The Effect of Maanshan NPS Due to the Earthquake Occurred on December 26, 2006

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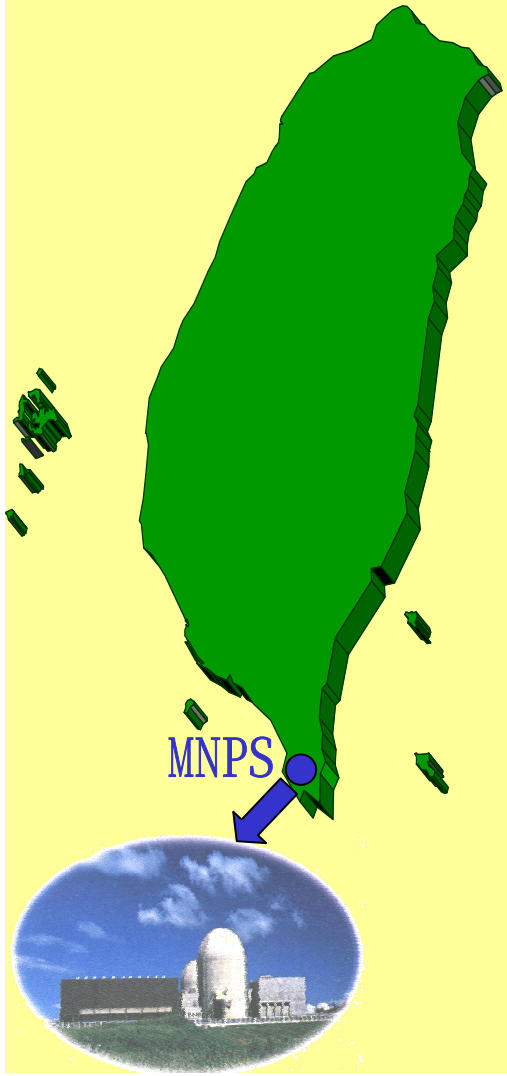
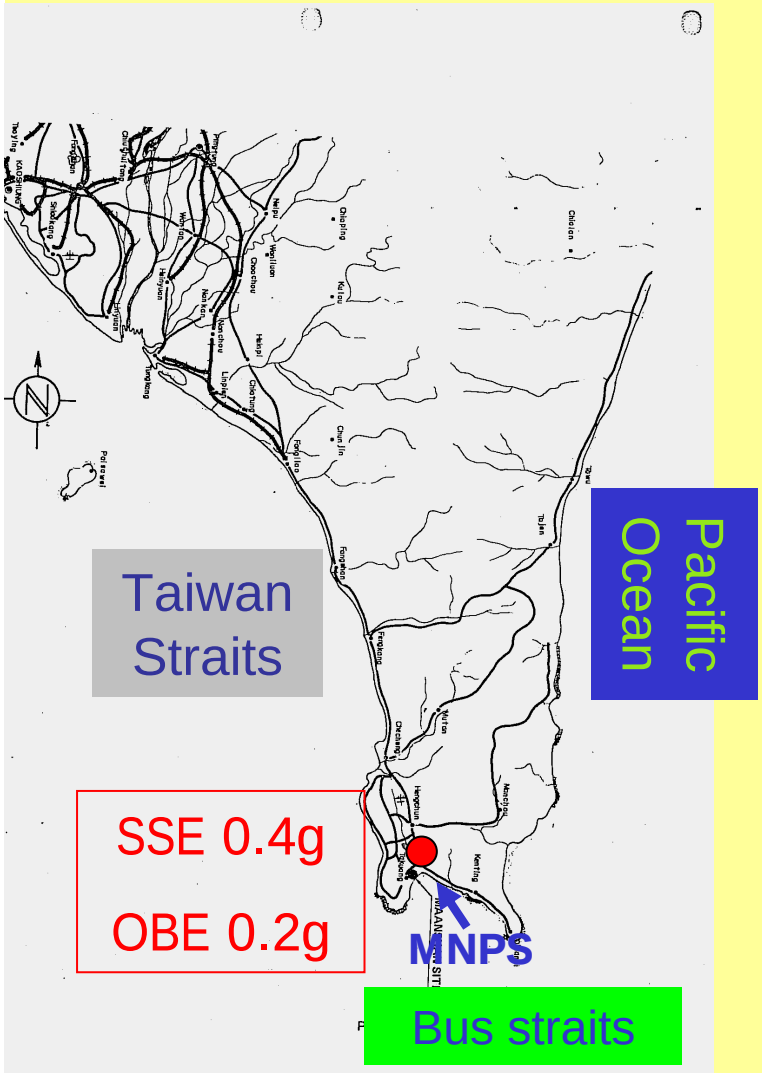
Preface

MNPS Basic Information



Rated thermal power (MWt)	2785	
Rated Gross electrical power (MWe)	951	
Reactor	Westinghouse, PWR, 3 Loop	
HP turbine rotor	GE	
LP turbine rotor	ABBx2	
Generator	GE, hydrogen / water cooling	
AE	Bechtel	
CTMT type	pre-stressed post-tensioned concrete	
Unit	Unit 1	Unit 2
CP date	67/04/01	67/04/01
Commercial operation date	73/07/27	74/05/18

Preface (continued)

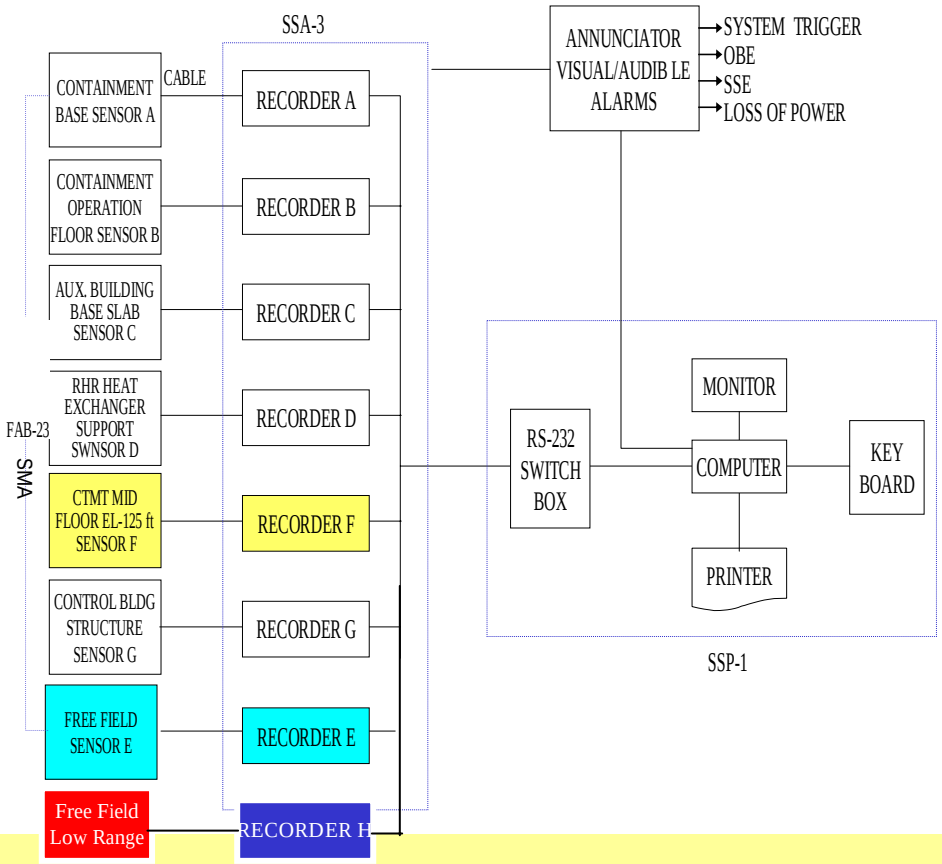


Seismic design basis of MNPS

The design basis earthquake is assumed that the largest known earthquake which occurred offshore east of Taiwan (the magnitude 8.3 event of June 5, 1920) might occur on the closest approach to the site of this nearest known fault which is about 35 kilometers away from MNPS site . Under these very conservative assumptions, the maximum ground accelerations at the Maanshan site produced by such an event is slightly less than 0.4g.

MNPS Seismic Monitor Instrumentations

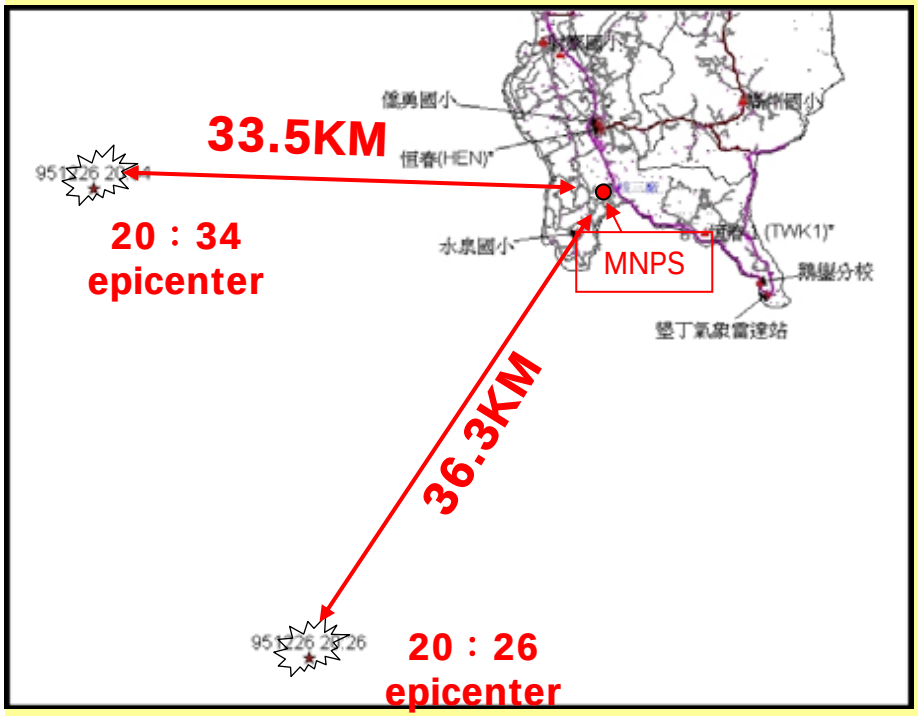
MNPS seismic monitor system sketch



- 3 sensors located inside unit #1 CTMT(100', 125', 148')
- 2 sensors located inside unit #1 Aux. building (74'，101')
- 1 sensors located inside unit #1 control building(126')
- 2 Free field sensors located outside of Protection Zone(126')

