Activity：Quality Inspection of Digital I&C Vendor

Place：GE and DRS (USA)

Place: Job Site of Lungmen NPS

Activity：RPV Internals & RIP Installation

The unusual events during construction

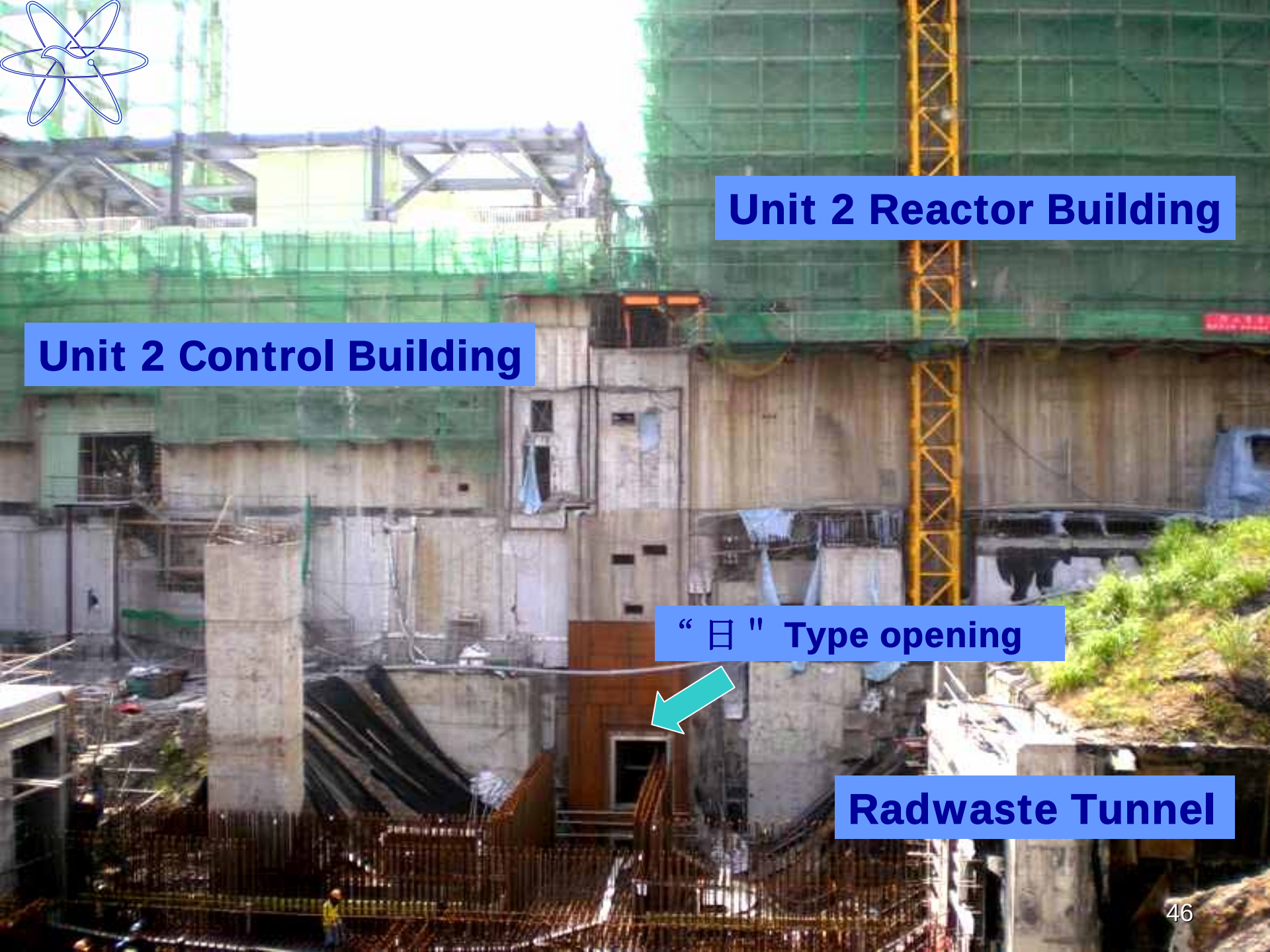
- #2 RB Flooding during Typhoon SINLAKU
- Rerouting of cables below raised floors
- Spent Fuel Pool Leakage
- RBSW AV Problems
- #1 RB Flooding during testing

#2 RB Flooding during Typhoon SINLAKU

- On Sep. 13th & 14th 2008, Typhoon SINLAKU hit the northern Taiwan with strong wind and heavy rains. It caused the flood in the Unit 2 Reactor Building Radwaste Tunnel of the LMNPP, which is still under construction.
- Some of the pumps failed to function due to offsite power outage in the evening of 13th. The flood level thus got higher and higher. （outside of RB）
- The flood overflew the sand bags and through the poorly sealed pipe （6 inches） towards the RB.

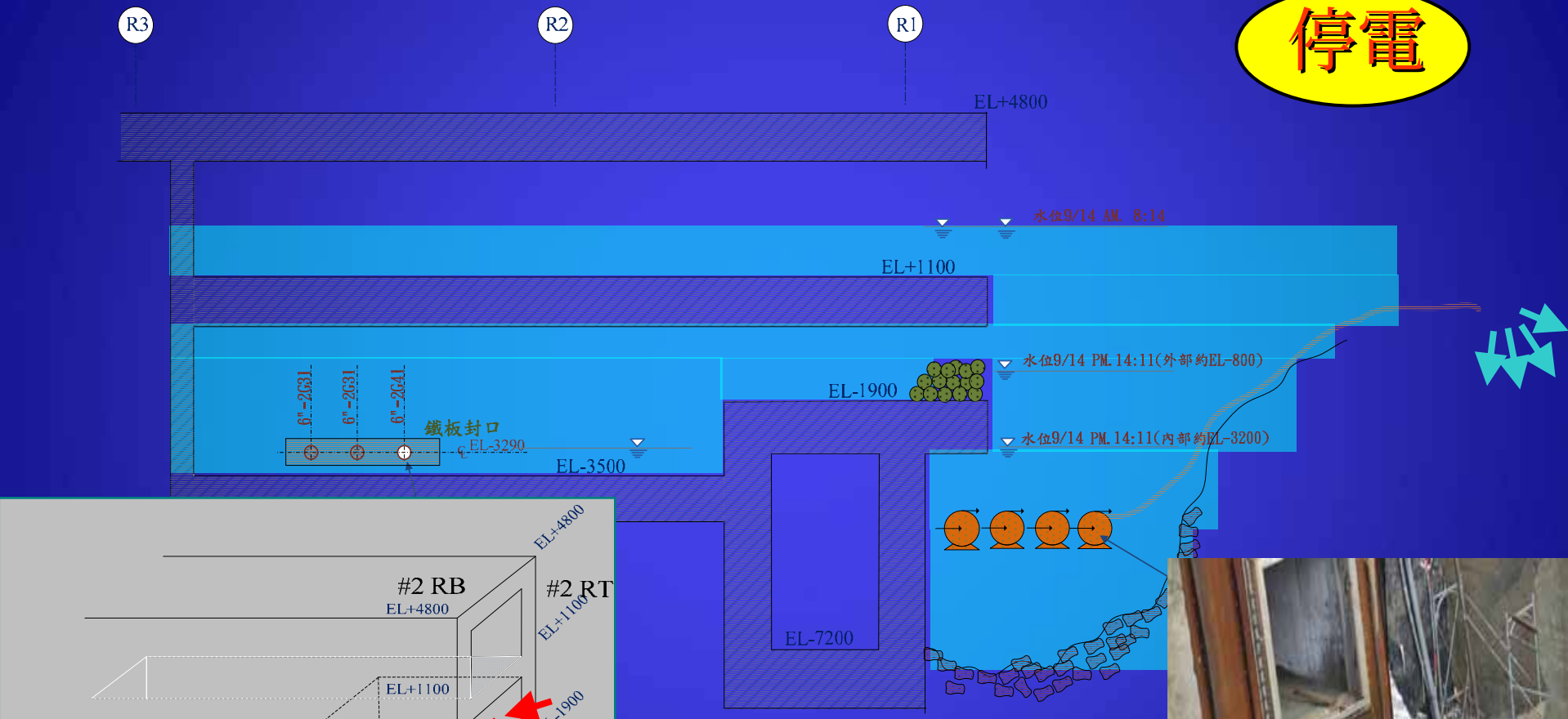
#2 RB Flooding during Typhoon SINLAKU

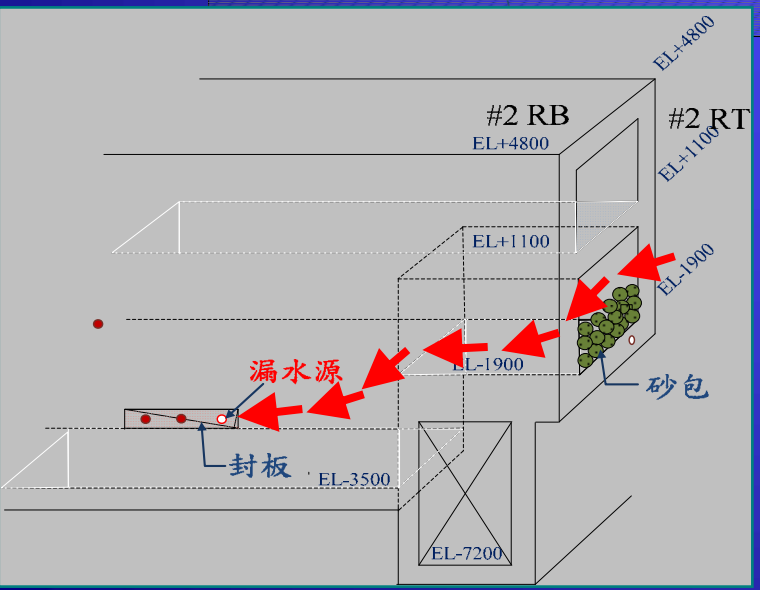
- The water flew through the hole into the RB, and flooded the pumps（not submersible pump） equipped at the basement （EL. -8200）. These 8 sets of non-submersible pump failed to function.
- The flood level eventually reached about 2 meters. （inside of RB）

