2011 AEC-NRC Bilateral Technical Meeting

Licensing and Inspection Activities at Lungmen Nuclear Power Station

Department of Nuclear Regulation

Atomic Energy Council, Taiwan

May 3-5, 2011

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- Introduction
- Lungmen Licensing
  - Final Safety Analysis Report Issues
  - Operator Examination
- Lungmen Inspection
  - Construction Inspection and Major Findings
  - Initial Test Inspection and Major Findings
- Concluding Remarks

Progress of Lungmen Project

1980 Lungmen Project proposed

1996.6 GE ABWR Awarded

1999.3 Construction Permit issued

First Concrete pouring

Lungmen Project Suspended by DPP government

2000.10

2001.2

Lungmen Project Resumed

2005.3

Unit 1 RPV Sitting

2006.10 Unit 2 RPV Sitting

2007.7

161kV Energized (only partial electric distribution systems installed)

2008.11 Unit 1 RPV Hydro test

ECCS Pre-op

2009.7

2010.4

FIV

2010.8

Pre-op tests start

Present

Introduction

- A two-step licensing review process is adopted for nuclear plant in Taiwan.
- For Lungmen Project, a construction permit was issued following a preliminary safety analysis report (PSAR) being satisfactorily reviewed in March 1999.
- AEC started the construction inspection, including resident inspection, after issuing construction permit.

Introduction (cont.)

- Taipower Company submitted first version of FSAR in August 2007 for AEC's review.
- After over 3 years of review, AEC is currently preparing a draft safety evaluation report (SER), waiting for approval from higher authority.
- AEC will conduct readiness inspections for Lungmen plant to confirm the FSAR commitment before issuing fuel loading permit.

Introduction (cont.)

- As plant operators play a key role in their dynamic responses to normal operations and anomalies, their qualification and ability are among the main themes for nuclear safety.
- Plant operators and senior operators are required to pass stringent tests, including written examination, plant walk-through and simulator operation, before they are allowed to work at the main control room of the plant.

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FSAR Issues

- Ch 3. Design of Structures, Components, Equipment and Systems
  - The review of Lungmen RPV stress analysis report concludes that the RPV meets ASME Code Sec. III design requirement.
  - TPC commits to evaluate the reactor water environmental effect on 60-year fatigue for each unit before the startup of second refueling outage, respectively.
  - The acoustic resonance evaluation report reveals that steam dryer and main steam lines of Unit 1 are not affected by acoustic resonances and FIV.
  - TPC commits to install strain gauges on main steam lines of Unit 2 to verify that acoustic resonance doesn't affect the operation of SRVs, and to submit the steam dryer structure integrity evaluation report.

FSAR Issues (cont.)

- Ch 4. Reactor
  - As the issue of BWR fuel channel bow is not completely excluded, TPC is required to prepare the procedure of “Control Rod Fully Insertion Test” before initial fuel loading, and to address the effect of earthquake.
  - TPC is required to implement “BWR Control Rod Long-Term Handling Program” at Lungmen, and refer to the method of operating plants to establish “Lungmen Control Rod Sampling Inspection Plan during Refueling Outage”, which should be submitted prior to a 3-month period before first refueling outage.

FSAR Issues (cont.)

- Ch 7. Instrumentation and Control Systems
  - In view of long-term plant operation, Taipower should concern with Lungmen DCIS in all aspects and be prepared to deal with problems that may arise. Given below are certain examples currently fore-seen:
    - (1)Design: handling of numerous design changes which have been / will be generated from design changes in NI (e.g., FDIs) and BOP.
    - (2)Implementation: proper incorporation of design changes into DCIS.
    - (3)Installation: of special concern is the workmanship of fiber optic cable (proper bending radius, quality of splicing, adequate connectors, etc.)
    - (4)Testing: adequacy of testing scope, qualified testing personnel and CM for changes made during testing, etc.
    - (5)Operation: effective use and manipulation of VDUs by the operators, etc.
    - (6)Maintenance: performing maintenance in a corrective manner; training of personnel on digital control, etc.

FSAR Issues (cont.)

- Ch 8. Electric Power
  - A swing diesel generator (SDG) is originally designed as an alternative AC source with capacity of powering a complete set of normal safety shutdown to meet 10 CFR 50.63 SBO requirement, however, the SDG capacity is not enough for a normal shutdown as recommended by SECY-90-016, and SECY-93-087.
  - After extensive discussion, TPC finally commits to install two gas turbine generators.
    - Due to the lesson learned from Fukushima Diichi accident, the completion date now is set to June 30, 2013 or the date for issuing operation license of Unit 1, whichever is earlier.

FSAR Issues (cont.)

- Ch 14. Initial Test Program
  - Due to extended delay of emergency diesel generator (EDG) installation and testing, TPC could not perform vessel injection in time, so it is to seek overlap test method to perform LOOP/LOCA testing. That means the end to end test is only tested with offsite power. When EDGs are available at later time, the flow will go through test return to suppression pool instead of reactor vessel.
  - After consulting with NRC and holding regulatory conference with TPC, AEC urges TPC to perform at least one division of low-pressure ECCS system to minimize the impact to installed reactor internals. For Unit 2, TPC will arrange full scope of vessel injection for both high and low pressure systems.

