Installation of Automatic Seismic Trip System in Existing NPPs

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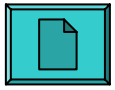
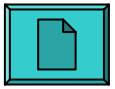
Contents

- Background
- Approach
- ASTS design logic
- Major elements in the ASTS
- ASTS installation
- Major dedication process
- Conclusion

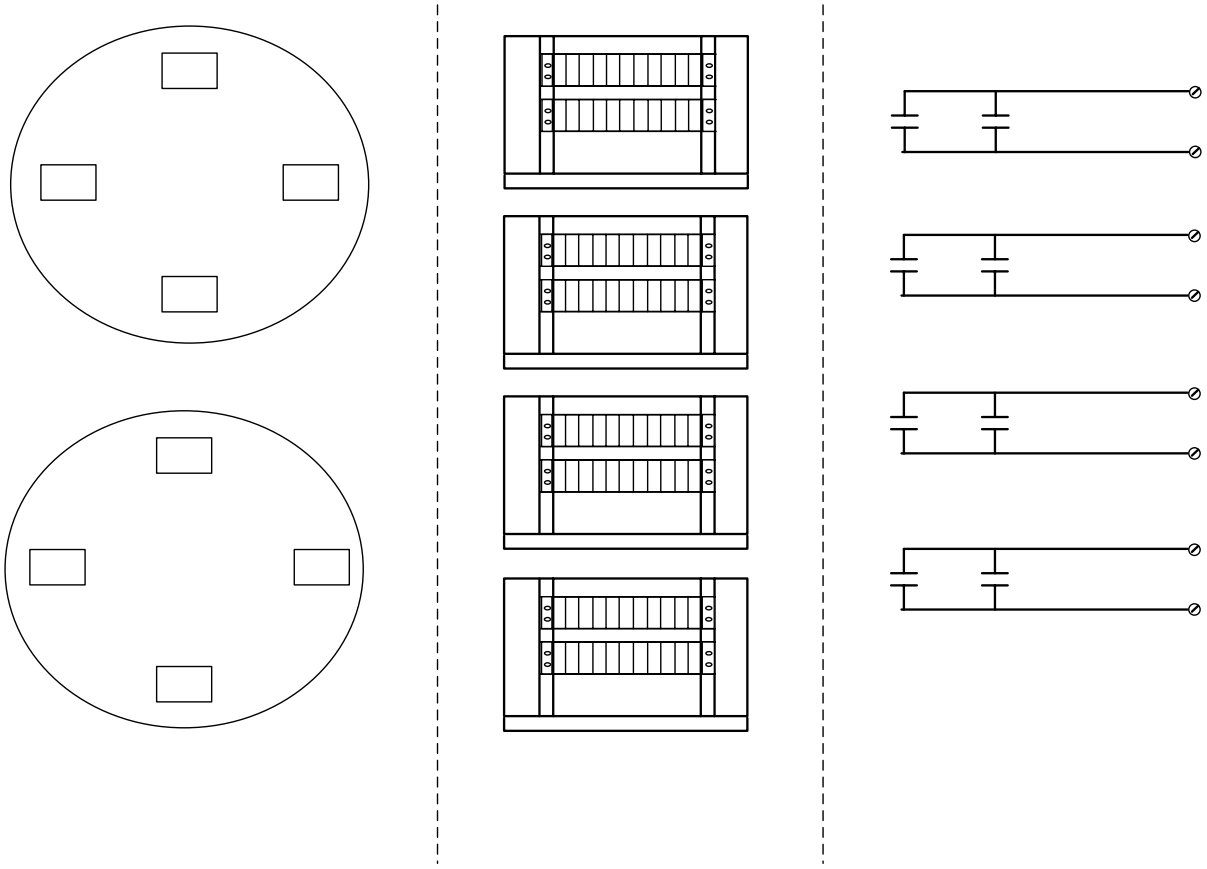
Background

- Taiwan island is located at a complex juncture between the Eurasian plate and Philippine sea plate 
- It was the disastrous Ji-Ji earthquake(M=7.3) occurred on September 21, 2000 triggered TAEC to suggest TPC to install the ASTS in its 6 existing nuclear units to further ensure the safety. 
- ASTS is mandatory in Japan, but not in US..