Hengchun Earthquake Data

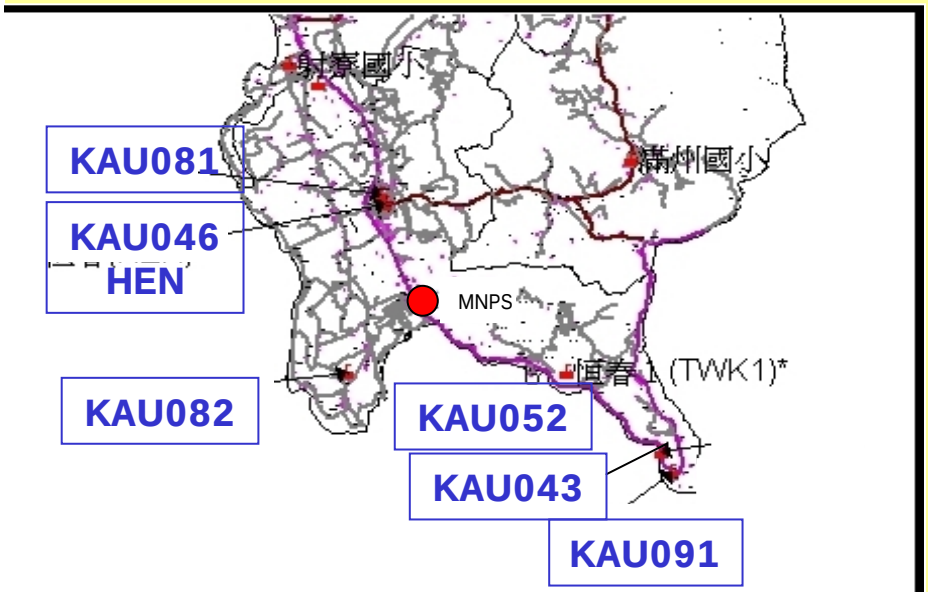
- From 20:26 December 26, 2006, a series of earthquakes occurred near Hengchun where MNPS located. The epicenter, depth and magnitude of two main earthquakes are as follows:



	time	epicenter	depth (KM)	magnitude
1	2006/12/26 20:26	21°67 ºN 120°56’ ºE ’	44.1	7.0
2	2006/12/26 20:34	21°97 ºN 120°42’ ºE	50.2	7.0

Local seismic monitoring stations

- **list of seismic monitoring stations of Central Weather Bureau in Hengchun area**



Station code	Station name	North latitude	East longitude
HEN	Hengchun weather station	22.00	120.75
KAU043	Eluan branch school	21.91	120.85
KAU046	Hengchun weather station	22.00	120.75
KAU052	Hengchun1 (Livestock Research institute)	21.94	120.81
KAU081	Ciaoyong elementary school	22.01	120.75
KAU082	Shueicyuan elementary school	21.94	120.73
KAU091	Kending weather radar station	21.91	120.86

Peak ground acceleration data during earthquakes

time：2006/12/26 20:26

Unit: gal=1cm/sec^2

station / direction	MNPS Free field (E)	MNPS Free field (H)	Shueicyuan elementary school (KAU082)	Ciaoyong elementary school (KAU081)	Kending weather radar station (TWK1)
vertical	72.37	73.91	78.03	57.31	70.28
N-S	138.40	137.69	240.3	181.64	125.61
E-W	159.96	156.55	217.87	191.92	159.88
Approx.Distance from epicenter (km)	~36.3	~36.3	~33.2	~40.3	~38.8

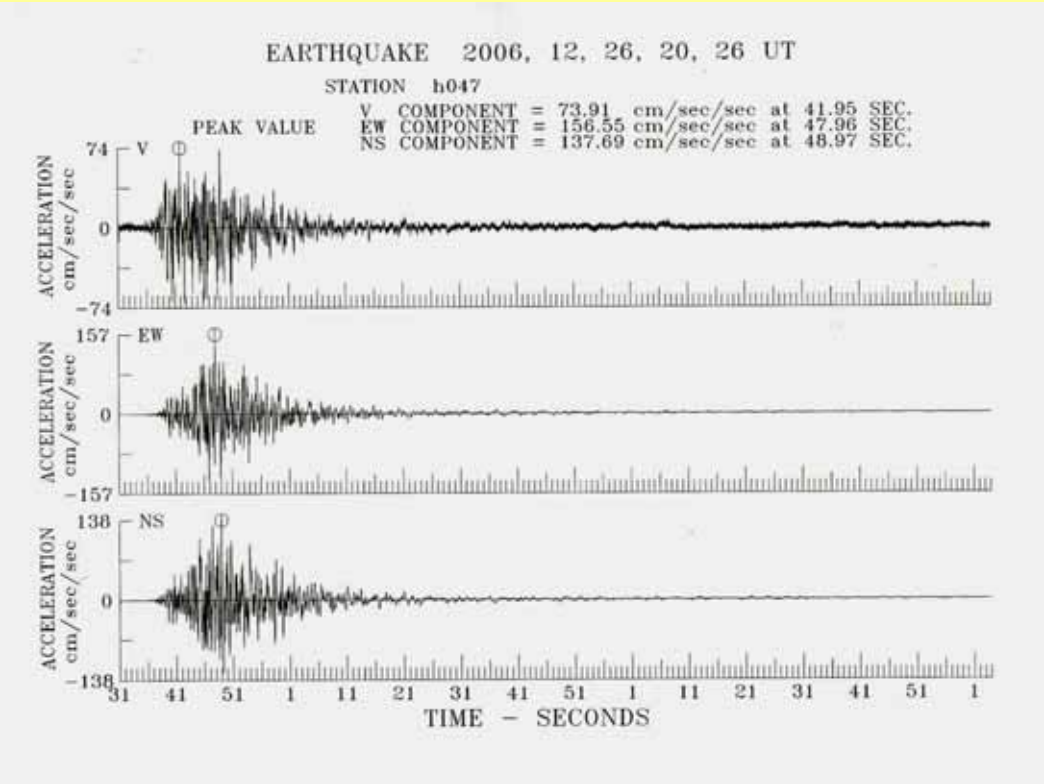
Peak ground acceleration data during earthquakes(continued)

- The measuring data form each seismic sensor in MNPS:

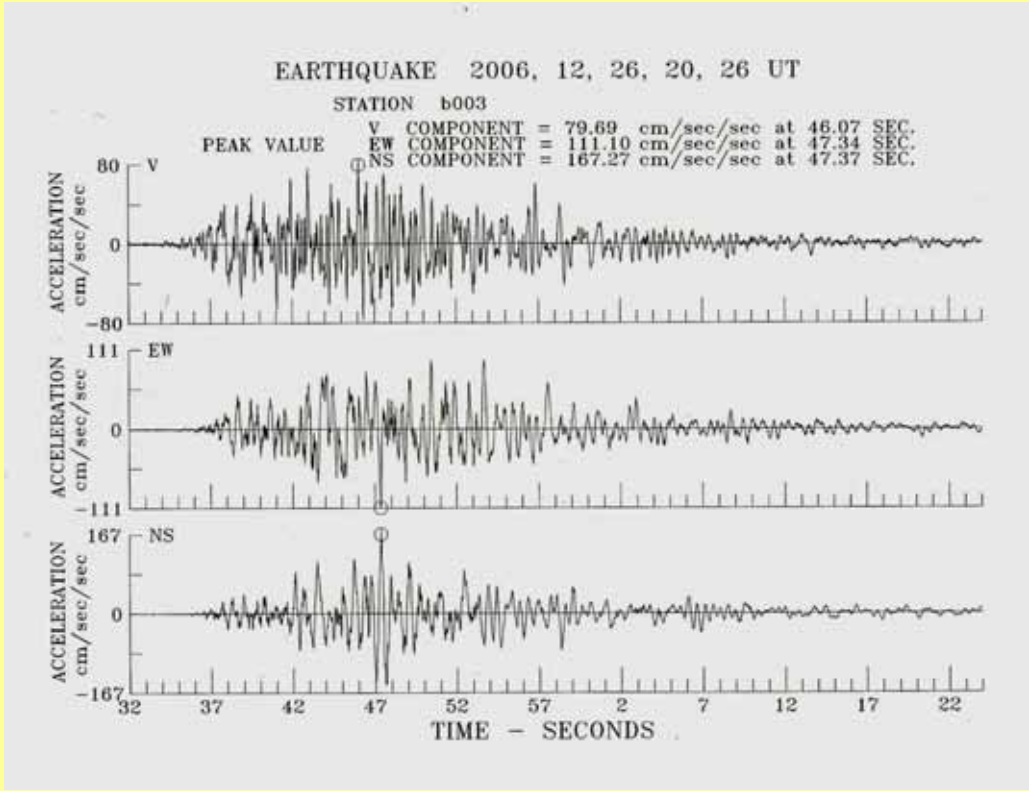
time ：2006/12/26 20:26 Unit: gal=1cm/sec^2

Sensor Location	CTMT 100'	CTMT 148'	Aux. Building 74'	Aux. Building 101'	Free Field（E）	CTMT Middle floor	Control Room #1	Free Field（H）
CH.1 N-S	101	168	99	105	138	139	106	138
CH.2 VERT.	84	79	74	77	72	78	81	74
CH.3 E-W	80	111	75	86	160	90	89	157