FSAR Issues (cont.)

- Ch 17. Quality Assurance
  - TPC is required to establish Nuclear system CAP (Corrective Action Program).
  - TPC is required to include the provisions and statements of “Quality Assurance Criteria of Nuclear Reactor Facilities” to QA Program to make the program more complete.
  - TPC is required to set the minimum requirement of audit frequency.

FSAR Issues (cont.)

- Ch 18. Human Factors Engineering
  - The main control room VDU (video display unit) appears dazzling due to reflecting ceiling lighting.
  - The LED display on MCR Mimic panel is not clear to watch, e.g. decimal point.
  - The original designed space for MCR cables was found not enough. The floor is elevated and makes HFE problems.
  - The font size of safety-related displays in MCR is obviously smaller than that in simulator, and not the same as that of non-safety-related displays.
  - Lungmen MCR display color conventions are different from those of other operating nuclear plants. Therefore, operators from other plants should be trained on this part.

FSAR Issues (cont.)

- Ch 19. Severe Accident Analysis
  - Containment integrity
    - Passive COPS actuation for high containment pressure.
    - Leave it open (no action of manually closing isolation valve until restoration of RHR) or manually close need to be justified.
  - Extra water source (raw water reservoir) other than AC Independent Water Addition (ACIWA) system via fire protection line and tanks will be used.
  - Severe accident management procedure amendment and practice before fuel load is required.

FSAR Issues (cont.)

- App. A. Probabilistic Risk Assessment
  - As an advanced LWR plant, Lungmen sets the limiting value of Core Damage Frequency to be 10^{-5}/reactor-year.
  - The results of Lungmen PRA conclude that various risks (core damage, large early release, health effects) are smaller than their limiting values with significant margins.
  - The NUREG/CR-2300 master logic diagram approach was used to analyzed Lungmen internal initiating events.
  - The list of transient initiating events is made and categorized from the results of event analysis report and review of past BWR PRAs, and compared with NUREG/CR-3862. In addition, the newer NUREG/CR-5750 data are used.

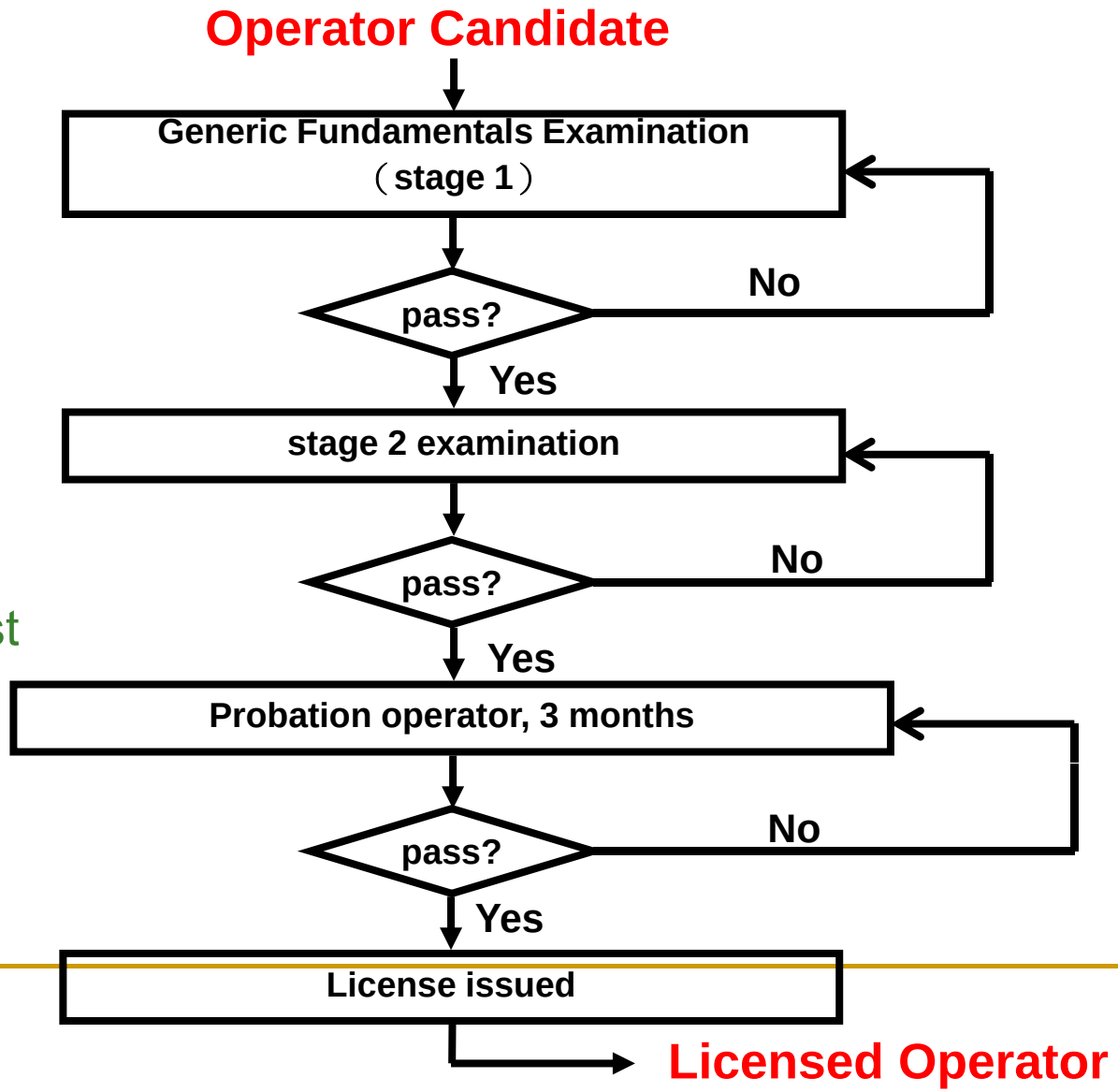
FSAR Issues (cont.)