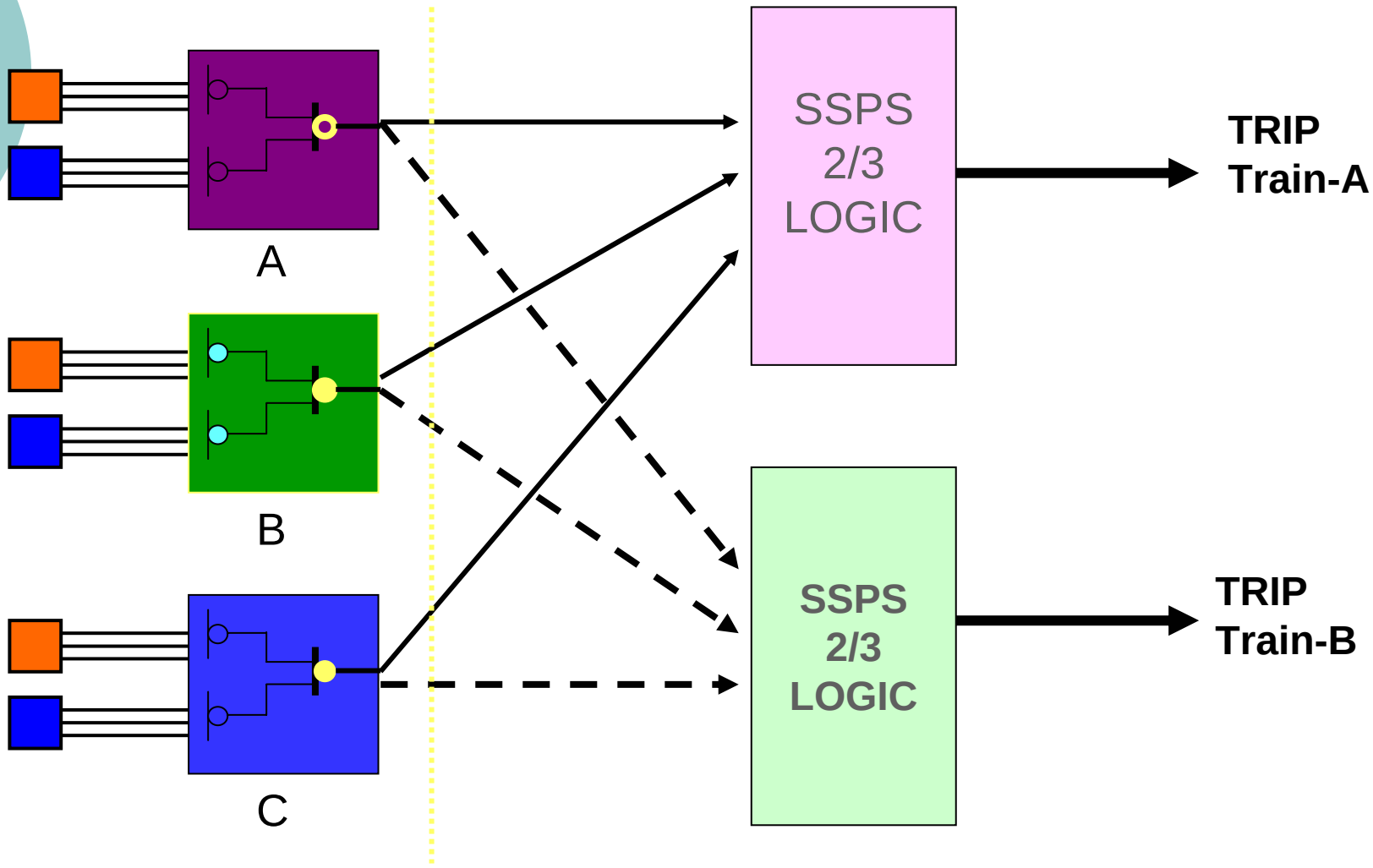
Approach

- Technical requirements in the purchase specification was prepared by the TPC and approved by the TAEC.
- Foxboro/Invensys design/product plus INER dedication process.
- Use plant's RPS trip logic

