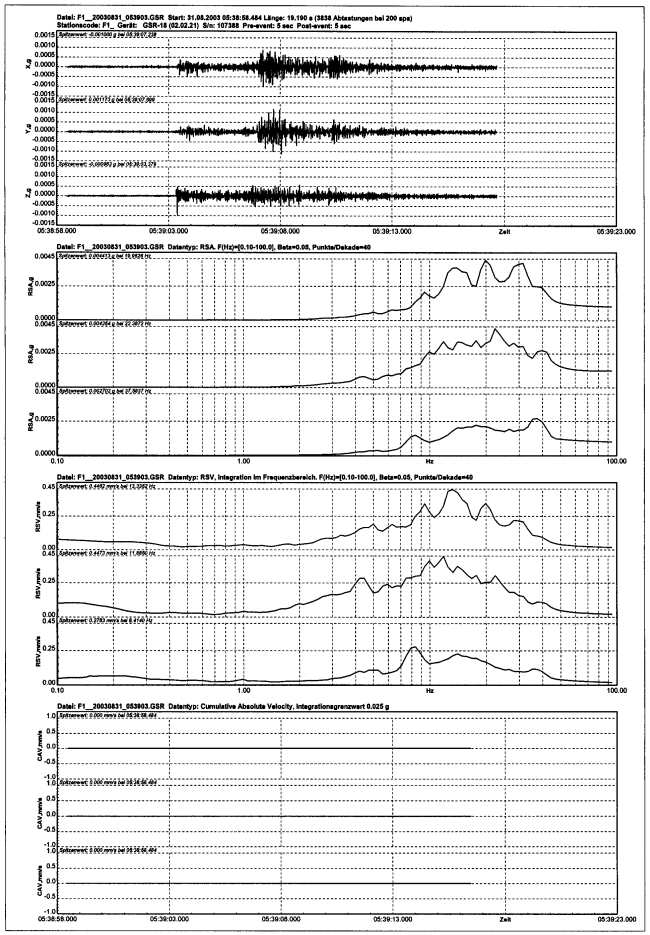
Station	Seismische Prüfung	OBE	SSE	OBE Alarm	SSE Alarm
F1_	Nein	Nein	Nein	Station generiert keine Alarme	
F2_	Nein	Nein	Nein	Station generiert keine Alarme	
G1_	Nein	Nein	Nein	Station generiert keine Alarme	
G2_	Nein	Nein	Nein	Station generiert keine Alarme	
G3_	Nein	Nein	Nein	Station generiert keine Alarme	
N1_	Nein	Nein	Nein	Station generiert keine Alarme	
R1_	Nein	Nein	Nein	Station generiert keine Alarme	

Kriterium seismisch	Grenzwert
Anzahl Registriergeräte	min. 1
FFT Spitzenwert	max. 33.0 Hz
Dauer	min. 2.0 s

OBE = Seismische Prüfung + (RSAobe oder RSVobe) + CAVobe
SSE = Seismische Prüfung + (RSAsse oder RSVsse) + CAVsse

KKW Beznau
Erdbebeninstrumentierung
Ereignisprüfung

NOK



Conclusions

- Every NPP seismic monitoring system has to fulfill user specific requirements
- During past years, GeoSIG gained excellent experience with the seismic instrumentation of three Nuclear Power Plants in Switzerland, which are all equipped with the modern Seismic Monitoring Systems manufactured by GeoSIG
- We offer two different topologies of such systems and customized measuring solutions allowing for specific requirements of any NPP and for a cost optimization
- GeoSIG has built excellent partnership relations with the Nuclear Logistics company
- As a result, we supplied first modern SMS system to the US NPP market in this year

….and we believe – more systems to come

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YOUR QUESTIONS

The End

Thank you for your attention

GeoSIG

The Swiss manufacturer of seismic NPP instrumentation solutions