- App. A. Probabilistic Risk Assessment
  - Three PRA models should be refined after commercial operation to meet the requirement of living PRA and risk-informed applications:
    - The conservatism and reality of model assumptions were not compromised, e.g. the human reliability of seismic and fire analysis, as well as of internal events.
    - Part of important analysis results can't be verified in construction period, e.g. seismic fragility and updated I&C configurations.
    - The assessment of using ACIWA during SBO is under perfect conditions. If the SBO is caused by a serious earthquake, the impact to operators would make them more likely to err. It should be taken into account in future update of Lungmen PRA model.

Operator Examination

Stage 2 examination

- Site-Specific written examination
- Simulator operating test （individual, group）
- Walk-through



Operator Examination (cont.)

Percentage of operator exam passage (up to Jan., 2011)

GFE（passed）		2009	2010 1st	2010 2nd
	SRO（passed）	12%	28.6%	66.7%
77%	RO（passed）	0%	25%	62.5%

The number of passed operators has met the minimum requirement for Lungmen Unit 1 operation

Operator Examination (cont.)

- Lessons Learned and Challenges
  - Before fuel loading, make sure operators be acquainted with operational procedures and Tech Spec, which not yet completed during pre-operational testing period
  - Choice of walk-through exam mode and time in a constructing site
  - The training between operator license issued and actual operation (if the interval is long)
  - The probation of passed operators while the plant is not operated
  - The hot plant experience required by NEI 06-13A for each shift is not allowed to replaced by training