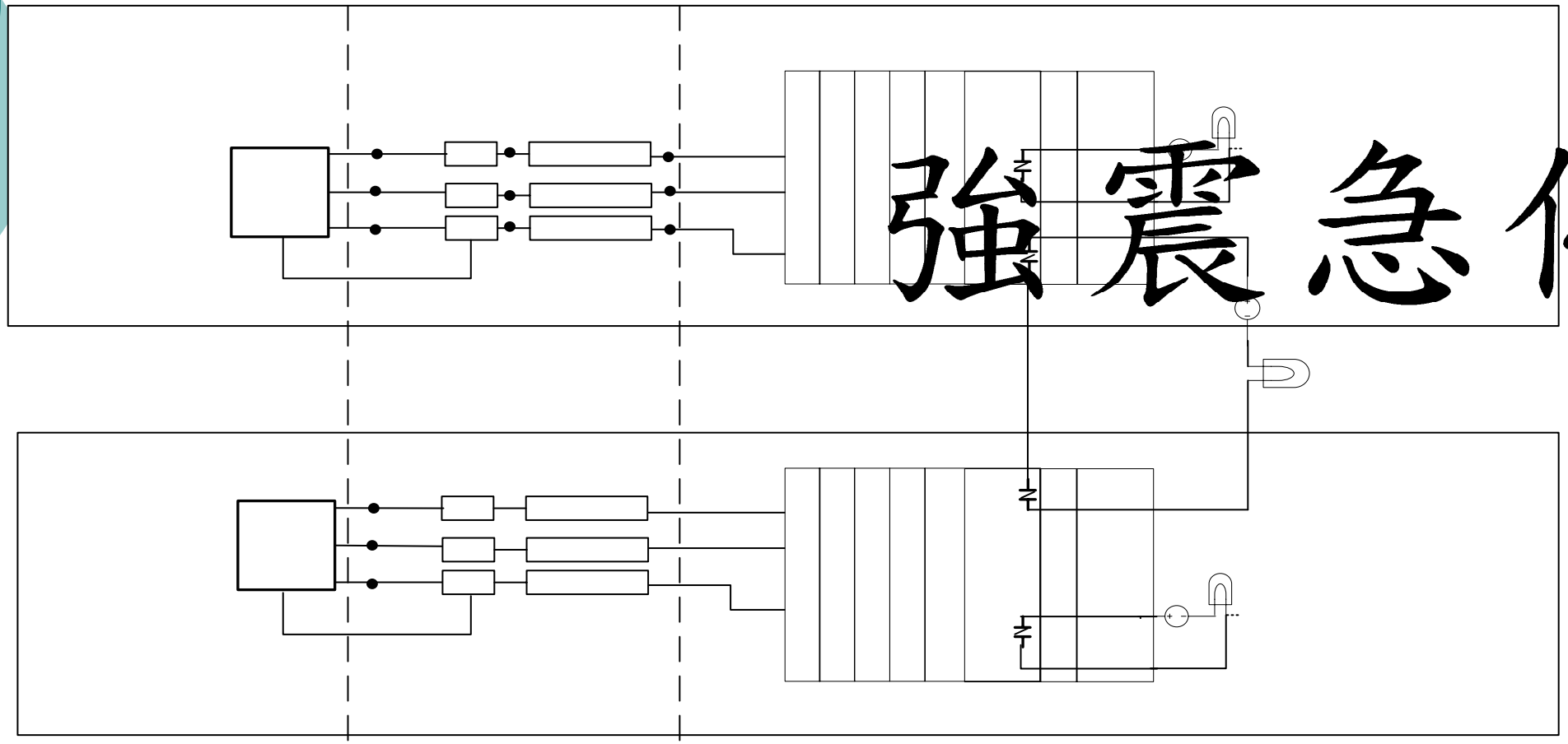
Trip wiring for TPC NPP1,2 (OR logic)