Ground acceleration Measured by MNPS seismic sensor: （20：26）

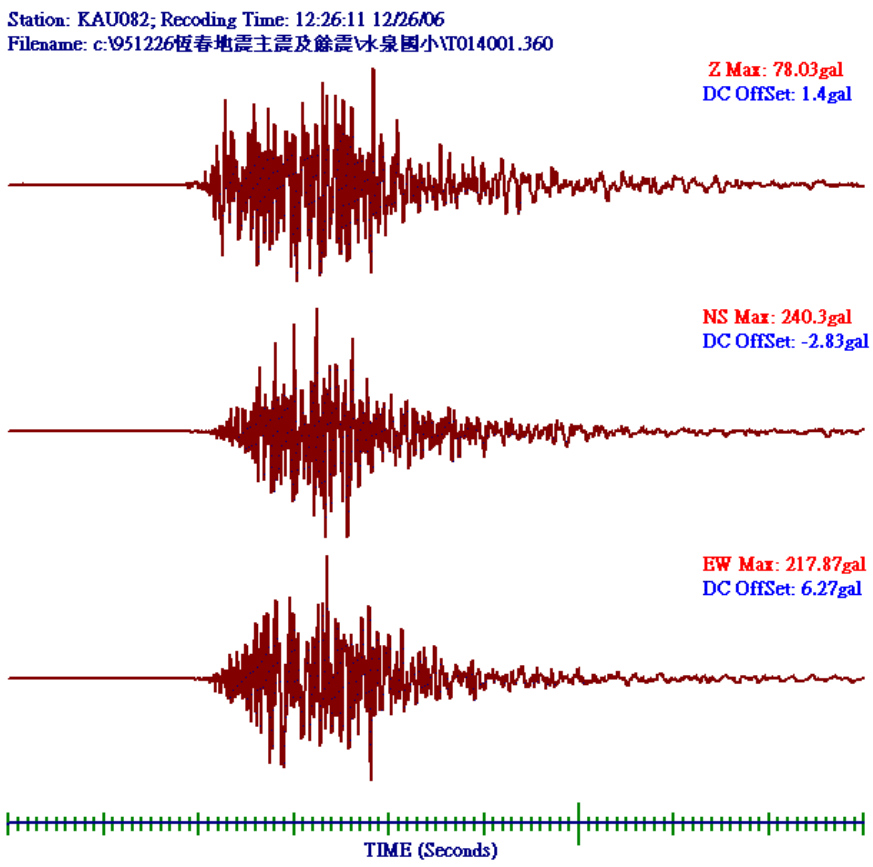


FREE FIELD sensor（H）

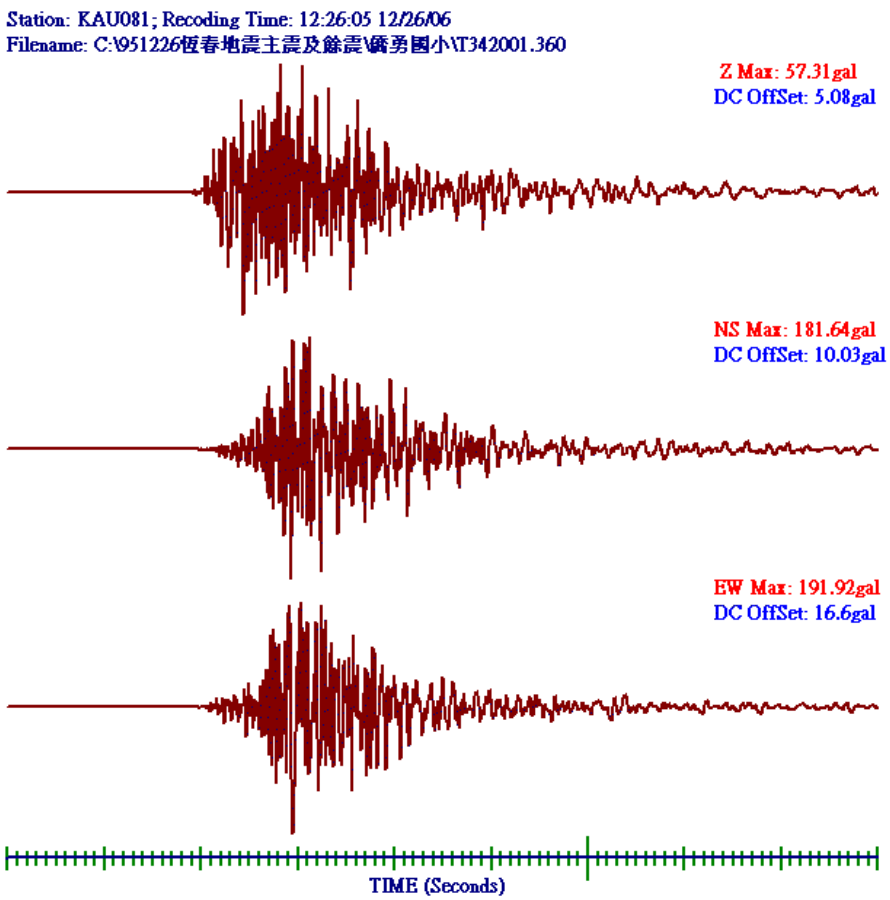


CTMT 148’（B）

Ground acceleration Measured by Central Weather Bureau seismic station （20：26）



Shueicyuan elementary school
（ KAU082 ）



Ciaoyong elementary school
（ KAU081 ）

Peak ground acceleration data during earthquakes(continued)

time ：2006/12/26 20:34

Unit: gal=1cm/sec^2

station / direction	MNPS Free Field (E)	MNPS Free Field (H)	Shueicyuan elementary school (KAU082)	Ciaoyong elementary school (KAU081)	Hengchun weather station (KAU046)
vertical	71.97	74.06	82.1	59.58	69.97
N-S	160.86	162.12	176.14	250.89	254.16
E-W	139.88	140.85	182.47	195.56	172.38
Approx. Distance from epicenter (km)	~33.5	~33.5	~31.4	~33	~33

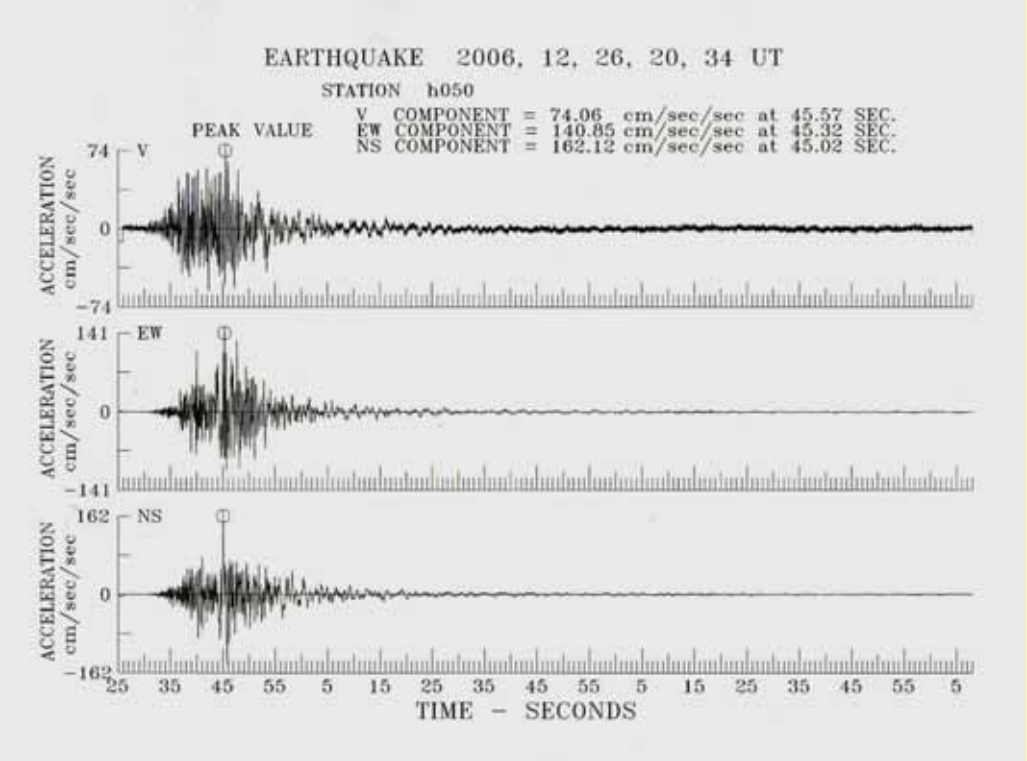
Peak ground acceleration data during earthquakes(continued)

- The measuring data form each seismic sensor in MNPS:

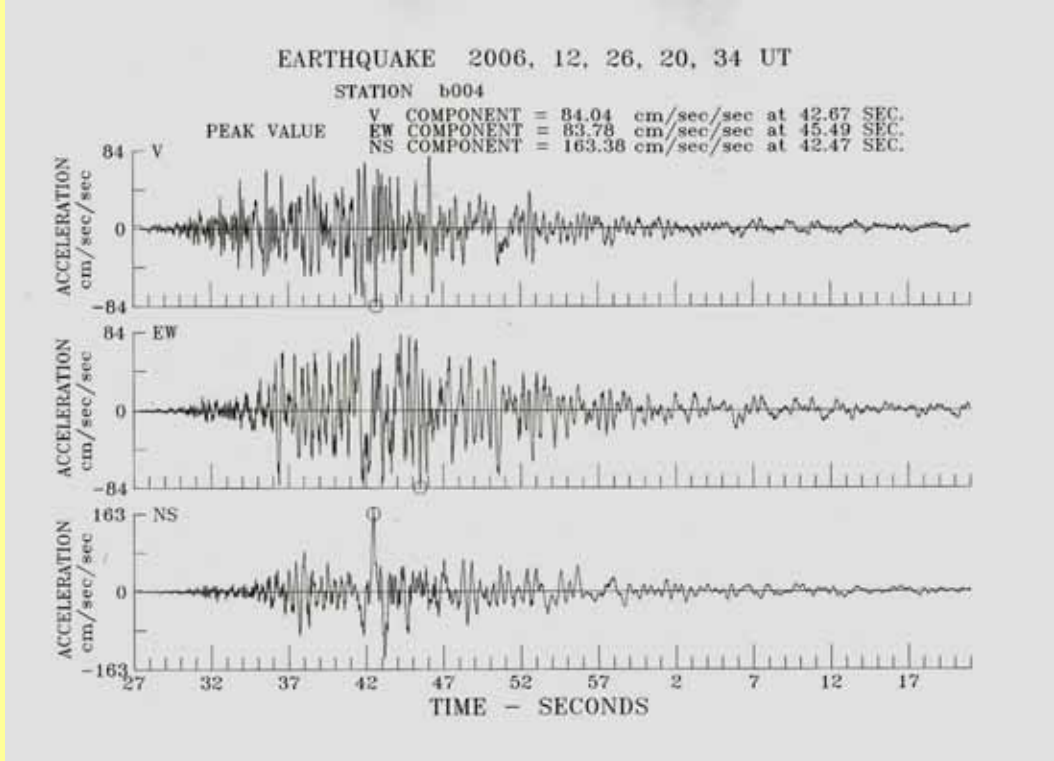
time：2006/12/26 20:34 Unit: gal=1cm/sec^2

Sensor Location	CTMT 100'	CTMT 148'	Aux. Building 74'	Aux. Building 101'	Free Field（E）	CTMT Middle Floor	Control Room #1	Free Field（H）
CH.1 N-S	123	164	127	131	161	133	132	162
CH.2 VERT	118	84	63	68	72	87	66	74
CH.3 E-W	74	83	93	106	140	82	109	141