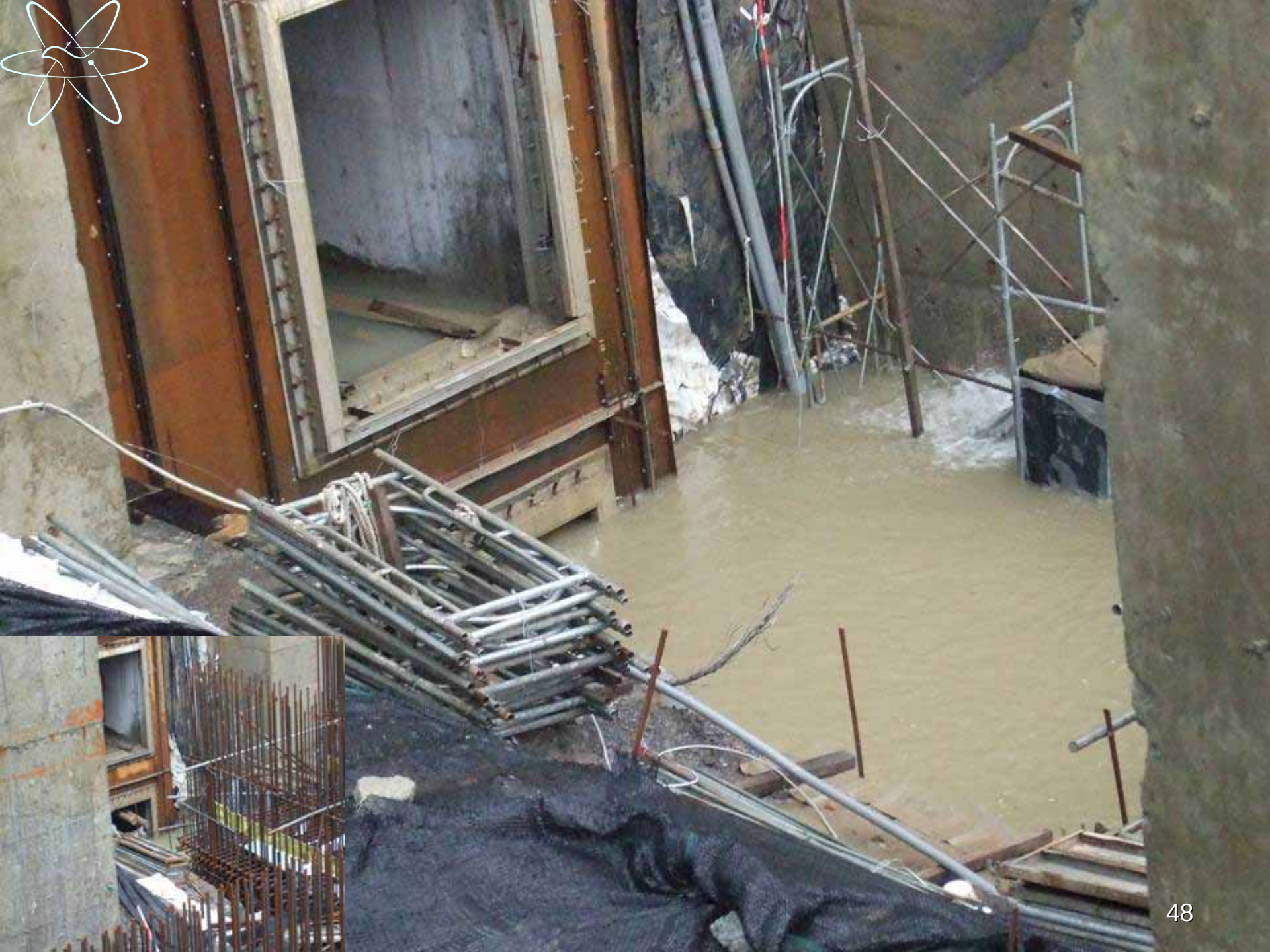

Unit 2 Reactor Building
Unit 2 Control Building
“日” Type opening
Radwaste Tunnel

Typhoon SINLAKU Flooding Path

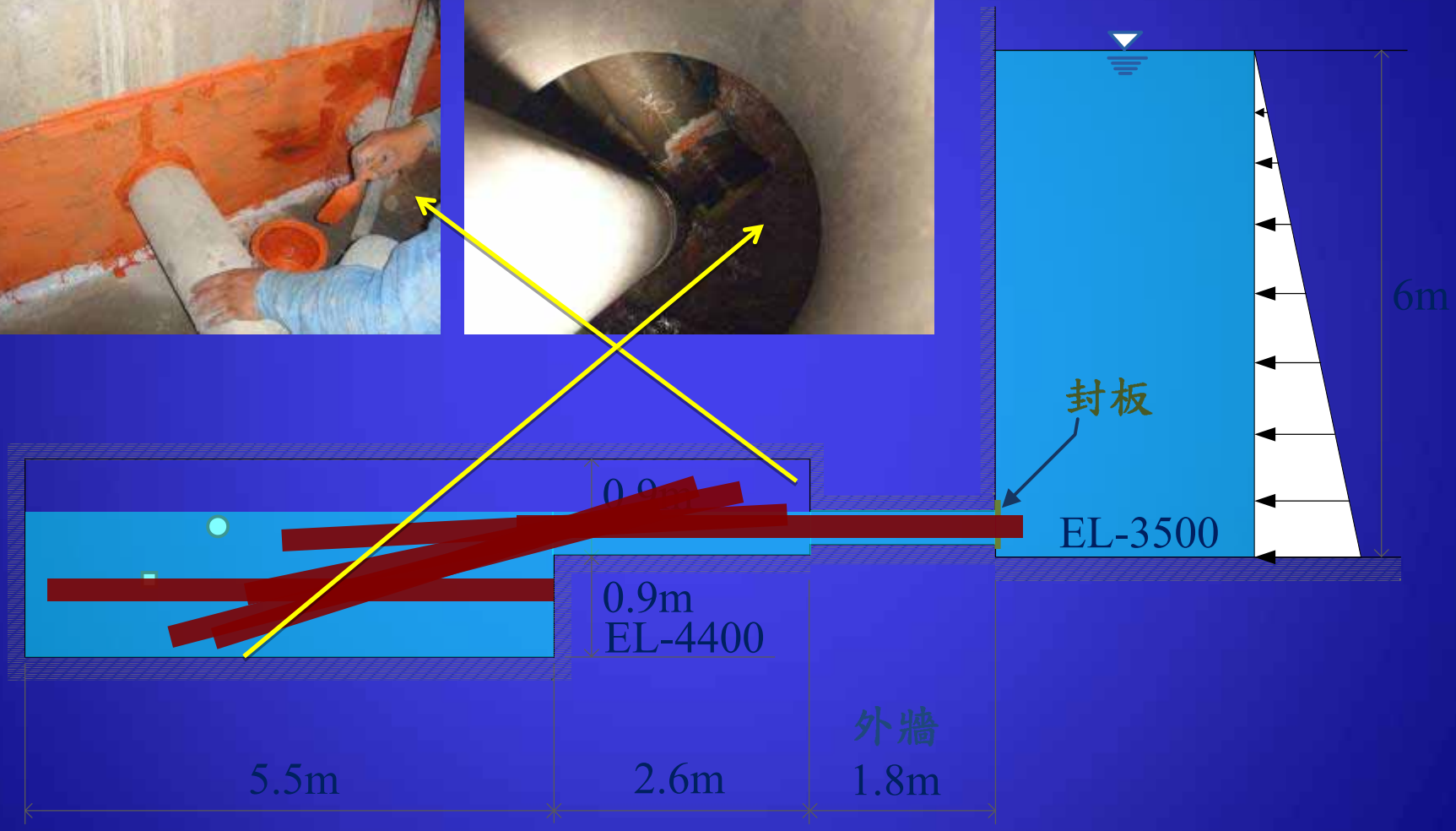
停電







RB Room 149 Flooding Sketch Map



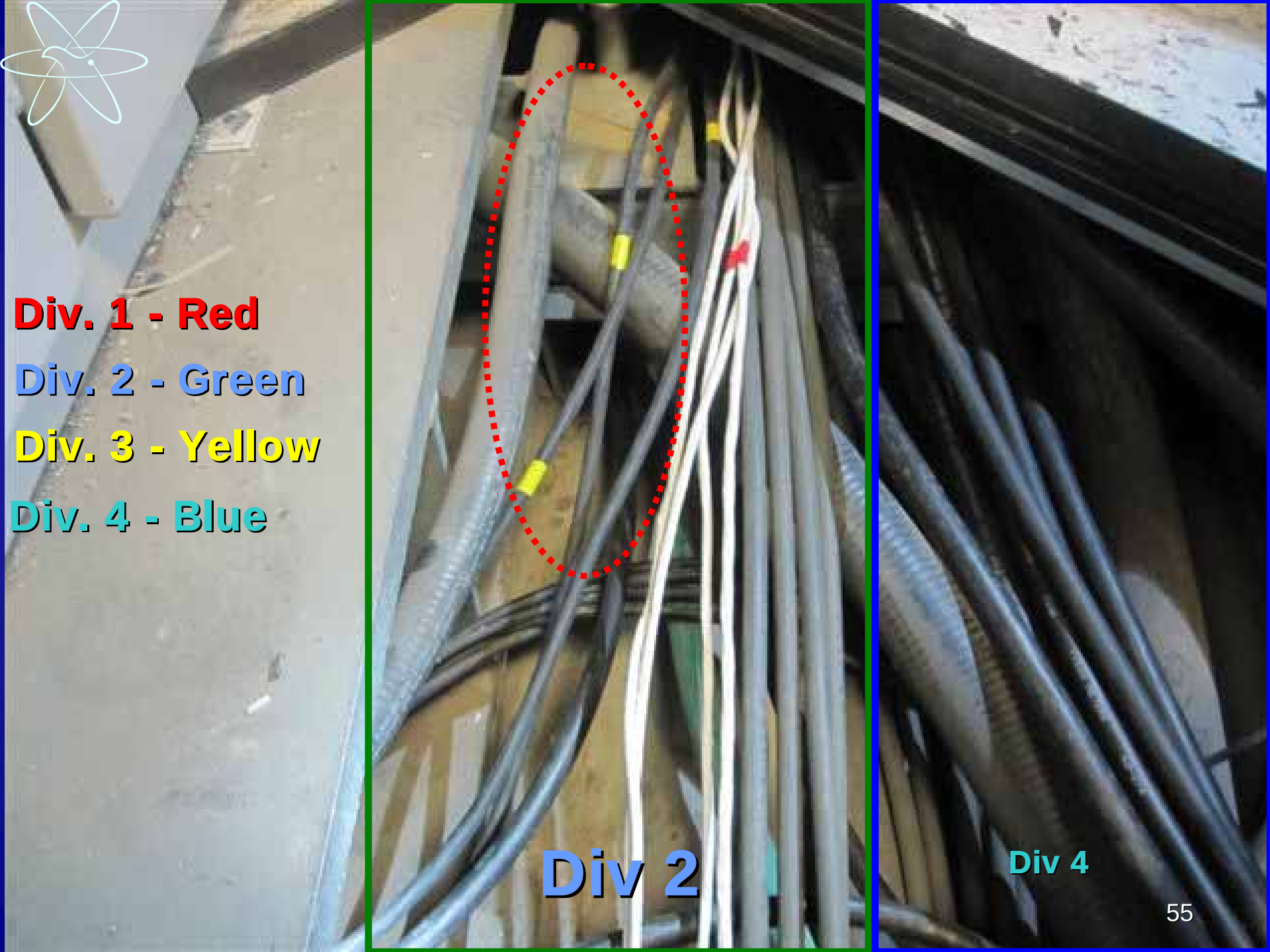

HITACHI

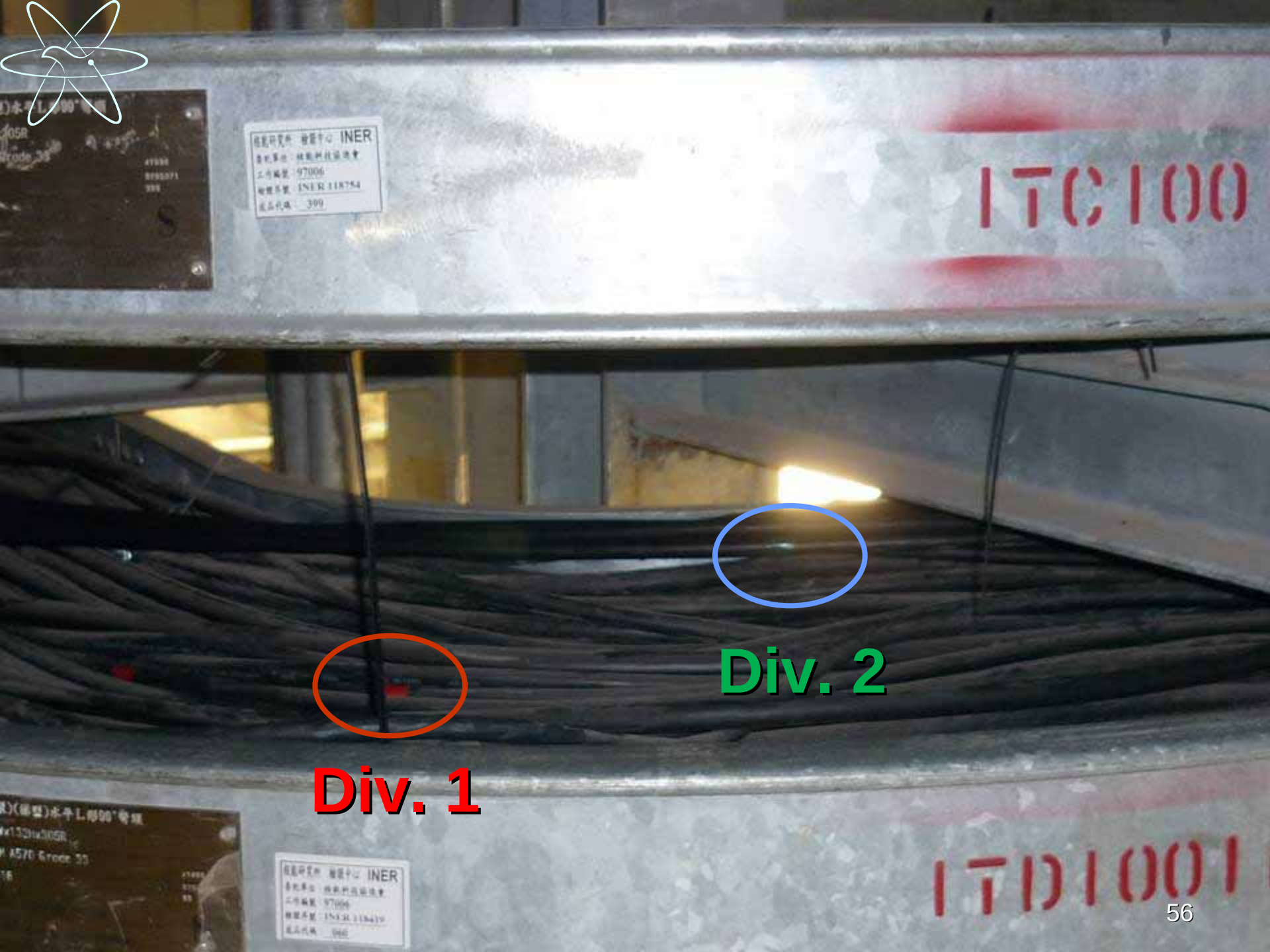
Recovery Plan

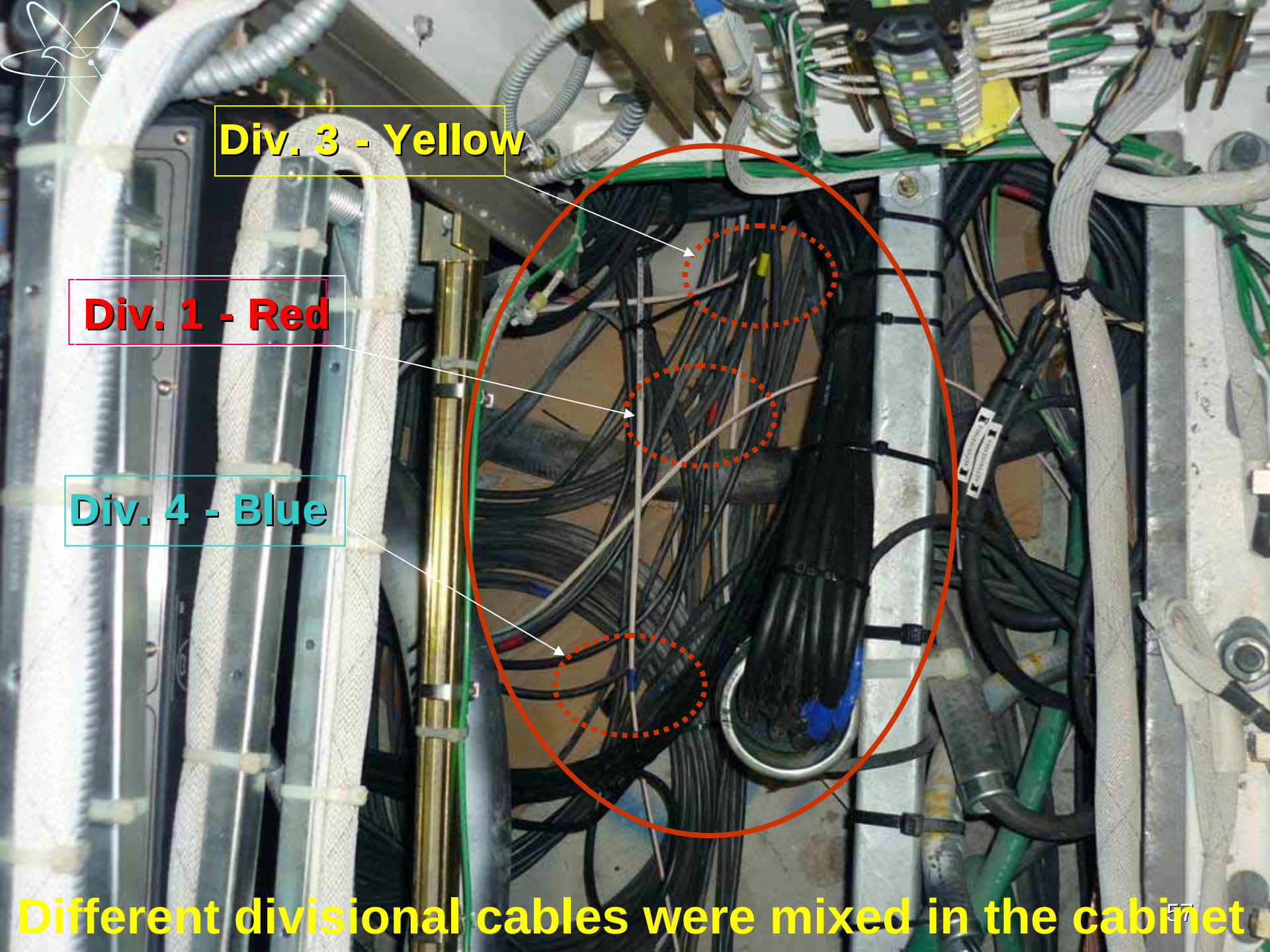
- All affected equipment have been repaired according to the recovery plan
- TPC established 「Special maintenance plan before turnover」（including Post Construction Test phase）
- TPC set up 「Special maintenance plan after turnover」（including Pre-operation test, Startup test, commercial operation phase）
- Evaluate the PCT, Pre-op, Startup test result
- Enhanced supervision for at least 2 cycles after commercial operation
- Ensure the affected equipment can perform its intended safety function not only in testing phase but also in operating phase

Rerouting of cables

- 39th Periodic Inspection conducted by AEC (June 21 ~ June 25,2010)
- Major Inspection Findings:
  - Violation of Independence and Separation criteria
  - Inadequate Cable Routing Condition


Div. 1 - Red
Div. 2 - Green
Div. 3 - Yellow
Div. 4 - Blue
Div 2
Div 4


Div. 2
Div. 1



Different divisional cables were mixed in the cabinet


Power or control cables and
instrument cables are mixed together


Field Run?
Free Run ?


Oh! My God !
What a mess
Cables cannot be installed twisted together


Insufficient bending radius

Investigations & Corrective Actions

- Investigations
  - Limited space for cable raceway.
  - Lack of cable spreading room.
  - Deficiencies in installation of field run cable
    - No separation of instrument cables from control or power cables will introduce potential EMI problems.
    - Defects in separation between different divisions of safety related cables and between safety related cables and non-safety related cables

Investigations & Corrective Actions

- **Corrective actions:**
  - **Rerouting/Rearrangement Plan taken immediately**
  - **Re-inspection of cable installation in other areas**
  - **Enhance the training and experience feedback for workers.**
  - **Modifying the procedure for inspection of cable installation.**
- **AEC requested TPC to conduct a review from various aspects including design, construction and installation, inspection, personnel training, engineering management and organizational culture, etc., and to investigate the cause for the defects, and submit feasible improvement plans and thoroughly implement them.**