Trip wiring for TPC NPP3 (OR logic)



ASTS design logic



Seismic sensor

Major elements in the ASTS

- There are three sub-units in the ASTS:

  --Earthquake sensors:

  Kinemetrices FBA23 triaxial accelerometers.

  --Data process:

  BPF(up to10hz), B/U converter , V/A converter

  These two sub units are installed in one water-proof rigid box (sensor box)

  -- Trip control module:

  Foxboro spec200 module(with some modification), and two spec200 are installed in one 19” control cabinet

ASTS installation

- Install seismic sensors (FBA23) on both basemat floor and operating floor in major (reactor/auxiliary) building for BWR/PWR.
- The number of seismic sensors on each floor depends on plant's RPS trip logic, i.E.,4/floor for BWR and 3/floor for PWR. Total 44 sensors installed in 6 operationg units.
- One control cabinet responsible for two sensor boxes. Total 22 control cabinets installed in back panel rooms in control buildings.

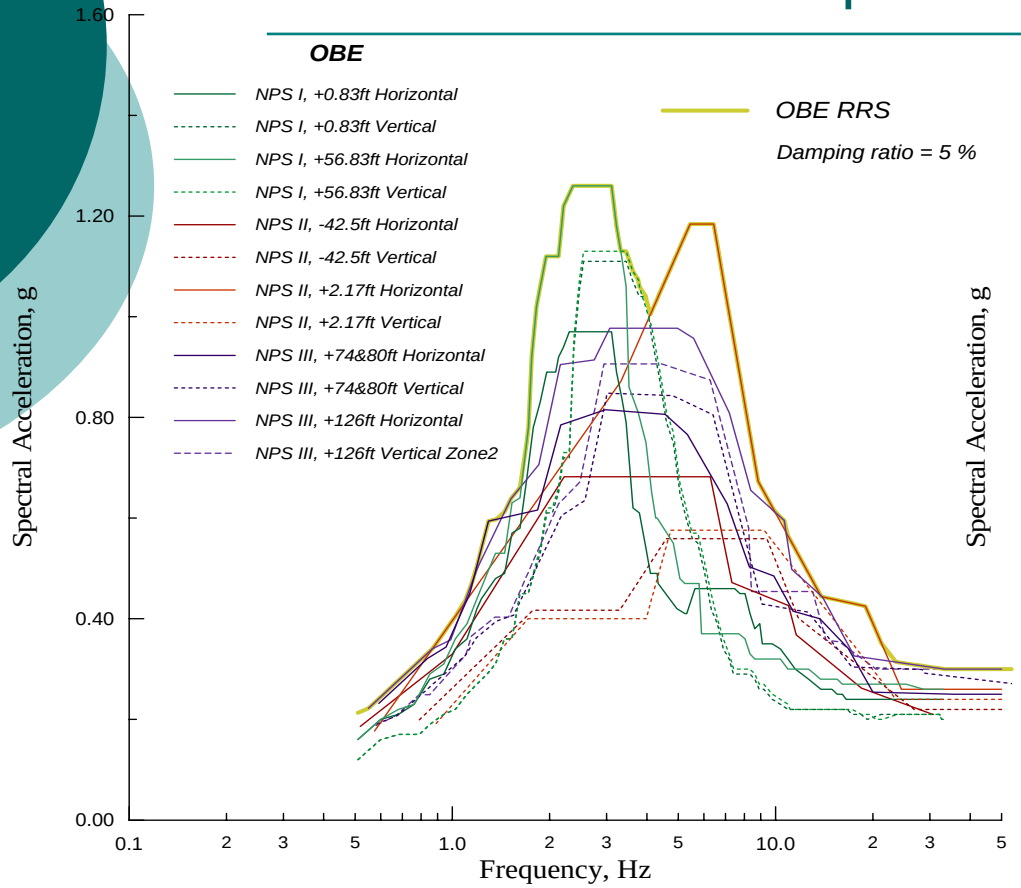
Major dedication process

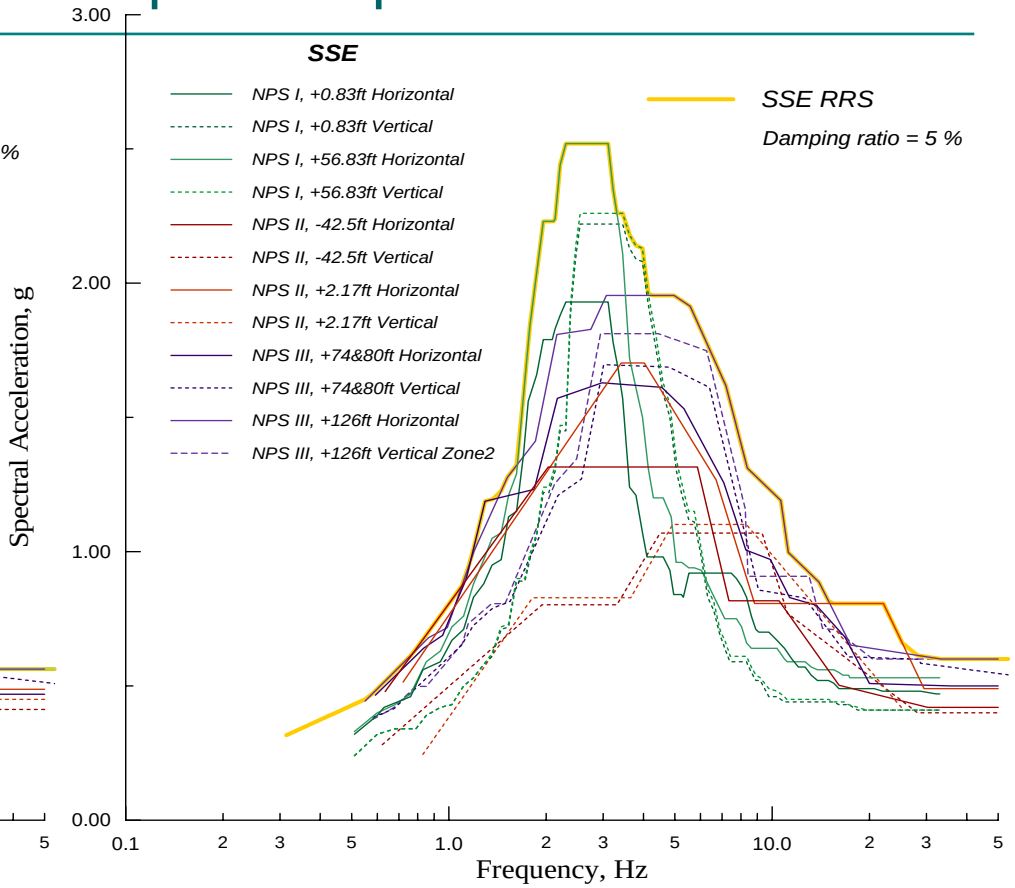
- NEMA4 water proof test
- Anti-radiation test: 8.76x100 rads over 40 years
- EMI/EMC test: follow RG 1.180 requirement

Major dedication process

- Seismic test: use plant specific required response spectrum, TRS envelop RRS
- Seismic auto-trip accuracy test: must not trip when filtered PA below set point minus 0.05g, and must trip when filtered PA exceeds set point over 0.05g.
- Trip signals occurred within 10 second interval are considered as same events