Ground acceleration Measured by MNPS seismic sensor: （20：34）

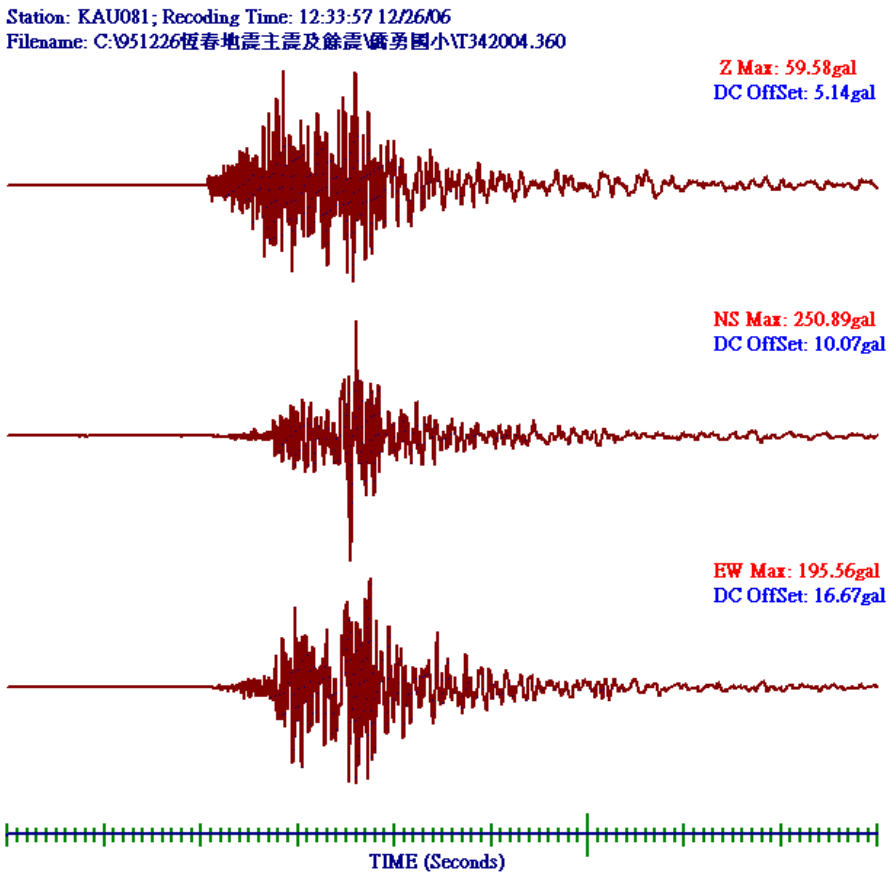


FREE FIELD sensor（H）

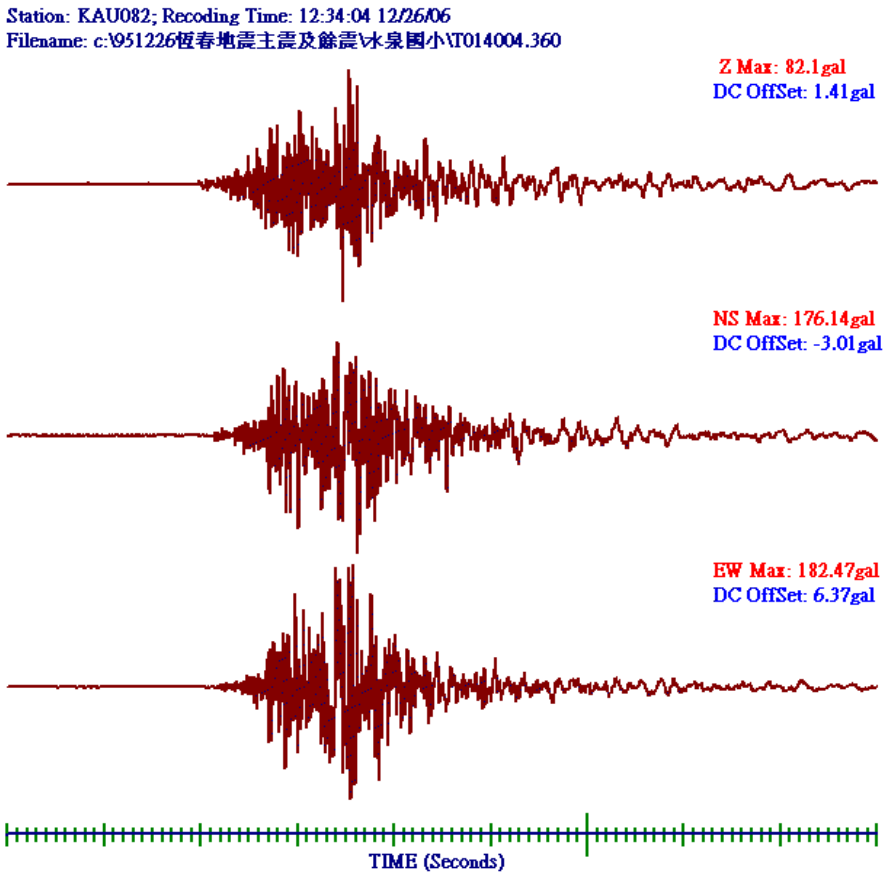


CTMT 148’（B）

Ground acceleration Measured by Central Weather Bureau seismic station: （20：34）



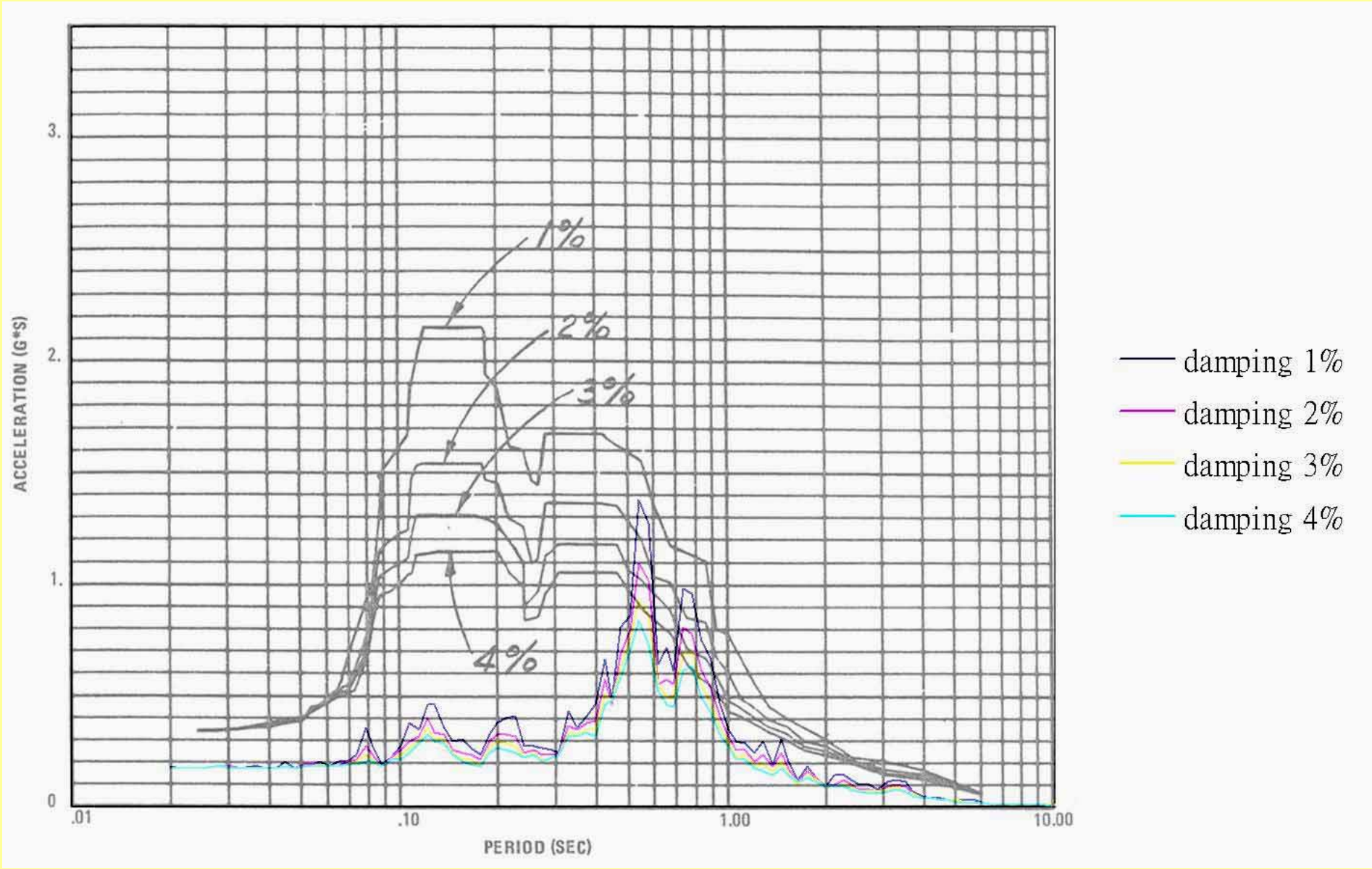
Shueicyuan elementary school
（ KAU082 ）



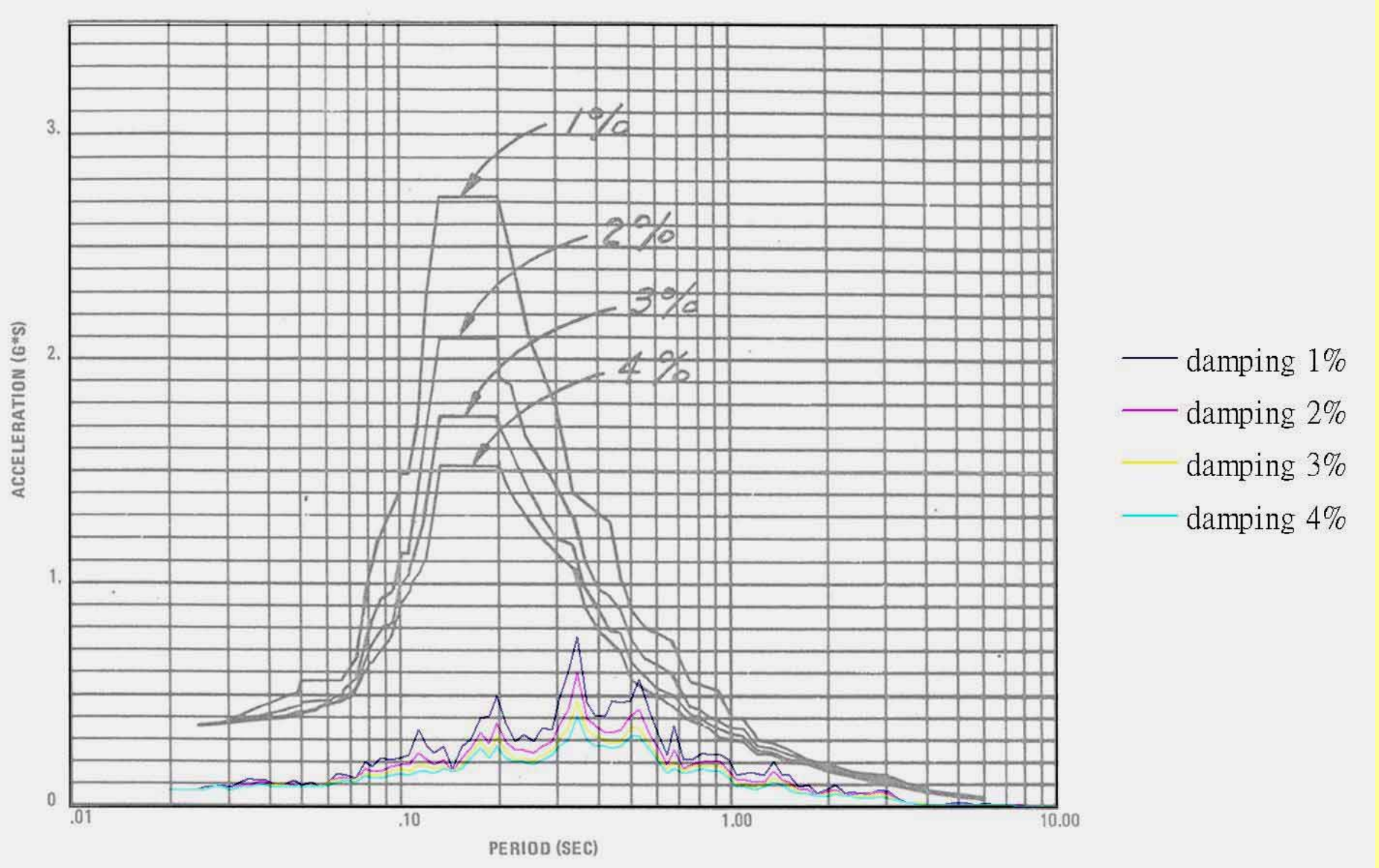
Ciaoyong elementary school
（ KAU081 ）

Peak ground acceleration data during earthquakes(continued)

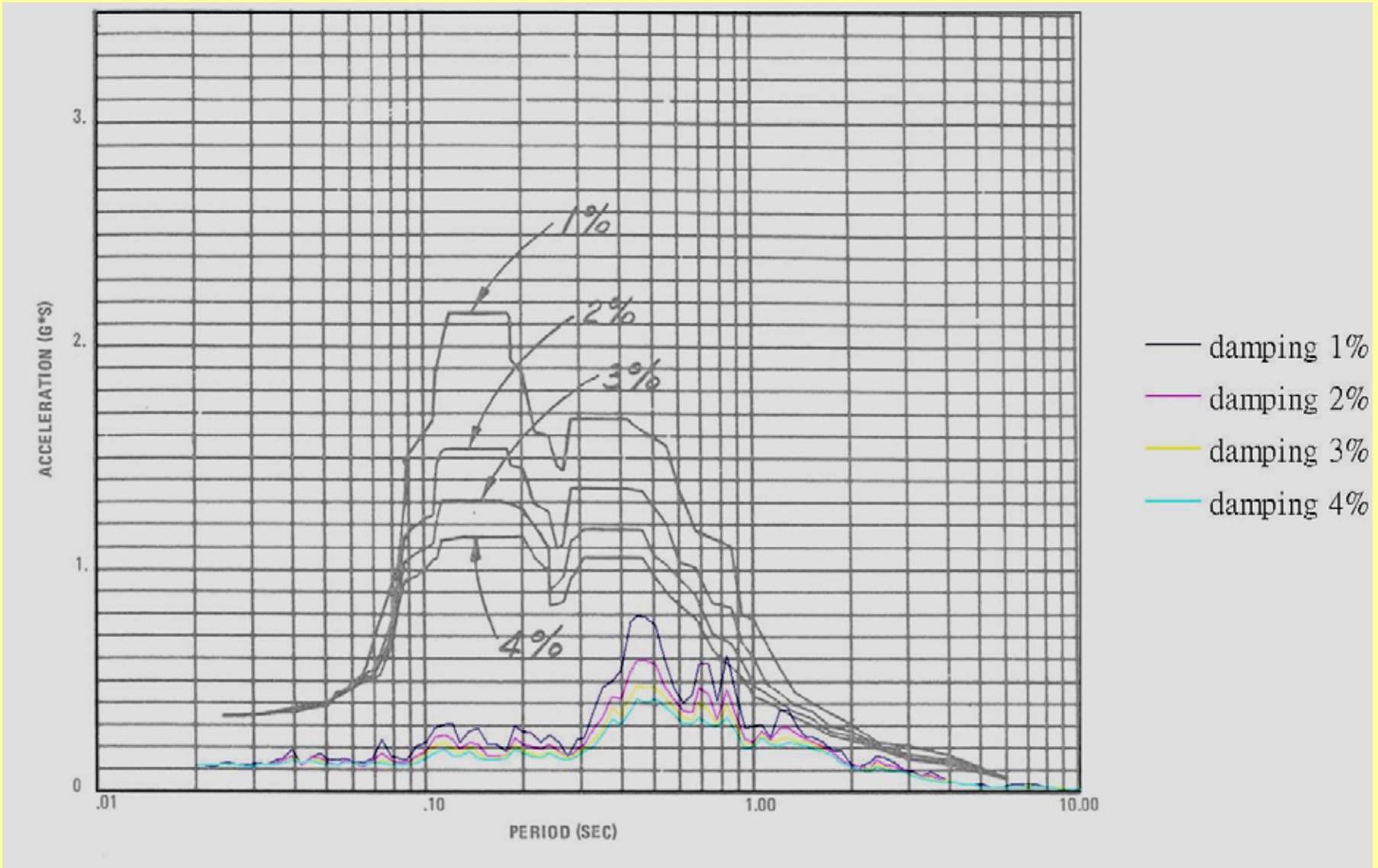
- Compares the ground acceleration spectrum measuring from each floor of MNPS with the OBE design spectrum, there is only one data (0.7 Hz at 20:34) exceed the OBE design spectrum (but not exceed 10%). All the other datas are under OBE design spectrum envelope.
- According to ANS 2.10 criteria, we concluded that OBE has not exceeded during earthquakes occurred on December 26, 2006 .