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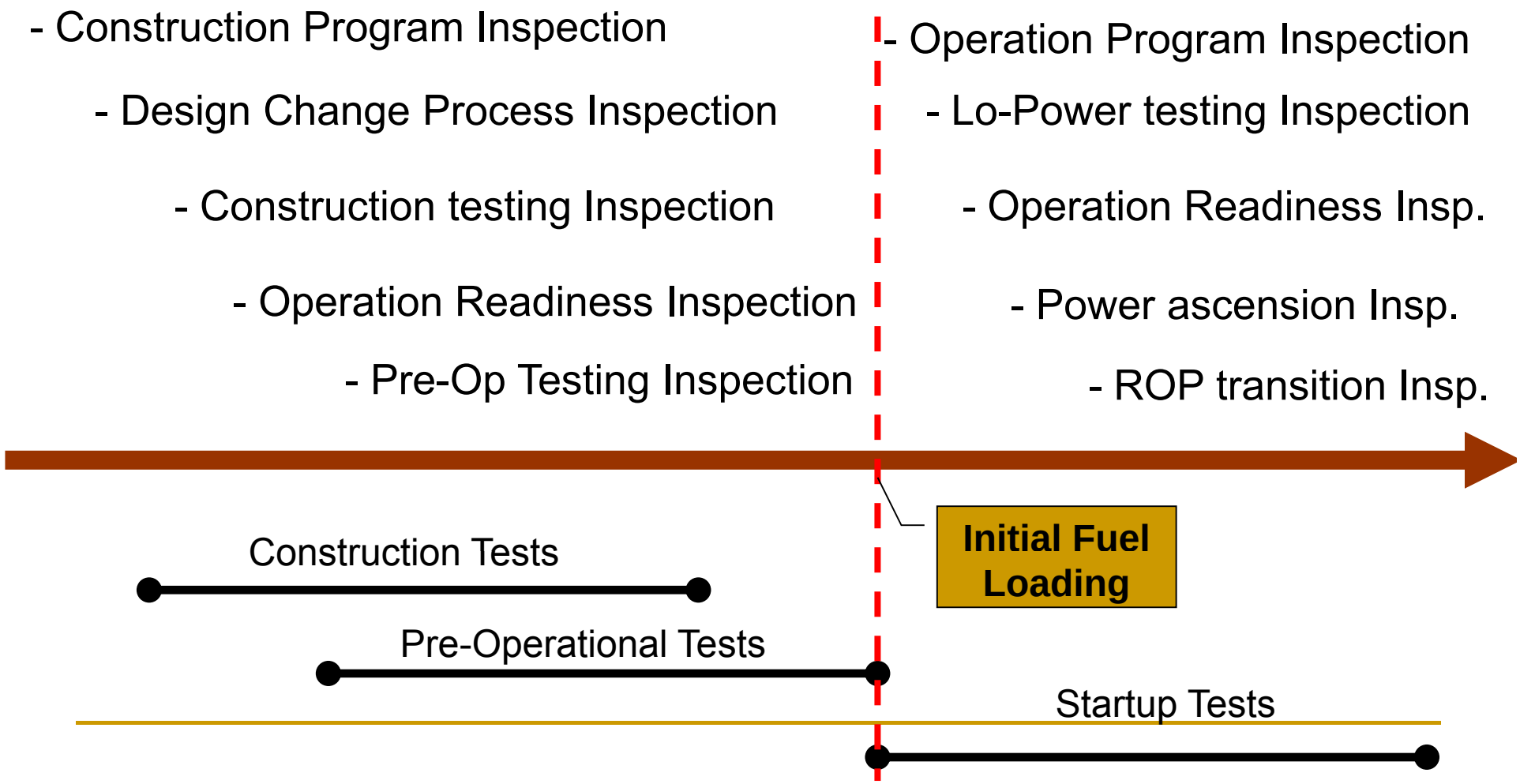
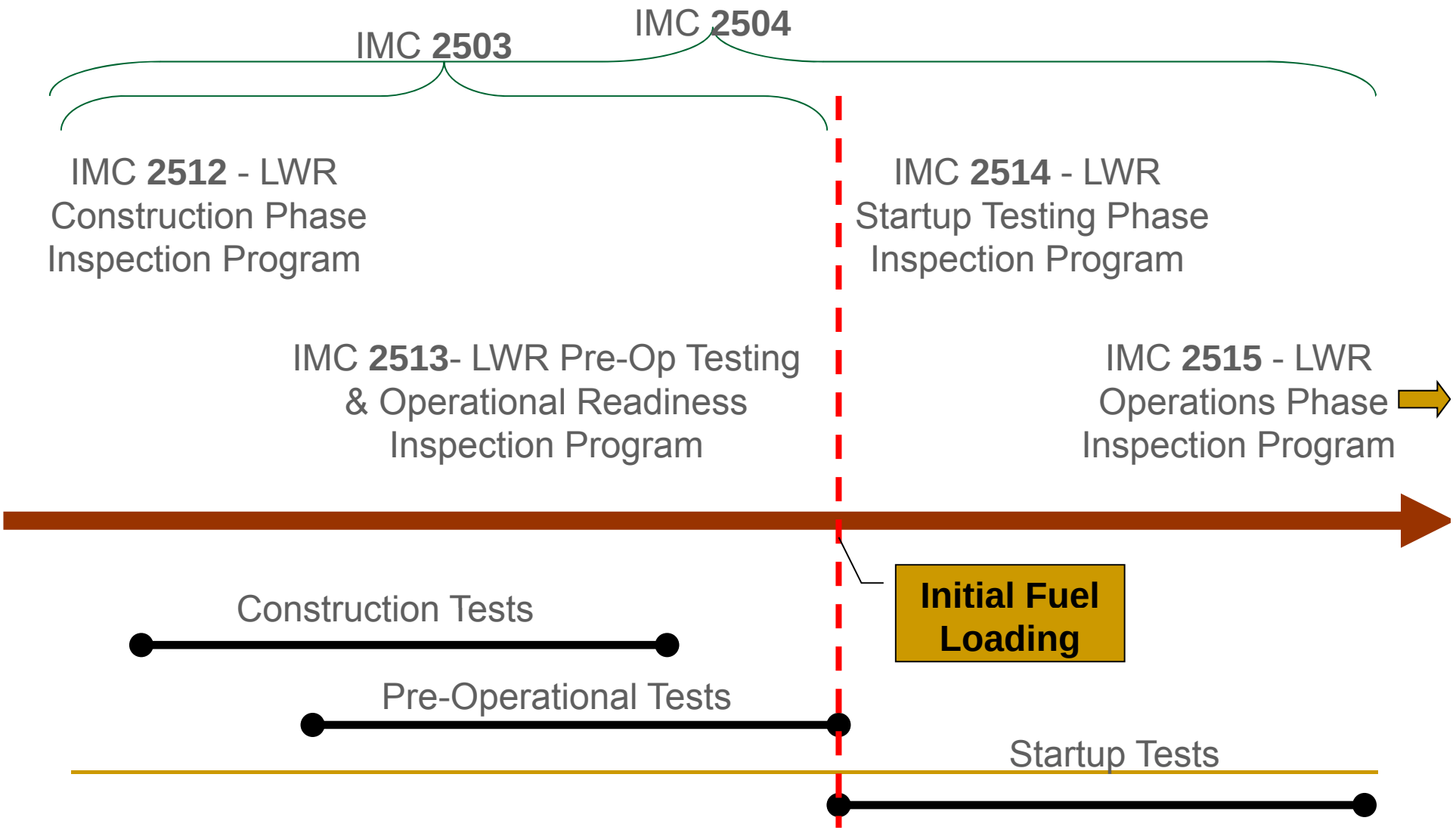
Construction Inspection Framework