OBE/SSE required response spectrum





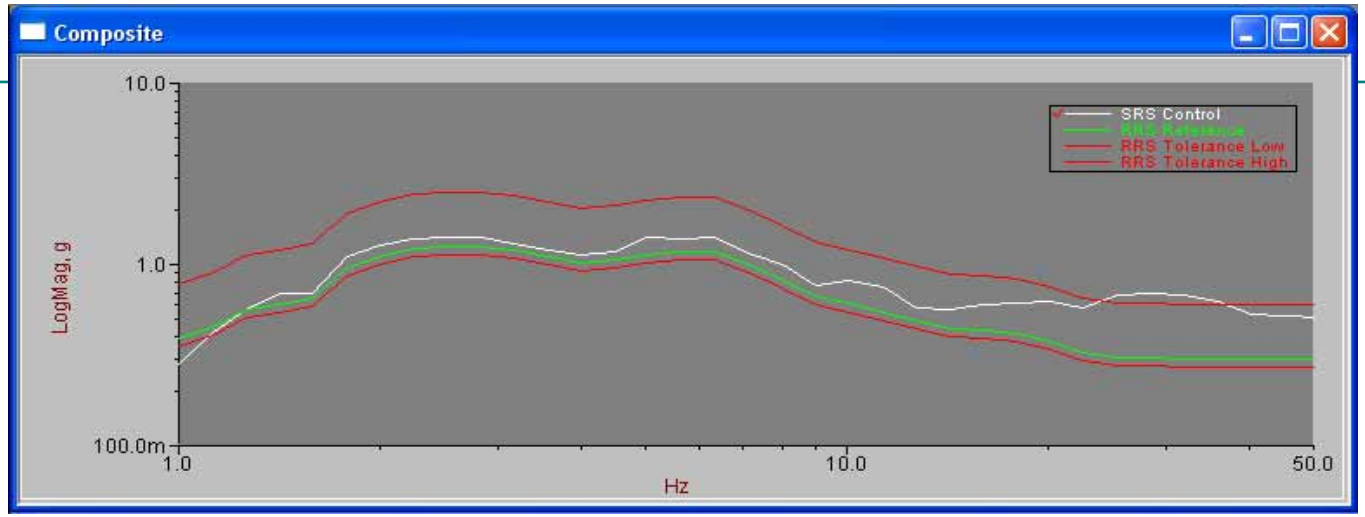
OBE RRS (envelope all floor RS)

SSE RRS(envelope all floor RS)