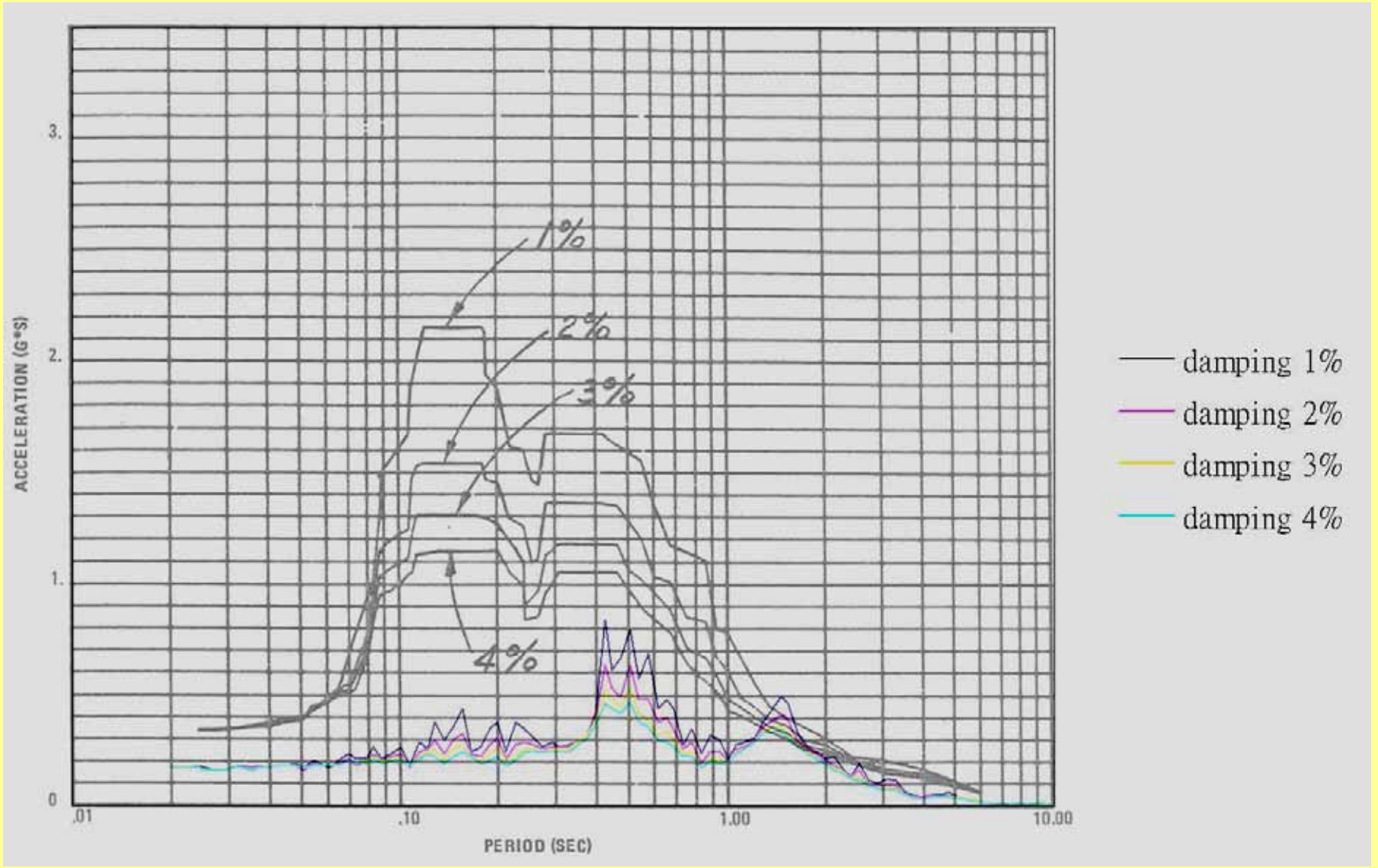
The CTMT 148’ N-S direction spectrum at 20:26
compare with OBE design basis spectrum



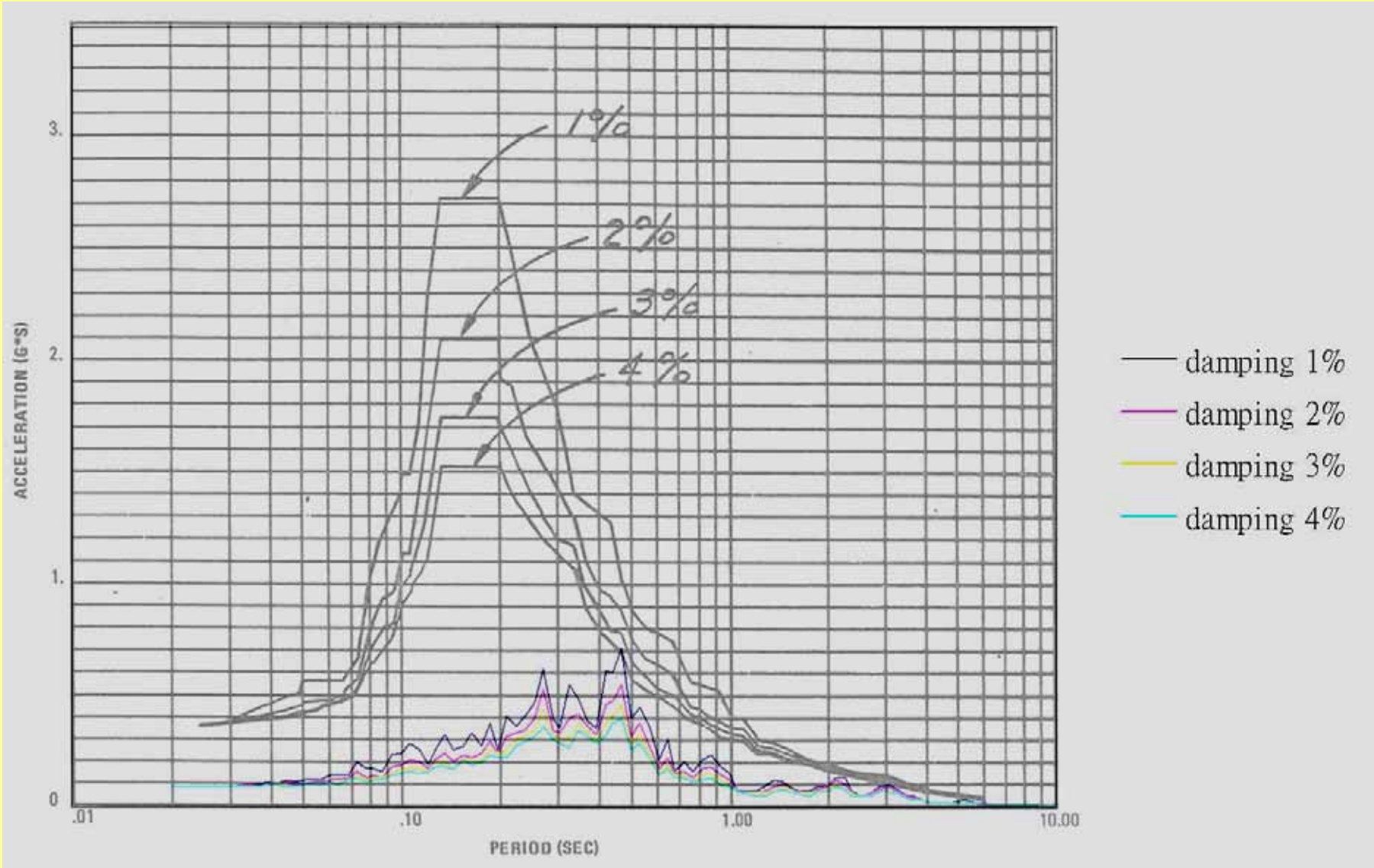
The CTMT 148’ vertical direction spectrum at 20:26 compare with OBE design basis spectrum



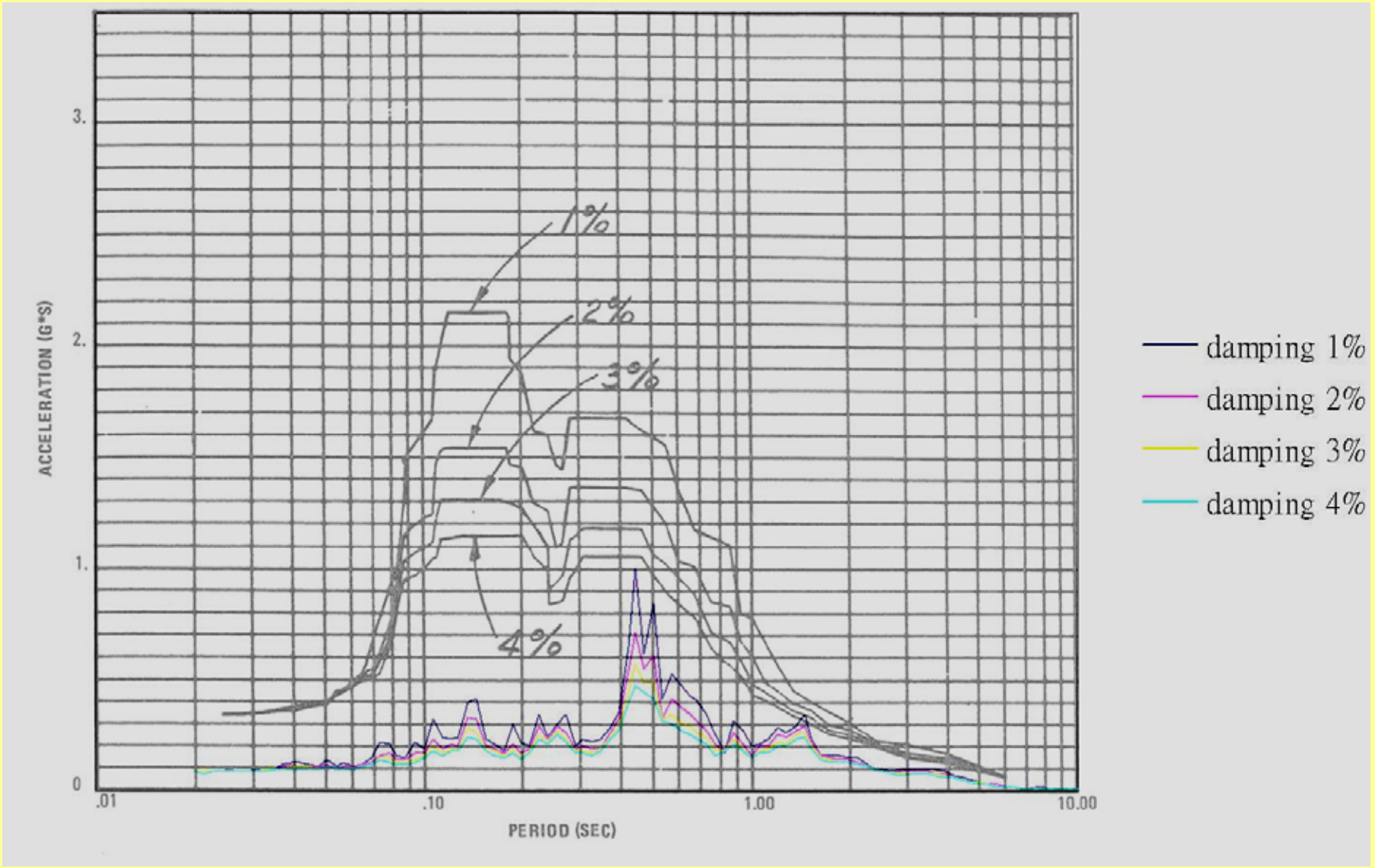
The CTMT 148’ E-W direction spectrum at 20:26
compare with OBE design basis spectrum