Inspection Manual Chapter Coverage



Construction Inspection and Major Findings

- Power generation area ground resistance not meet designed target value
  - Target ground resistance value = 0.063Ω
  - In Oct., 2010, the 8th measured value = 0.131～0.174Ω
  - In Oct., 2010, two grounding wells (3” wide, 20m deep) were dug in NE and SW sides of power generation area and connected to plant grounding grid. The averaged measured value = 0.15Ω
  - TPC future measures:
    - Use Mitton measuring meter (made in New Zealand) (higher current and lower noise) and repeat the measurement, expected in April, 2011.
    - Construct auxiliary ground grid and connect to plant ground grid
    - Use deep buried grounding electrodes

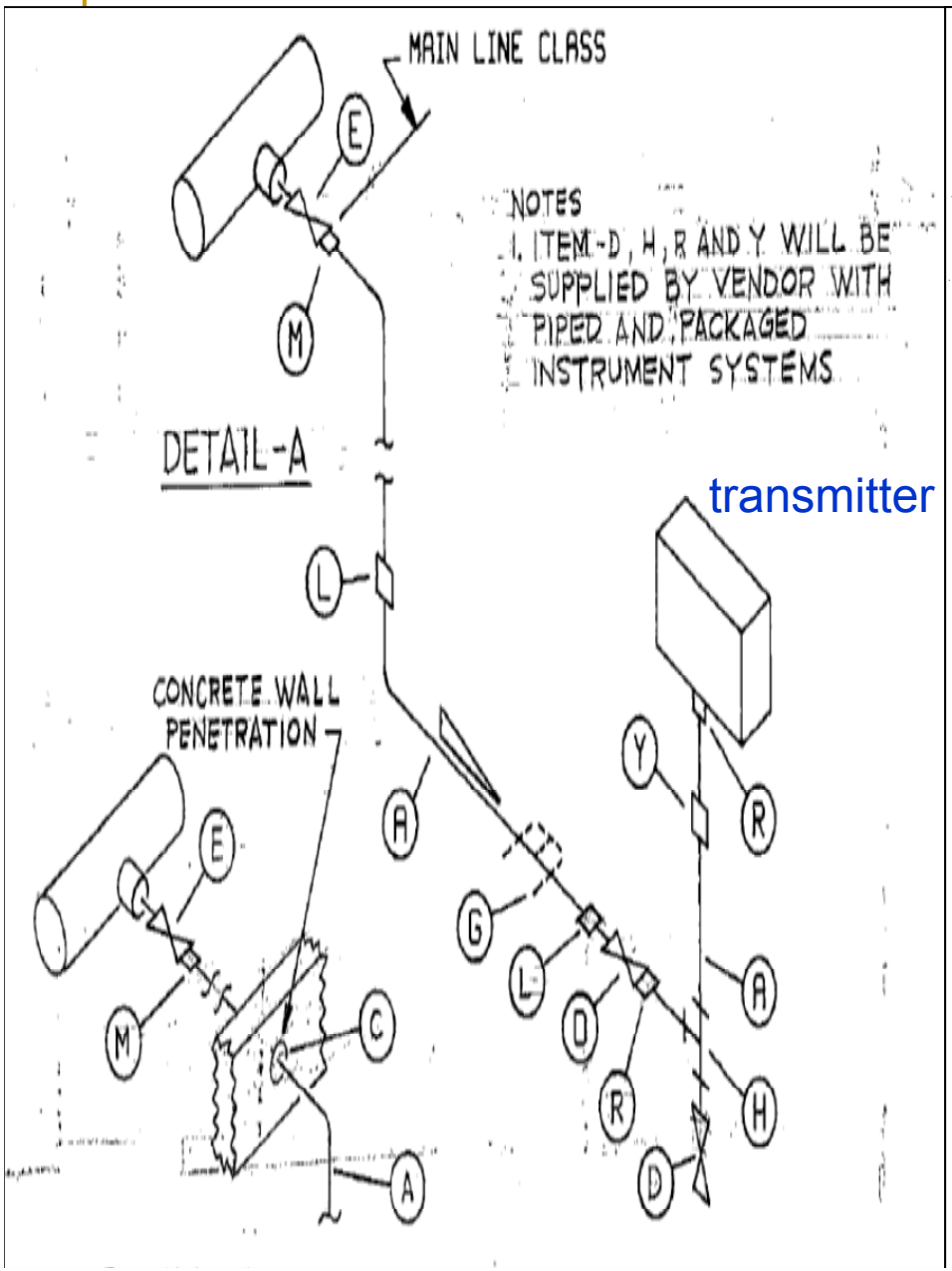
Construction Inspection and Major Findings (cont.)