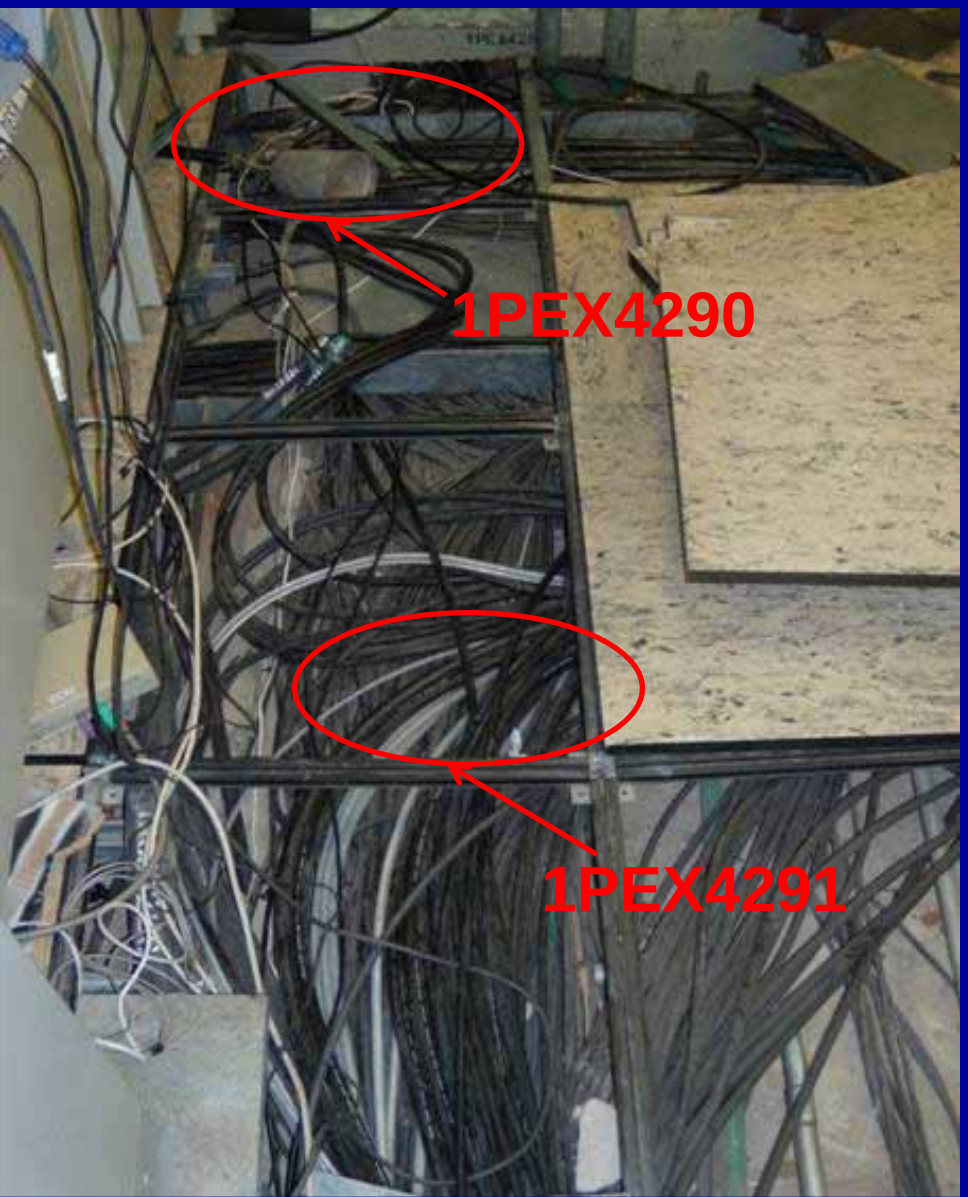
CB 12300 RM591, before

CB 12300 RM591, after

CB 12300 RM591, before

CB 12300 RM591, after

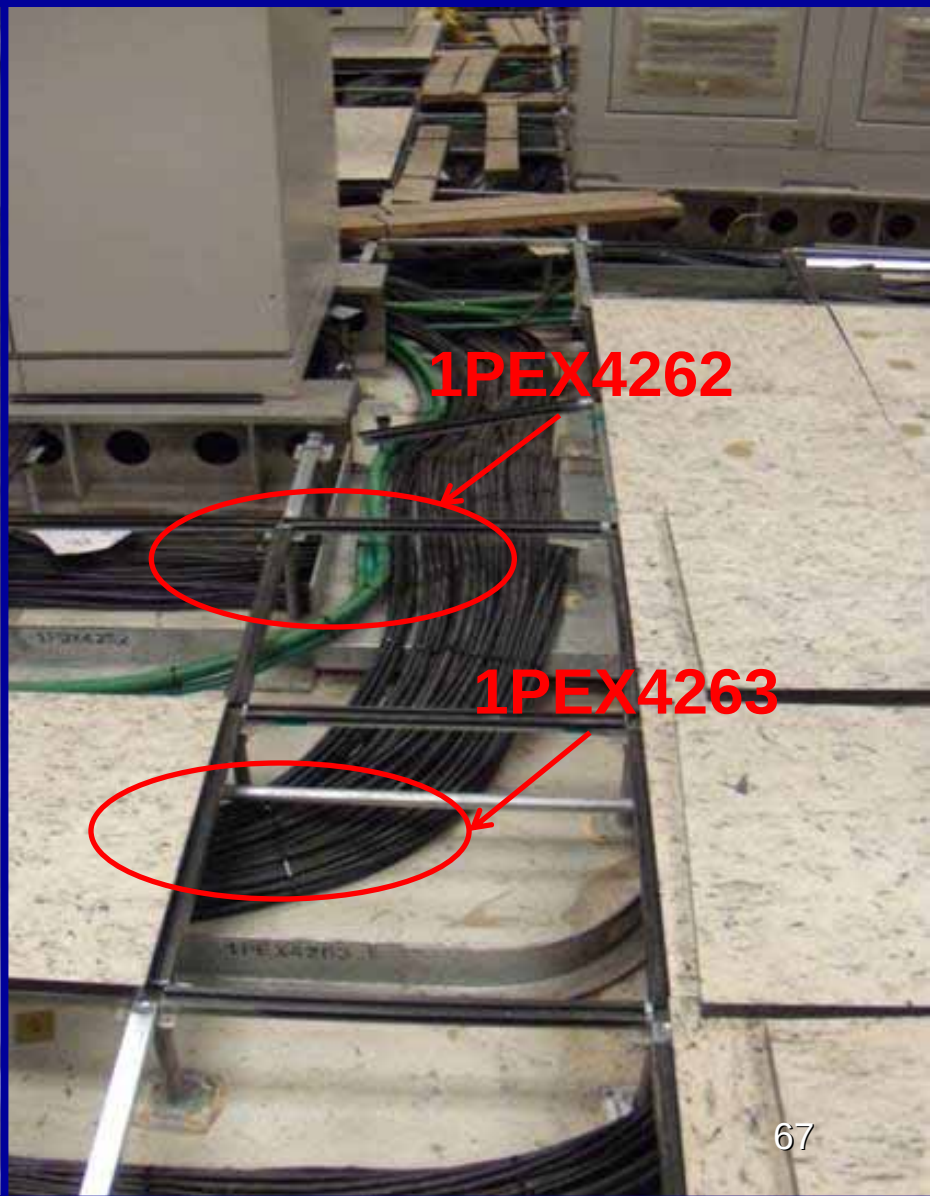
CB 12300 RM591, before



CB 12300 RM591, after

CB 12300 RM501, before

CB 12300 RM501, after



CB 12300 RM501, before

CB 12300 RM501, after

CB 7600 RM491, before

CB 7600 RM491, after