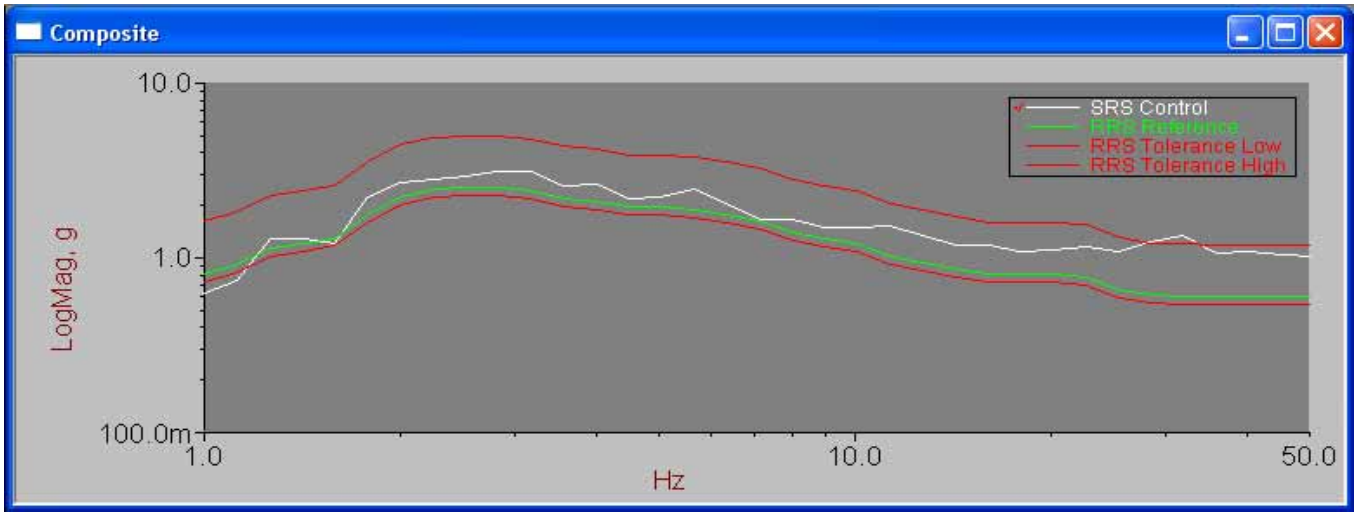
Sensor Box Seismic Test

Controller Rack Seismic Test

TRS envelopes RRS



Example of OBE TRS vs RRS



Example of SSE TRS vs RRS

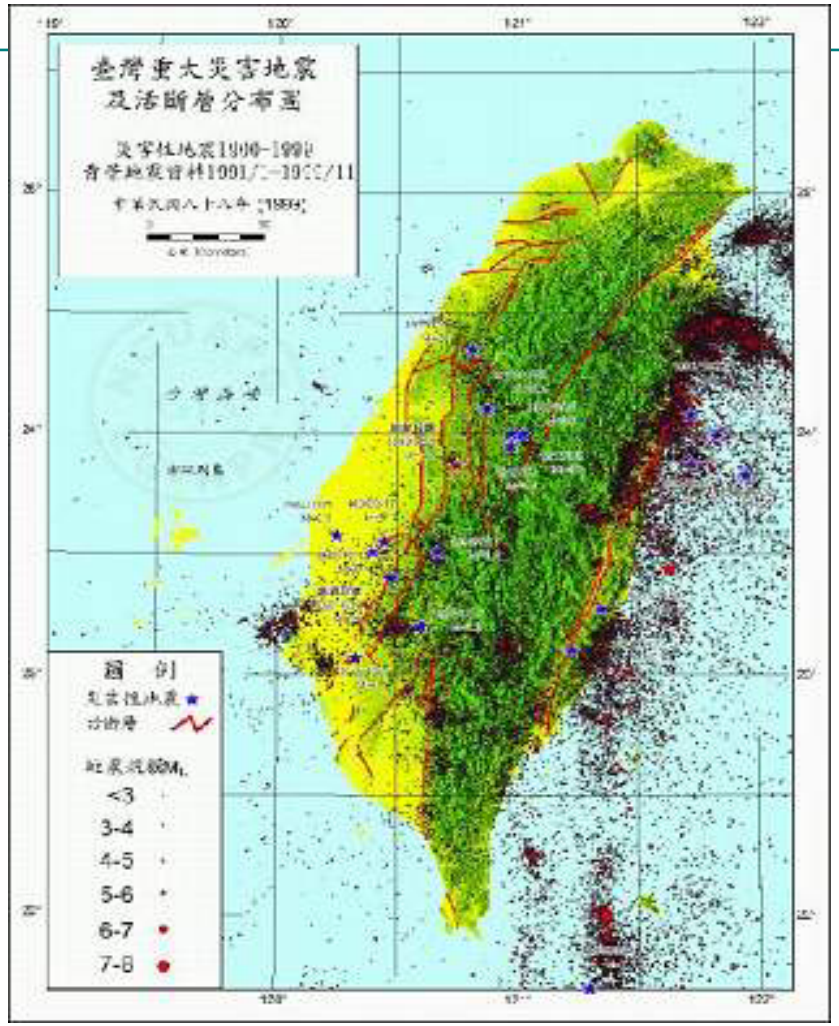
Trip Setting Accuracy Test

Conclusion

- This total 2,500,000.-USD project finished in 1 year.
- The important features of the ASTS include: Foxboro spec200 analog system(10 seconds timer card, 20ms trespassing time needed for relay to seal-in), low pass filter, and use pa(low-pass filtered) for auto trip parameter.
- Independent dedication process performed by INER