- Violation of independency and separation requirements of raceway routing (RG 1.75, IEEE Std-384)
  - Cause: Bad design, narrow working space and ineffective audit
  - Major finding: Violation of independency and separation of cable routing, small bending radius, wrong routing path, cable tray overfill, damage of cable jacket, etc.
  - Penalty: Level 3 violation and NT$500,000 fine
  - Required actions:
    - Plant-wide raceway survey and overhaul
    - Independency and separation of raceway routing survey and improvement
    - Cable routing path verification

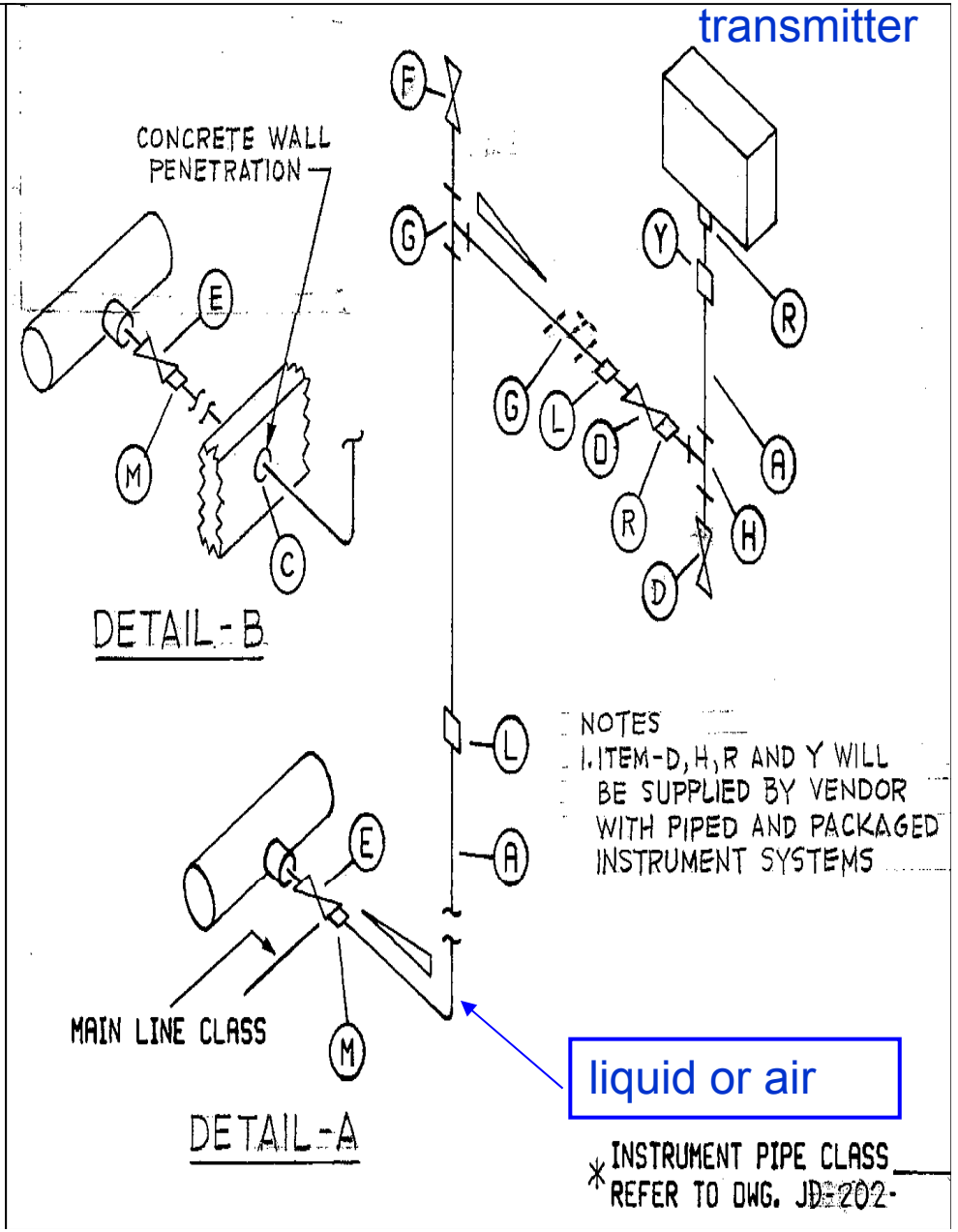
Construction Inspection and Major Findings (cont.)