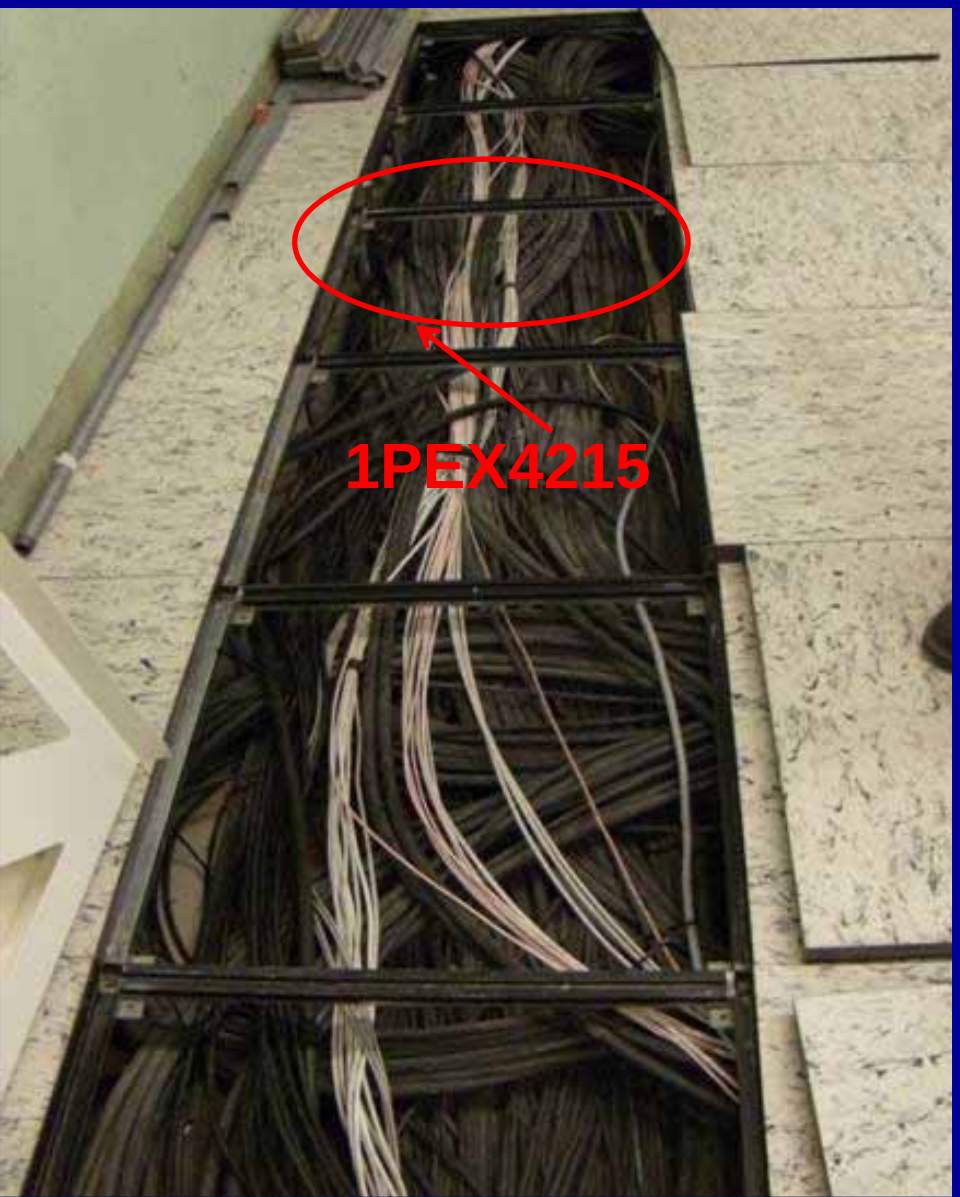
CB 7600 RM491, before

CB 7600 RM491, after

CB 7600 RM492, before

CB 7600 RM492, after

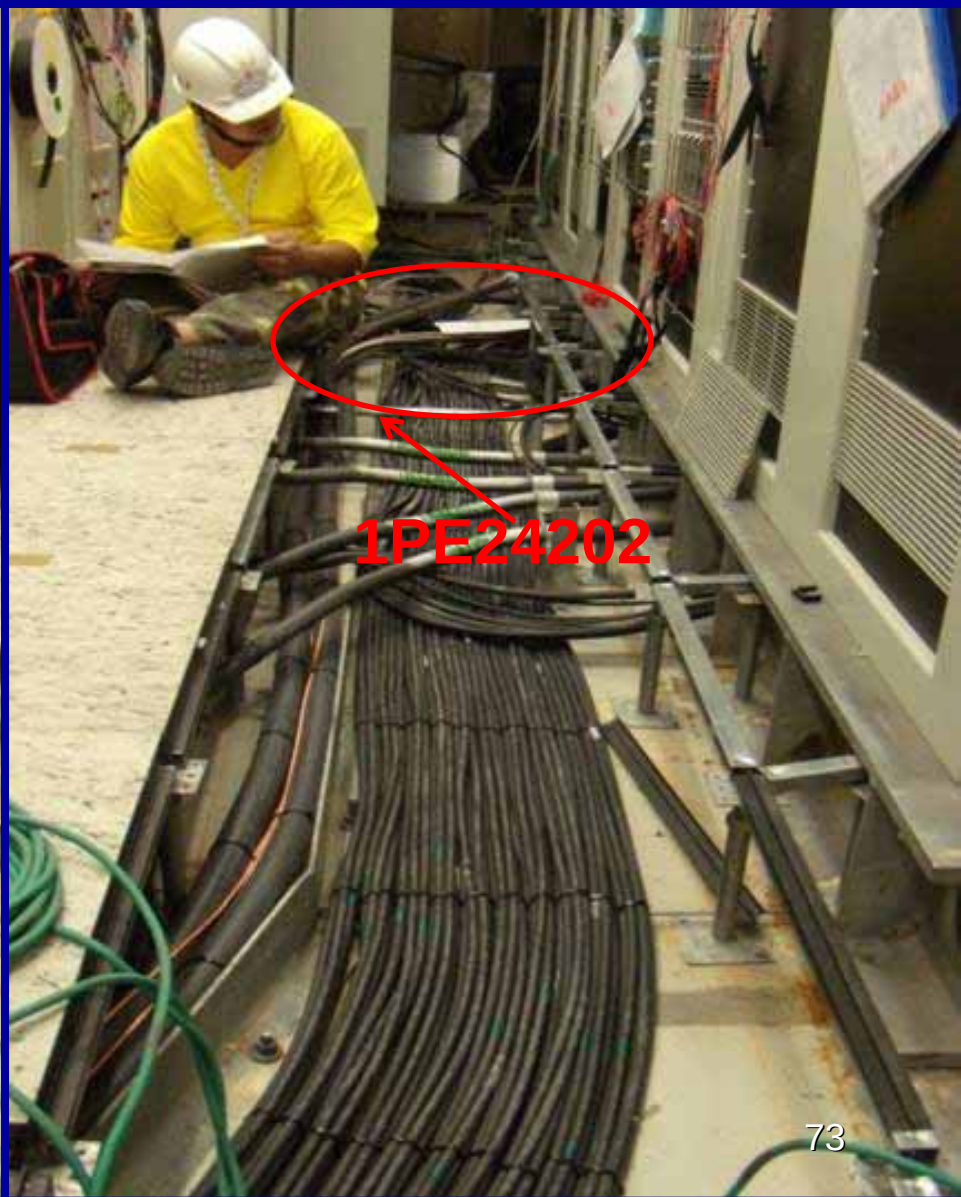
CB 7600 RM492, before



CB 7600 RM492, after

CB 7600 RM492, before

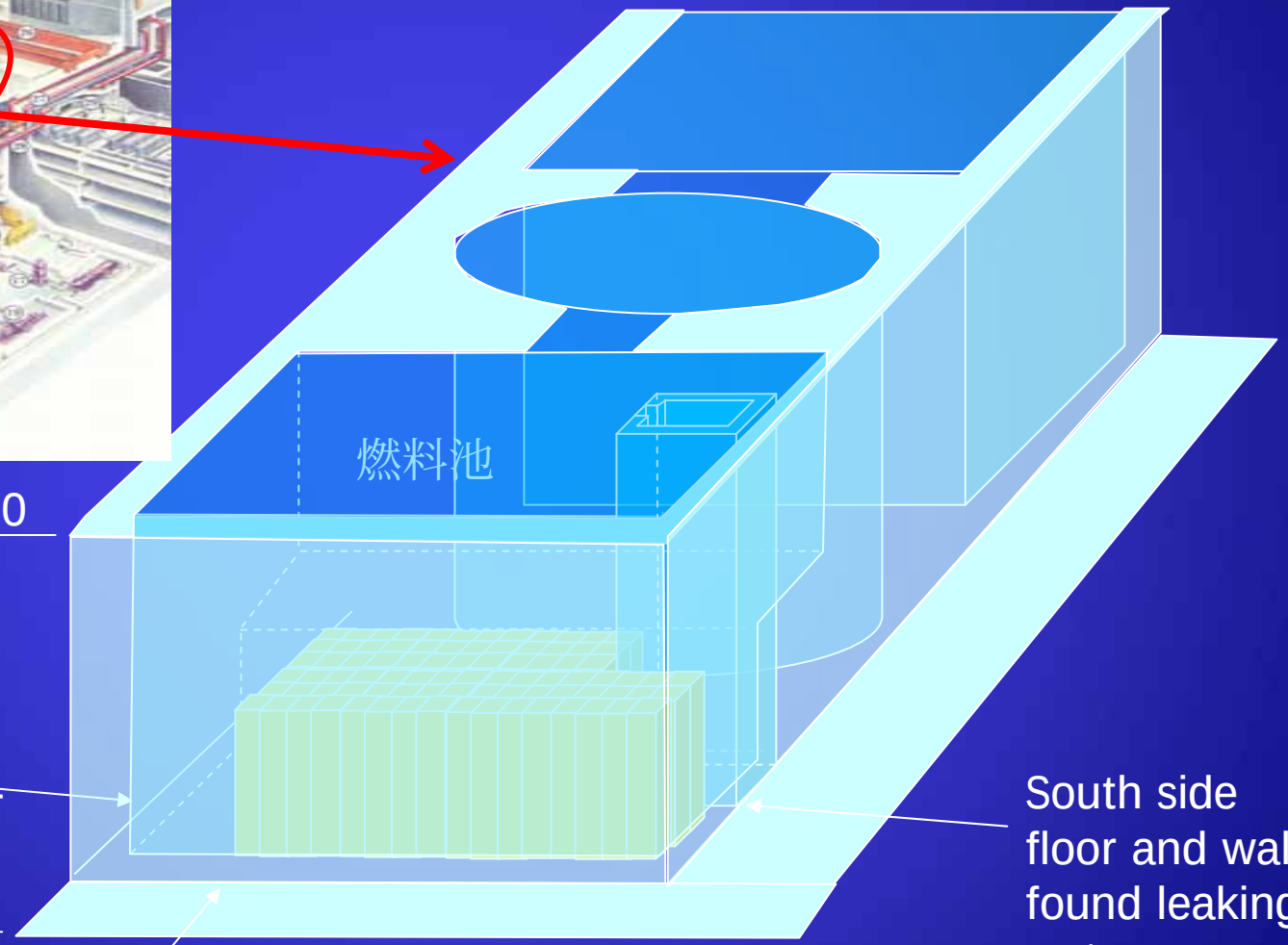
CB 7600 RM492, after



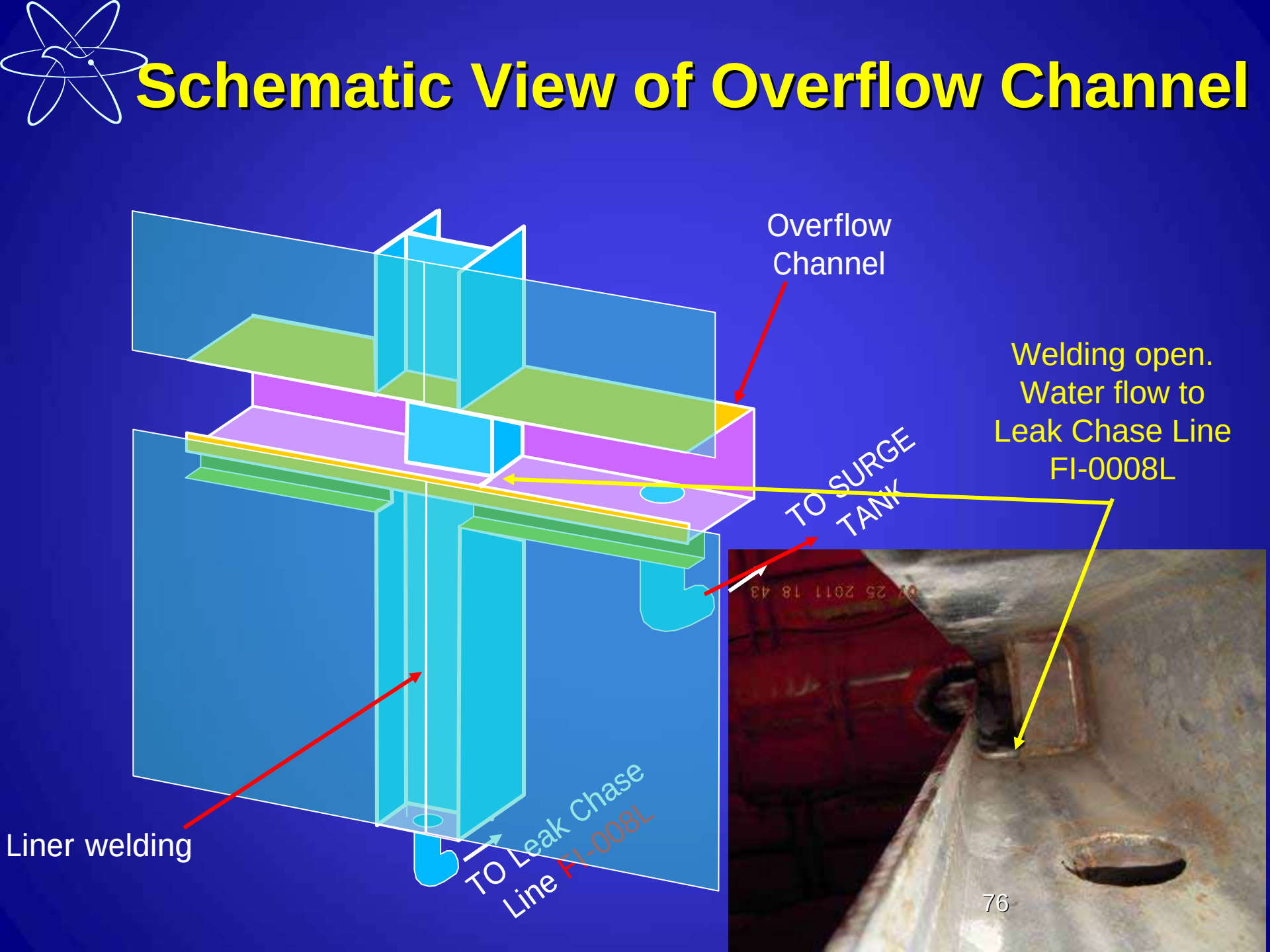
Spent Fuel Pool Leakage

- On 7/19/2011, SFP liner leakage detection piping level high alarm appeared, and suspicious water found on lower floor
- The leakage detection piping monitoring SFP bottom floor welding was full of water and the leakage rate reached 2.5 L/min
- Leaking water was found on south, north, and west side walls of SFP
- SFP weldings passed all VT, PT and VBT
- SFP passed full-water test

Spent Fuel Pool Leakage (cont.)