The CTMT 148’ N-S direction spectrum at 20:34
compare with OBE design basis spectrum



The CTMT 148’ vertical direction spectrum at 20:34 compare with OBE design basis spectrum

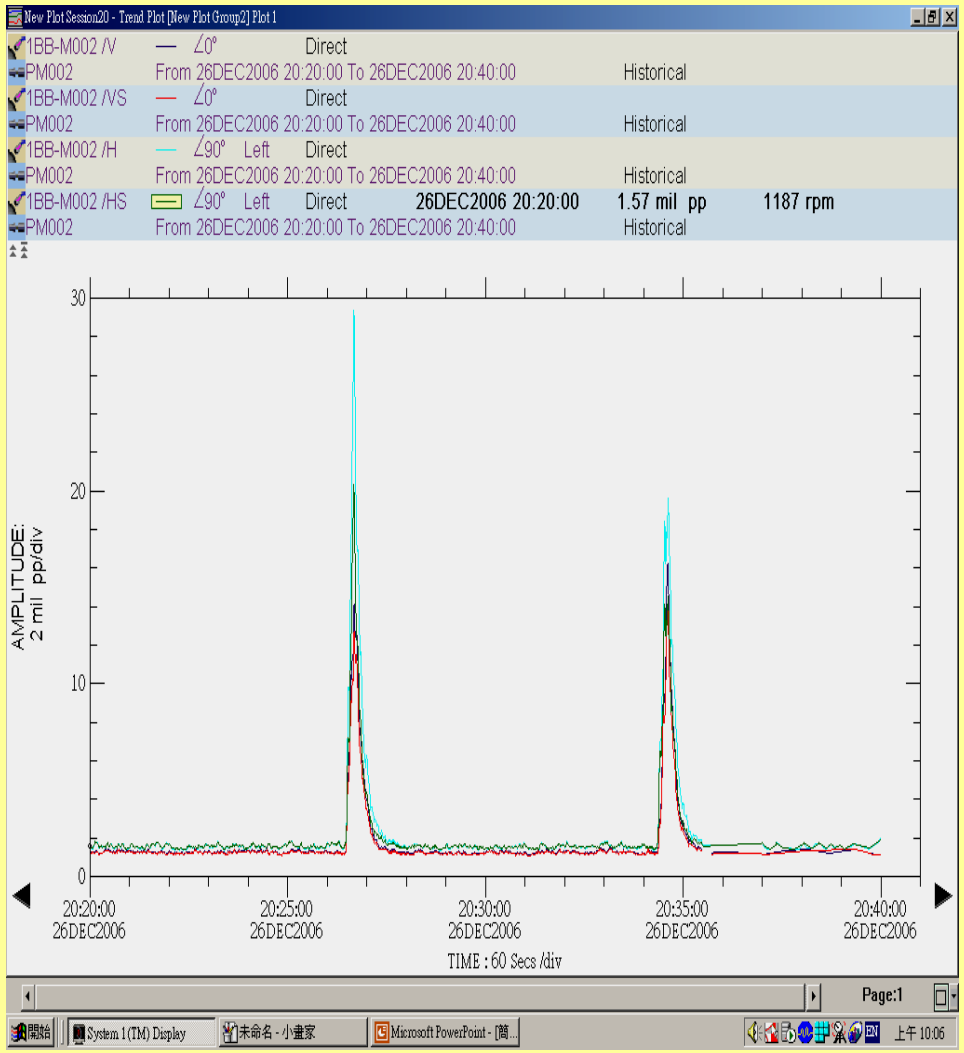


The CTMT 148’ E-W direction spectrum at 20:34
compare with OBE design basis spectrum

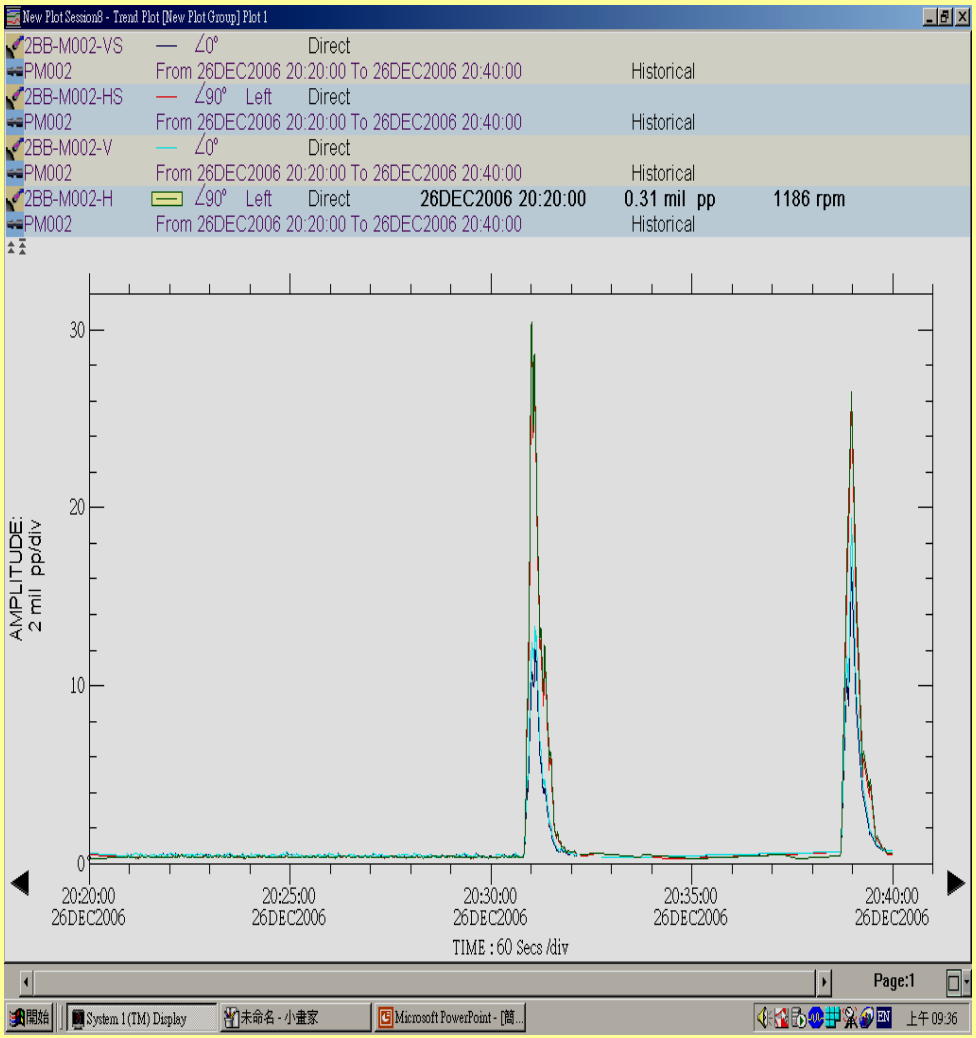
The status of two MNPS units after the earthquake

- During the earthquake, operators in both units had experienced of violent shock, and also noticed the RCP and main turbine high vibration alarms appeared. The unit #2 operators trip Rx manually. However, when unit #1 operators decided to took the same action, the earthquake had been slowed down and the alarms of high vibration could be reset, so they terminated action and the unit #1 keep in operating.