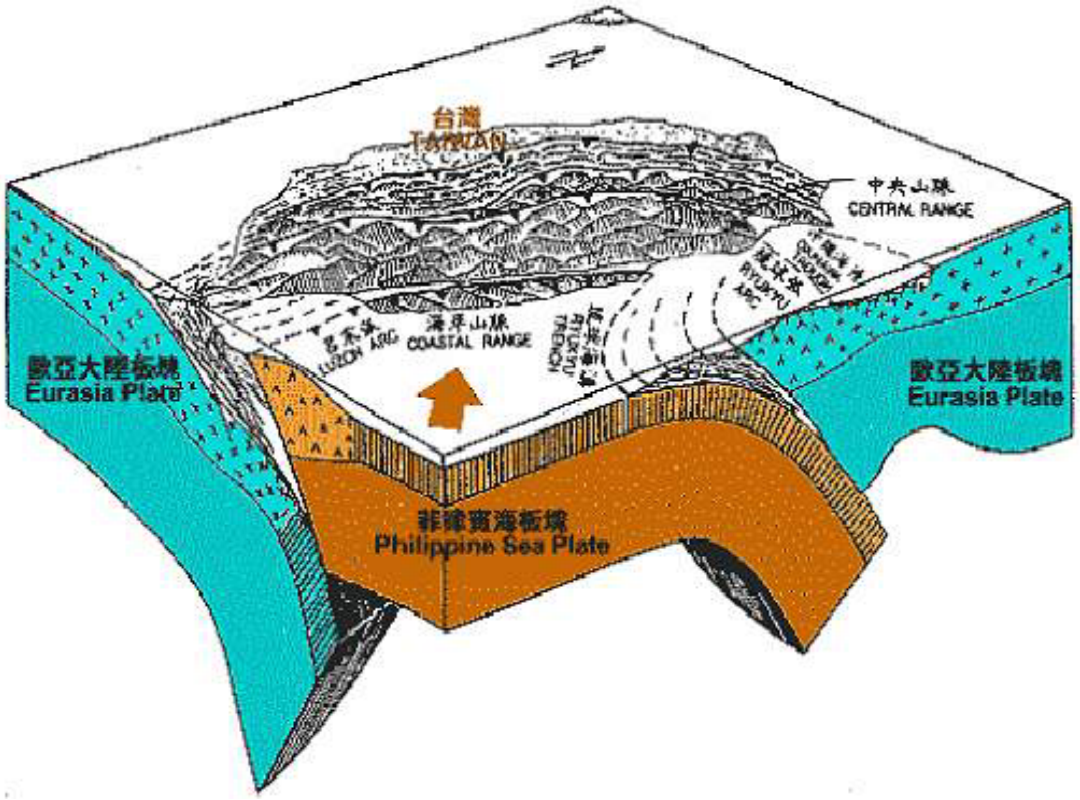
Historical Earthquakes

This map showed all felt earthquakes and major disastrous earthquakes ever struck Taiwan since 1900. It is noted that there are five in-land earthquakes with magnitude larger than 7.0 and these are those cause high fatalities



Tectonic plates of Taiwan island

This map showed the tectonic plates of Taiwan Island (After Angelier, 1986). Basically Taiwan is on the boundary between Eurasian Continental Plate and Philippine Sea Plate. Due to the process of collision of these two plates, eastern part of Taiwan moves toward NW at a rate about 2.5~8.0 cm/year based on actual GPS measurement starting from 1993.



Sensor Box

Spec 200 controller cabinet

Sensor box and ASTS control cabinet