Schematic View of Overflow Channel



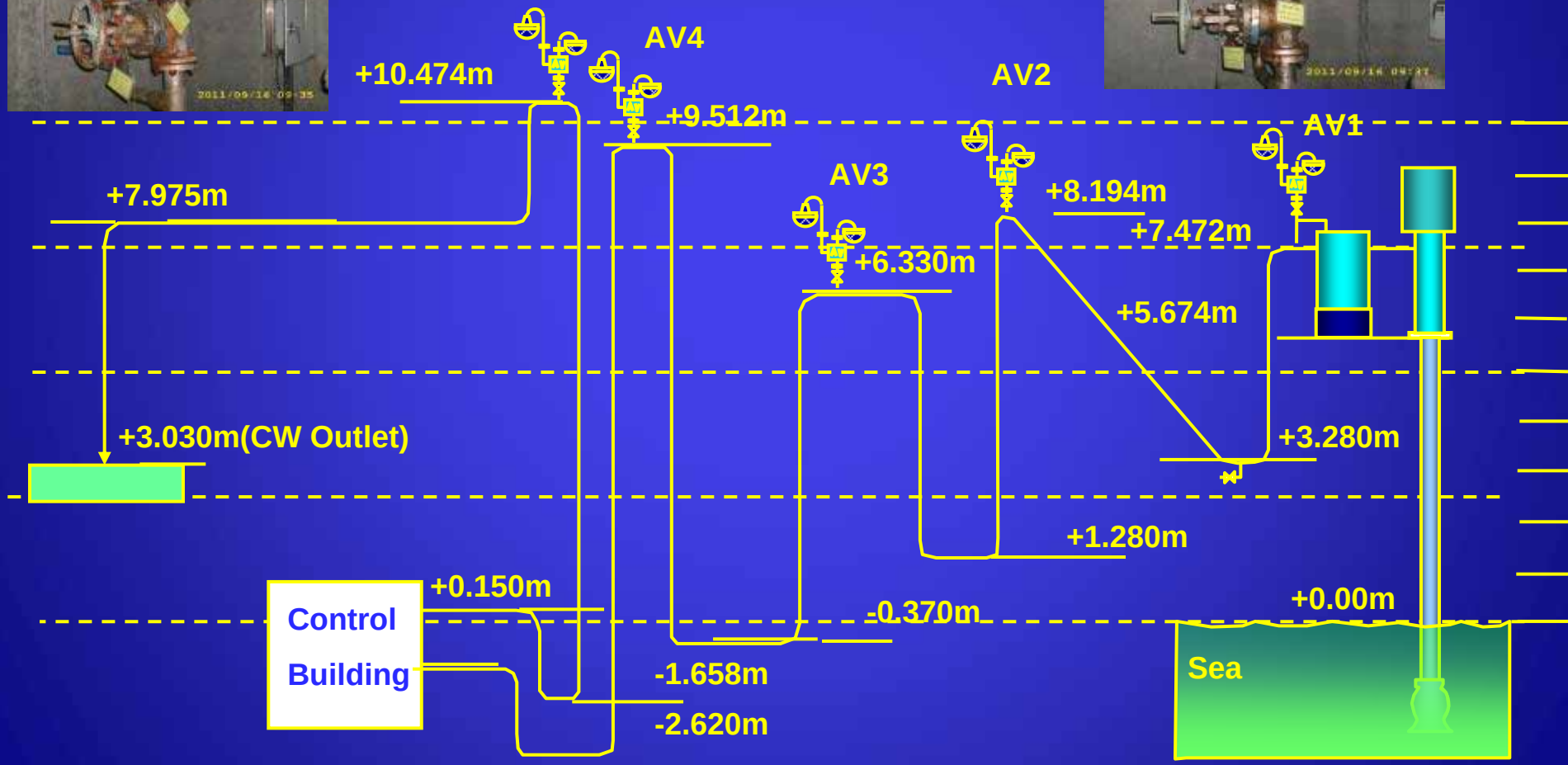
Causes & Corrective Actions

- After scrutiny into this event, some suspicious causes (SFP weld break, pipeline leakage) have been excluded.
- Finally the root cause was identified
  - The welding in SFP overflow channel was not completely done
  - That day RWCU has ever made a SFP level surge and some water flow through the welding open
- Submitted the recovery plan, then welded properly and implemented full water testing

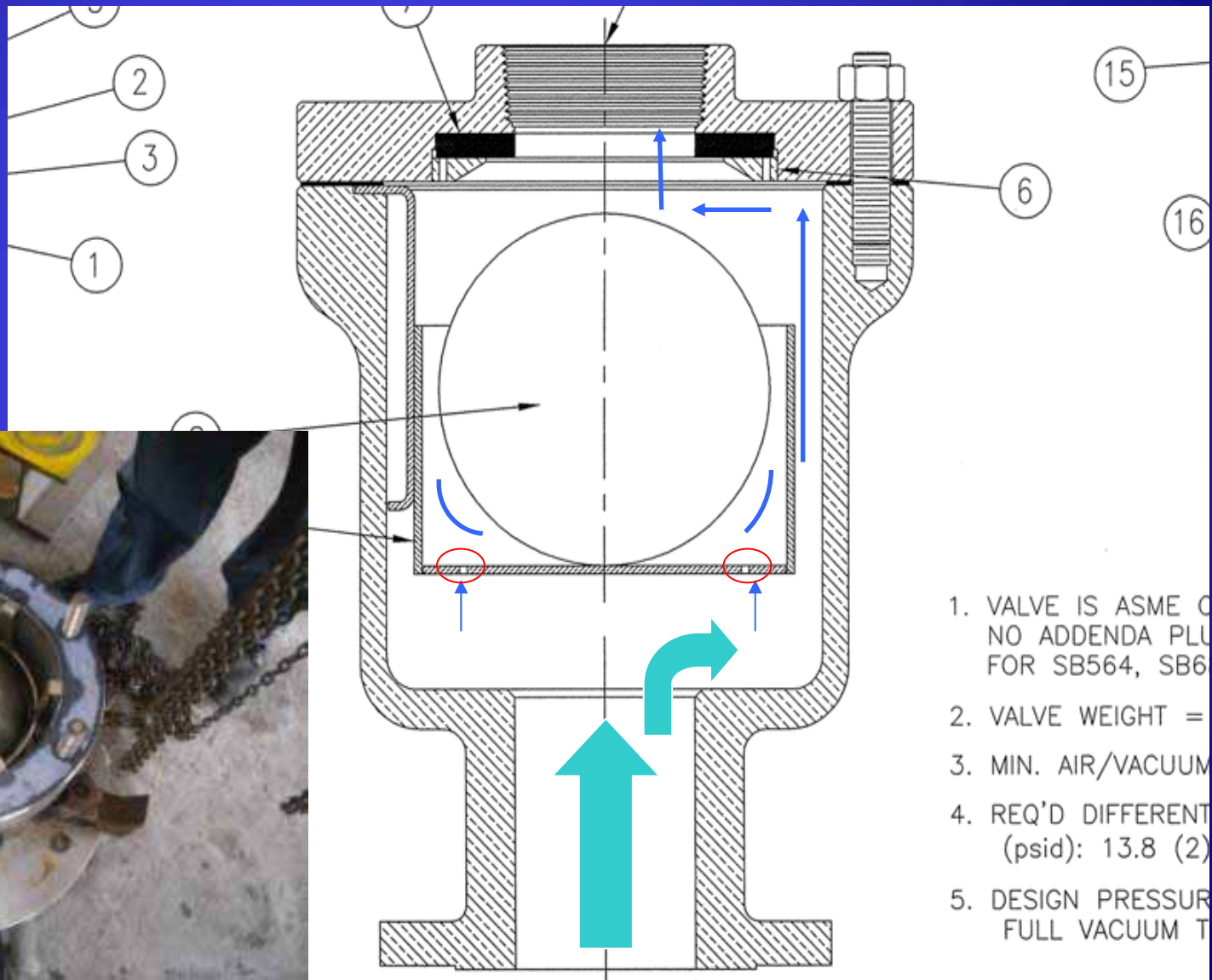
RBSW AV Problems at LMNPP

- Lungmen RBSW system uses automatic air & vacuum relief valves (AVs) to vent air in the seawater piping when the system starts
- Recently some AVs failure to function have been found. The ball inside AV fails to close after the air has been vented, and sea water flow out through the valve
- Since Sept. 2011, three major flooding events have happened at RBSW pump room, piping trench and valve rooms, respectively
- Two violations have been issued by AEC for the RBSW AV problems