- Sensing line slope not meet requirement, upward liquid tube tapping point, and incorrect instrument calibration range
  - Cause: Bad design, narrow working space, incorrect construction, calibration and audit
  - Major finding: bend/slant sensing lines, upward liquid tube tapping point, and incorrect instrument calibration range, etc.
  - Required actions:
    - Overall survey of liquid tube tapping point location
    - Overall survey of Instrument calibration range
    - Overall survey of sensing line slope

Better Design



Bad Design



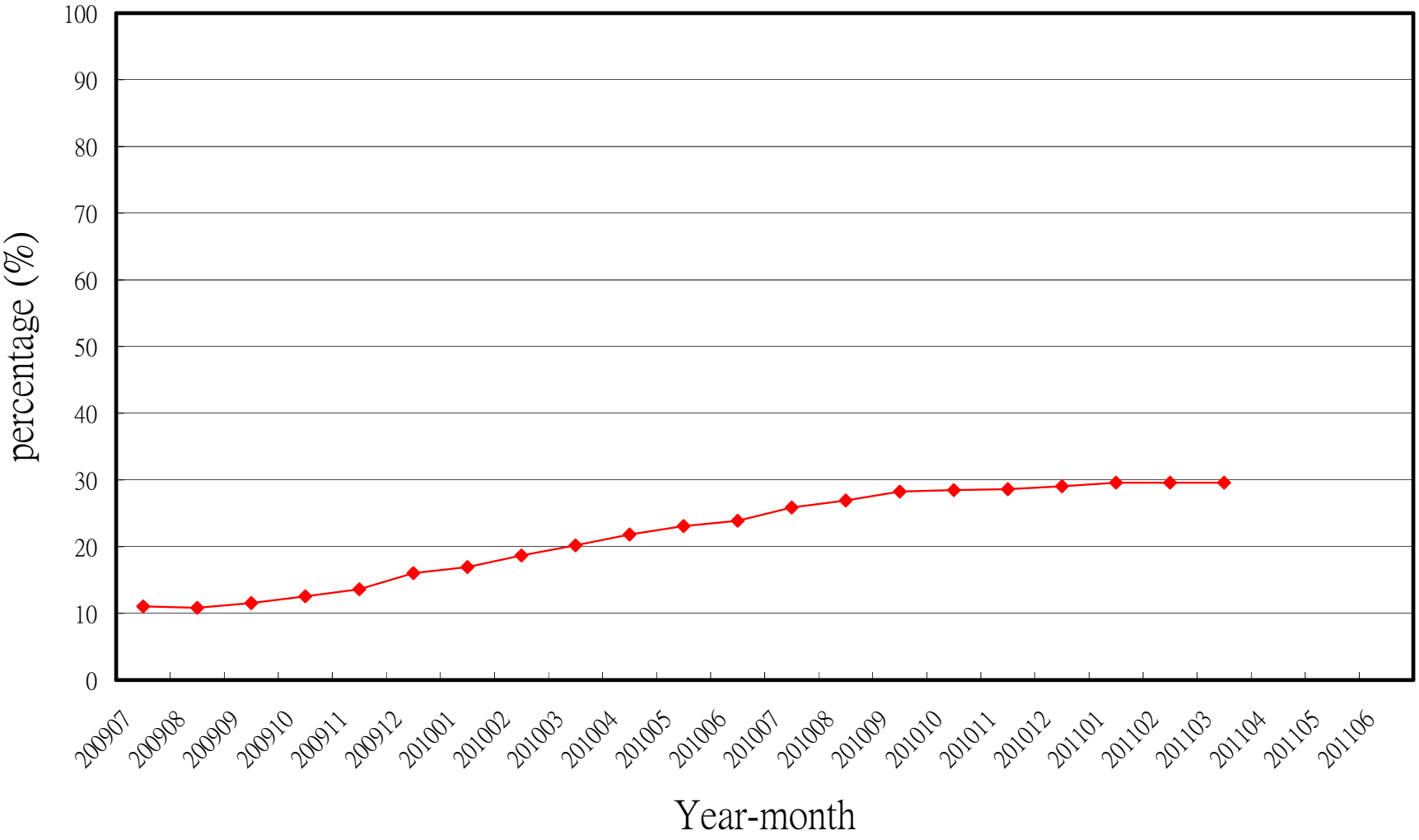
Construction Inspection and Major Findings (cont.)

- I&C Equipment Grounding not meet the requirement of IEEE Std-1050 (single-point cable shield grounding)
  - Cause: I&C system did not constructed based on engineering drawing and ineffective audit, etc.
  - Major finding: multi-point grounding, cable jacket damage and shield grounding, could cause noise and incorrect signal
  - Required action: overall survey and correction of I&C equipment and cable grounding