RCP motor historical vibration graph

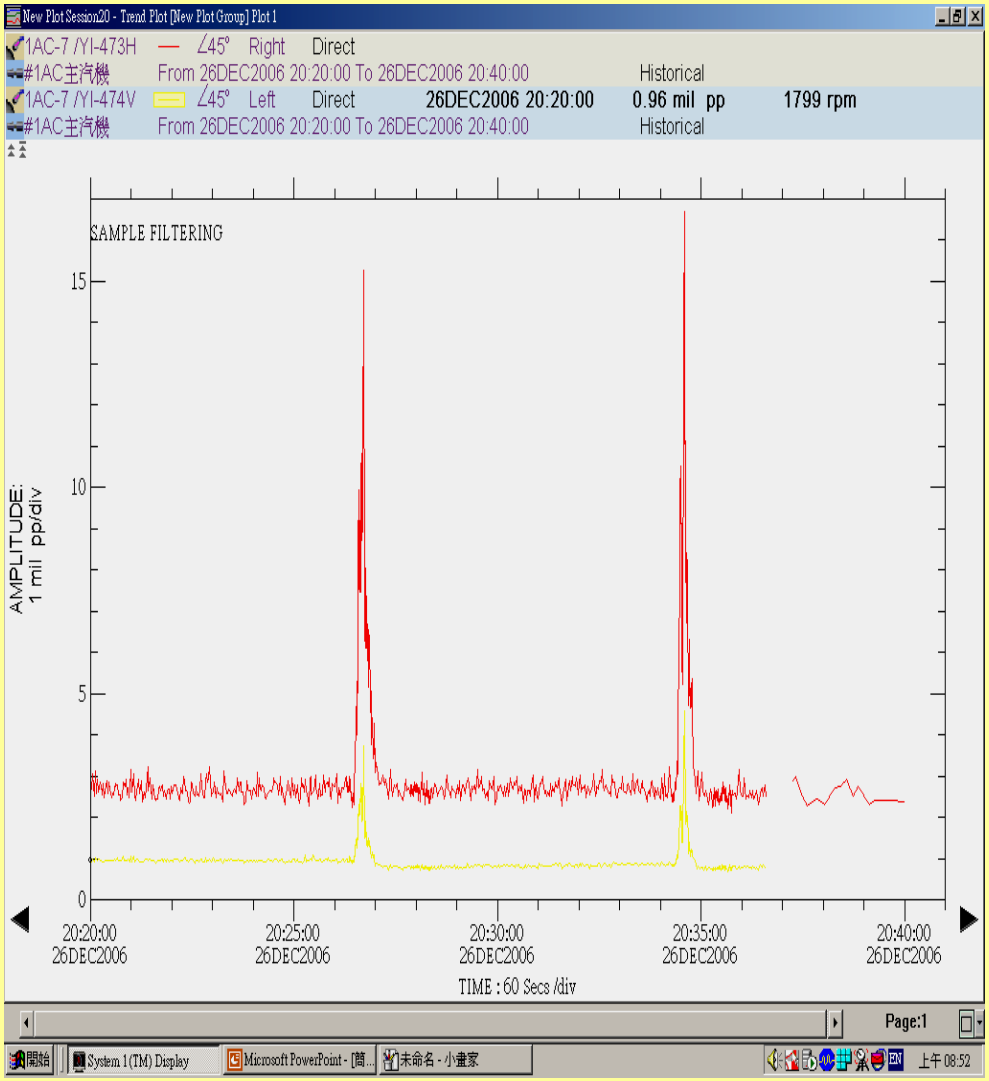


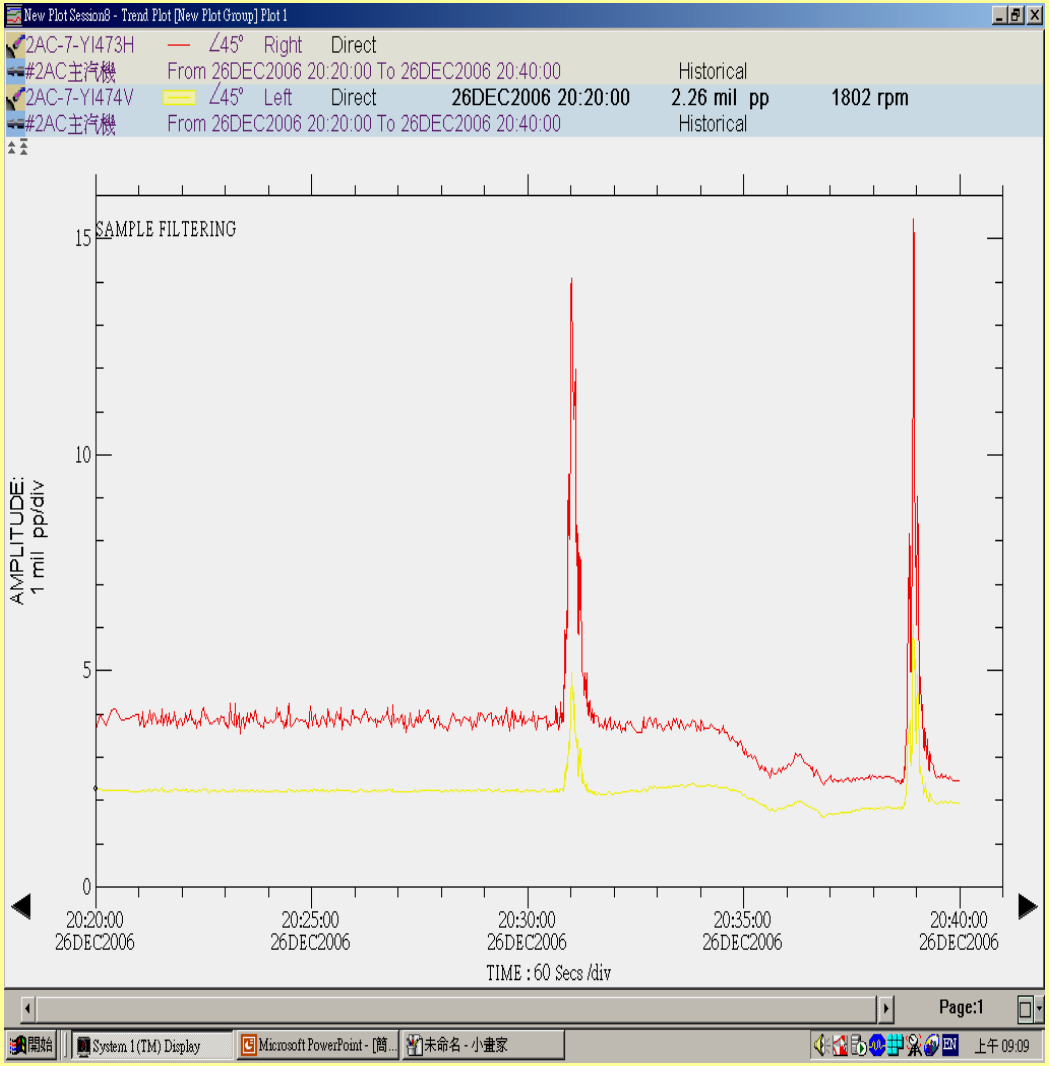
Unit 1 RCP B Motor



Unit 2 RCP B Motor

Main turbine historical vibration graph



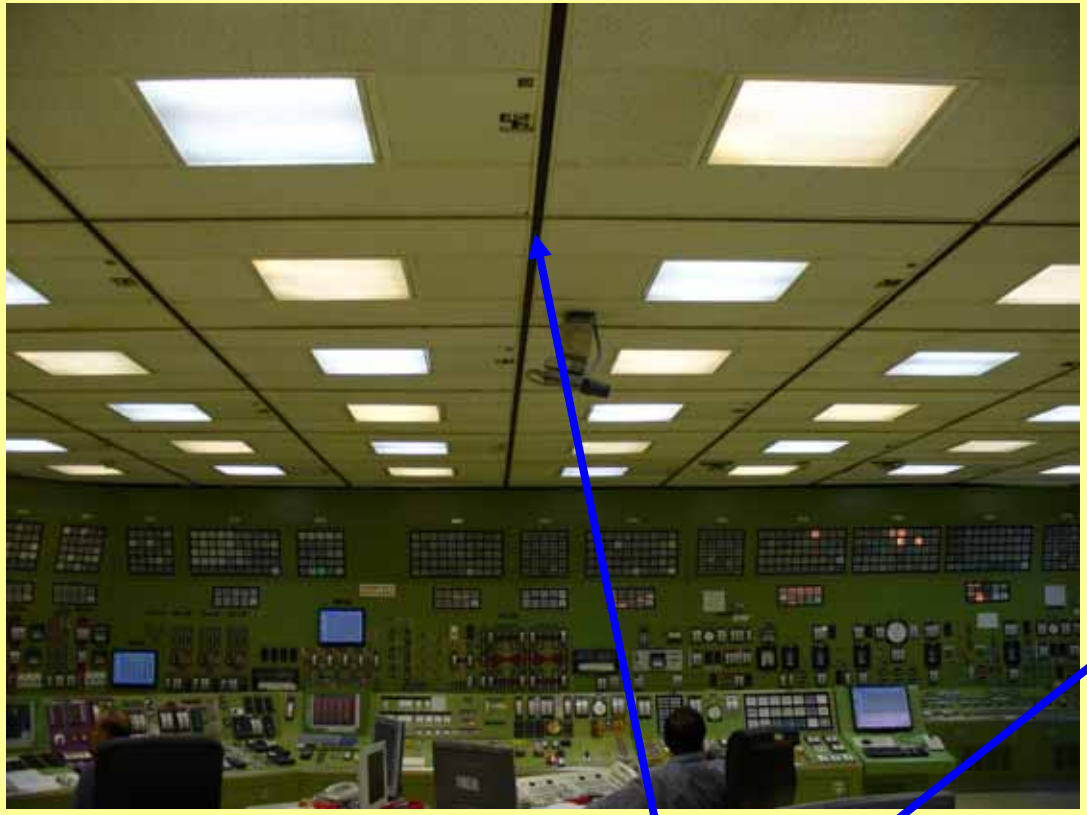


#1 turbine 7th bearing

#2 turbine 7th bearing

The status of two MNPS units after the earthquake(continued)

- After the earthquake, plant staffs followed the procedure 582.1 “checklist of significant equipment after shutdown due to strong earthquake” to examine the integrity of SSCs of both units（ except inaccessible areas of unit #1）.
- The result showed that there is no major damage on all SSCs of two units .Minor damages are as following items:
  1. some RCP C/T cable ducts connection are loose(unit #2)
  2. some water and oil spilt from Spent fuel pool and EDG fuel oil storage tank.
- Lots of dust accumulated inside ventilation pipe floated down from top ceiling of main control room during & after the earthquake.



Ventilation outlet

LESSONS LEARNED

- Re-review & standardize the procedures dealing with earthquake for all operating NPPs.
- Routine inspection records and digital images of major SSCs are essential information for checking activities after earthquake . it is important to gather & update those information during routine inspection tours by plant staffs periodically.
- Organize a plan to clean the dust accumulated inside ventilation pipe of main control room periodically.
- Study the possibility to incoroperate a seismic shaking table experience course into the operator on-job training .
- Study the ways (radiation level, humidity, temperature ,etc.) to monitor the status of inaccessible areas after earthquakes.