RBSW Waterway Elevation and AV Locations



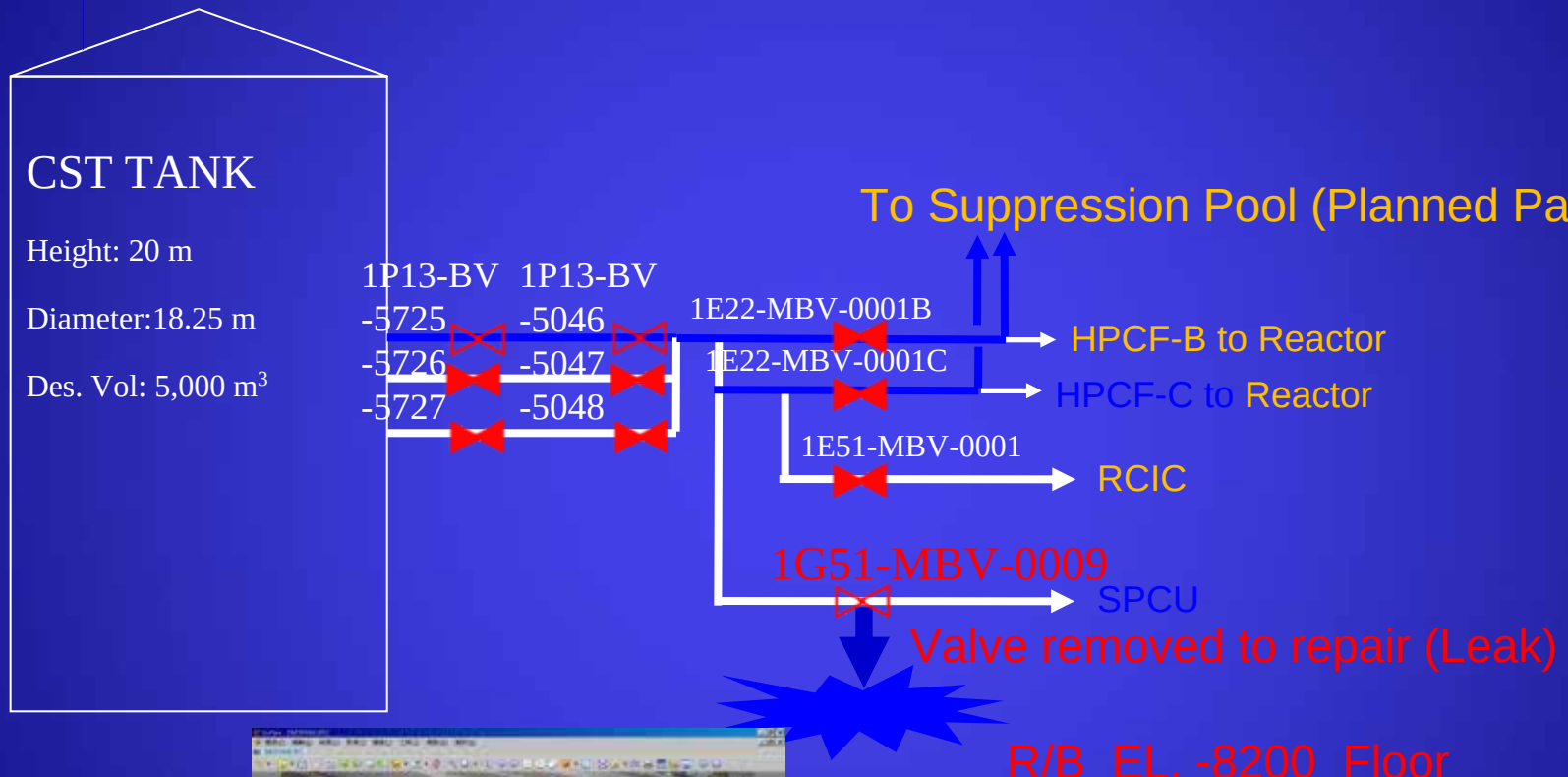
RBSW air & vacuum relief valve



Reactor Building Flooding

- On 8/16/2011, condensate water from CST was used to flood suppression pool, through HPCF piping, to facilitate performing following ECCS pre-op tests
- Condensate water flowed through a removed-for-repaired SPCU valve, which wasn't checked out beforehand, for 14 min., and flooded to the Reactor Building bottom floor
- RB sump Hi-Hi alarm appeared and MCR operator ordered people to shut the water down
- The flooded water level reaches 30 cm (= 12 in.)

Reactor Building Flooding (cont.)



Causes & Corrective Actions

- **Major Causes:**
  - Poor Change Management
  - Planning and preparation were not enough
  - Poor work coordination and communication
  - Tagging was not complete
- **Corrective Actions:**
  - Affected equipment were checked, retested, or repaired, and the list is maintained for further verification
  - Thoroughly review existing tagging and separation
  - Additional training on good working practice
  - Revising Tagging Procedure to enhance review, personnel qualification and training

Major Observations

- Lack of project coordination
- Unrealistic and unachievable milestone management
- Design deficiency
- Contract disputes
- Poor safety culture and housekeeping
- Digital control system challenge
- ASME codes and standards

Major Observations (cont.)

- **Lack of project coordination**
  - Lungmen is not a turn-key plant
  - Aside from several major contractors, hundreds of subcontractors involved in Lungmen construction, which complicated the interfaces. They are all managed by TPC with limited experienced staff and resources.
  - TPC fired the major architecture engineer (AE)-Stone & Webster, but substituted project management group (TPC and its local contractors) does not effectively positioned nor take over responsibility

Major Observations (cont.)

- **Unrealistic and unachievable milestone management**
  - Lack of detailed and coordinated construction schedule
  - Serious delays of installation and testing for pre-requisite systems, like electric distribution, digital control, service water and air systems, causing impossibility of reaching milestones.
  - Most past milestones were only symbolic , such as RPV setting, 161 kV power energizing, RPV hydrostatic test, sea water levee breaking, which don’t necessarily reflect true accomplishment.

Major Observations (cont.)

- **Design deficiency**
  - For GE, ABWR may still be first-of-a-kind or a “paper reactor”. All the ABWR details are in the hands of Hitachi, Toshiba and its subcontractors. For Lungmen, the Japanese only supplied the major equipment such as RPV, RIP and FMCRD and provided the containment design.
  - Taipower encountered many problems from designs by GE and its subcontractors Black & Veatch, DRS and AE-Stone & Webster.

Major Observations (cont.)

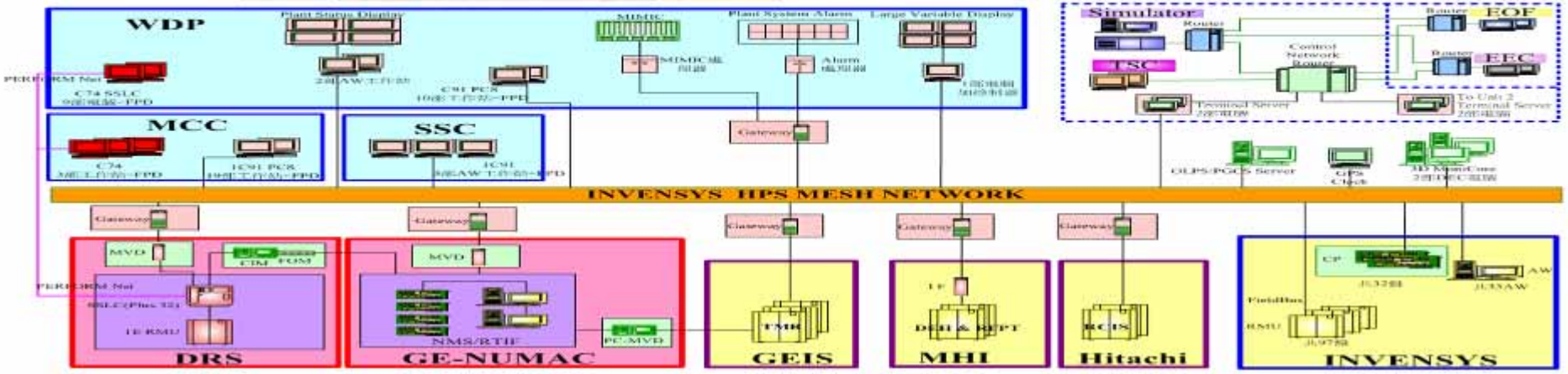
- **Contract disputes with GE and Stone & Webster affecting all areas of construction and commissioning activities, including:**
  - Final safety analysis report (FSAR) review - slow response
  - Design changes and quality assurance of safety-related SSCs - long delay and non-compliance
  - ASME code N-Stamp – non-compliance
  - No designer's involvement in preparing, performing pre-operational test and its results evaluation
  - Facing big challenge for the forthcoming start-up test

Major Observations (cont.)

- **Poor safety culture and housekeeping**
  - Poor work place management
  - Local workers lack of safety conscious resulted in high fatality rate
  - Procedure adherence is not solid
  - Short of basic working environment such as HVAC, elevator, sanitary, light, fire protection, etc
  - Flooding of unit 2 ECCS and HCU equipment room may cause crippling effect of its future operation
  - Management does not emphasize on implementing high standard instead of justifying minimum standard

Major Observations (cont.)

- **Digital control system challenge**
  - The Distributed Control and Information System (DCIS) in Lungmen plant is a complex, large scale, and full integrated system
  - As the first project to follow NRC codes and standards, and regulations on plant-wide digital I&C, the challenge is obvious



Major Observations (cont.)

- **ASME codes and standards**
  - Lungmen is probably the first NPP to fully implement the Section III of ASME B&PV codes and its N-Stamp requirements
  - Non-turnkey contracts and without an AE or utility holding ASME N-certificate results in incomplete N-Stamp for Lungmen NPP and probably all NSSS and BOP safety-related systems, i.e. ASME code compliance has not been fully met
  - Authorized nuclear inspectors (ANI) adopted in the ASME system played a very important roles identifying deficiency in design changes and signing correct date on QA documents

Conclusion

- Suspension and later-on resumption of Lungmen has had very damaging effect on the project
- After Fukushima Accident, the public are more concerned about the safety of NPPs and propose a Nuclear-free country in Taiwan. Many people suggest that the issue should be decided by referendum.
- The parliament freeze part of the budget of Lungmen Project in 2013. TPC could only apply for the funds for testing, but not for buying additional equipment.
- TPC shall put more concern on the pre-op re-test in order to show the effectiveness of the pre-op testing of LMNPP
- **Although LMNPP project had several hiccups, it is now moving right direction with relentless improvement.**


Thank You for Your Attention