Current Test Status of Unit 1

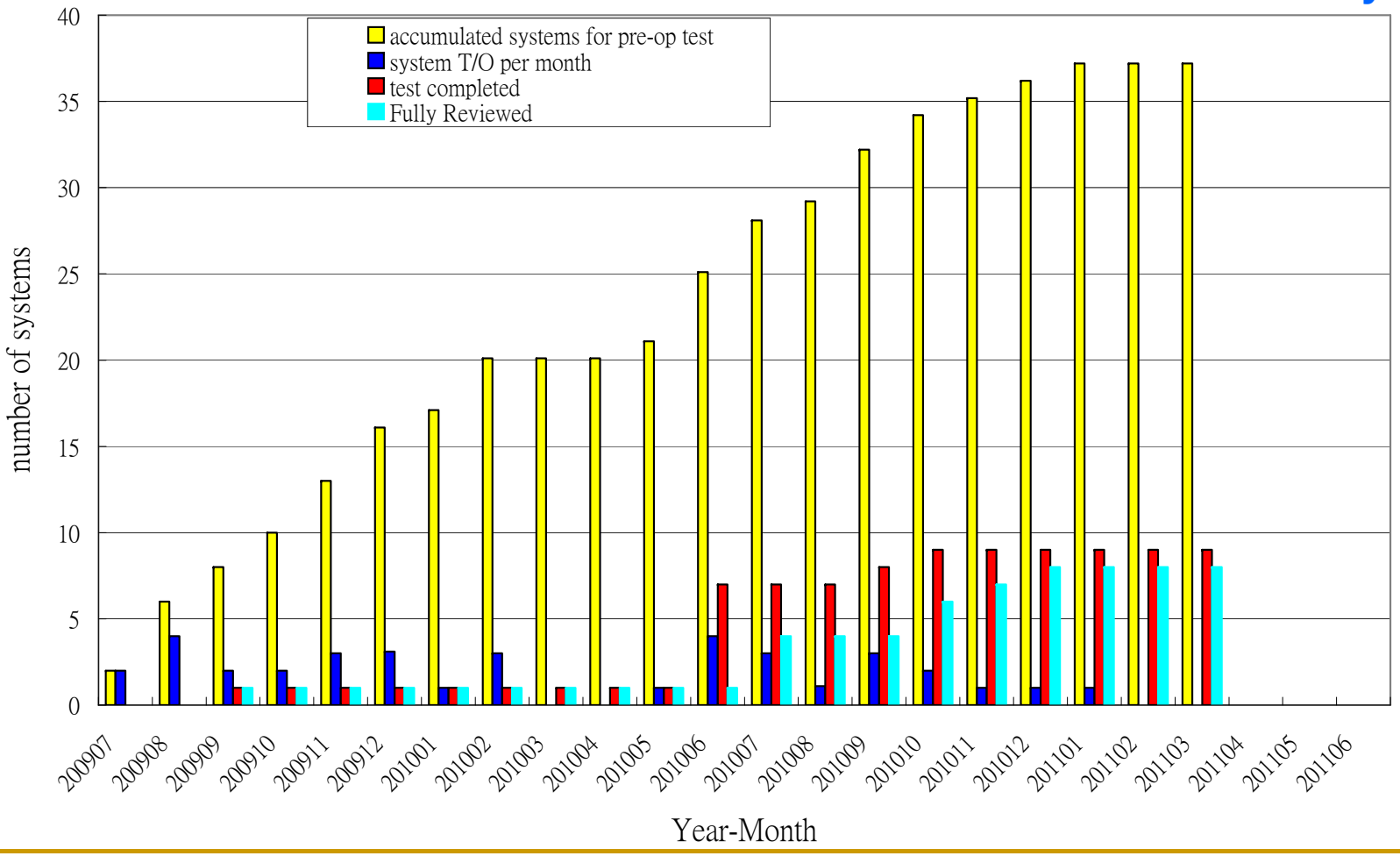
- 126 systems to be pre-operational tested
  - 99% of them have finished construction.
  - fully turned over: 37 systems
  - partially turned over: 11 systems
  - finished pre-operational test: 9 systems
  - completely reviewed: 8 systems
- Pre-operational test activity has stagnated since last September because of cable rearrangement
- Currently the most challenging issue is the massive instrumentation I/O and man-machine interface (MMI) retests after cable rearrangement
- Most systems, previously being tested, will be re-tested after cable re-routing

Unit 1 Pre-Operational Test Progress



Statistics of System Turnover (T/O) and Pre-operational Test

Goal: 126 systems



Initial Test Inspection and Major Findings (1/2)

- Insufficient support and field problem solving capacity from major vendors
- Some vendors reluctant to support, or even negligent (such as EDG and PCS vendors)
- Many test problems found out to be resulted from poor construction and equipment quality
- Long testing time and reworks make previous tests and maintenance in vain, such as piping flushing

Initial Test Inspection and Major Findings (2/2)

- Extended testing time results in long-term supporting system operation without proper maintenance
- First readiness inspection has been performed last November and found Lungmen plant is not ready to enter the phase of operation

Concluding Remarks

- FSAR review has been almost finished.
- The number of exam-passed operators is enough for Unit 1 operation
- The majority of Unit 1 constructions have finished, while the pre-operational tests are going to restart after completion of cable rearrangement.
- Based on the trends of system turnover, pre-op test activity, cable rearrangement and re-test afterwards, initial fuel loading date will likely be postponed to second half of 2012.

Thank you for your attention