壓水式電廠圍阻體集水坑濾網改善之規劃

SUMP STRAINER IMPROVEMENT PROJECT AT MAANSHAN NUCLEAR POWER PLANT (GSI-191 Issues)

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December 16, 2009

行政院原子能委員會核能研究所

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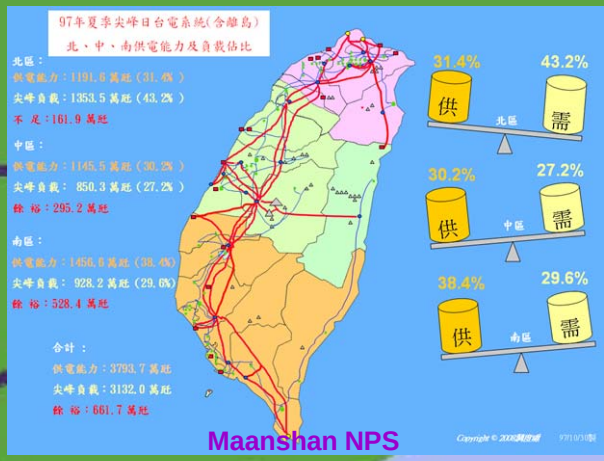
1. Maanshan Introduction

MNPS SITE LOCATION

Heng Chun



Guanshan

Lake Lungluan

Kenting National Park

Nanwan Bay

Paisha Bay

Maopitou

Houpihwu Fishery Port

Maanshan NPS

Oluanpi

Maanshan Nuclear Power Station Summary

- **Nuclear Units : 951 MWe × 2 PWR**

Important Milestones:	Excavation	Commercial
U-1	1978.1.16	1984.7.27
U-2	1978.7.16	1985.5.18

Major Equipment	Supplier	Type
Nuclear Reactor	Westinghouse	3-Loop PWR
Turbine	GE(HP) / ABB(LP)	1 HP & 2 LP
Generator	GE	Hydrogen/Water Cooled

- Gas Turbine： 51 MWe × 2
- Wind Power： 1.5 MWe × 3
- Solar Power ： 50 KWe × 1

2. GSI-191 – Overview

- 1992 – BWR strainer clogging issue reassessment by USNRC (Barsebäck, Sweden)
- Late 1990s – USNRC initiates Generic Safety Issue GSI-191
  - 2nd reassessment of PWR sump performance
  - 2001 PWR sump performance is a safety issue
- 2003 – Bulletin 03-01
  - USNRC asks plants to describe interim compensatory measures to reduce risks associated with debris blockage
- 2004 – Generic Letter GL 2004-02
  - Request plant-specific evaluations for ECCS&CS when considering post-LOCA debris
  - Implement any corrective actions necessary (replacing sump screens)
  - Completion of corrective actions by 12/31/07

2. GSI-191 – Overview (Cont.)

- **Most US licensees requested extensions beyond 12/31/2007 to complete certain corrective actions**
  - Head loss testing including chemical effects
  - Downstream effects analysis
  - Plant modifications
- **All US plants submitted supplemental responses to GL 2004-02 in Feb./March 2008**
- **The USNRC staff is nearing completion of initial review of the licensee supplemental responses**
- **Plant submittal addressing in-vessel downstream effects after WCAP-16793-NP issued**
  - Safety evaluation (SE) for in-vessel downstream effects by end of 2009 (may delay)

2. GSI-191 – Overview (Cont.)

- **After all US licensees have been issued closure letters, GL 2004-02 will be formally closed – expected to occur mid 2010**
  - Some modifications will be made after planned issue closure if plant has a satisfactory strainer evaluation and commitment for completion
  - USNRC will track all corrective actions to completion at all plants
- **All US PWR licensees have installed significantly larger (1 to 2 orders of magnitude) ECCS sump strainers and made plant improvements in response to GL 2004-02**

2. GSI-191 – Overview (Cont.)

- **Important open issues remaining for U.S. fleet are:**
  - Nukon fiberglass insulation Zone of Influence (ZOI)
  - In-Vessel Blockage

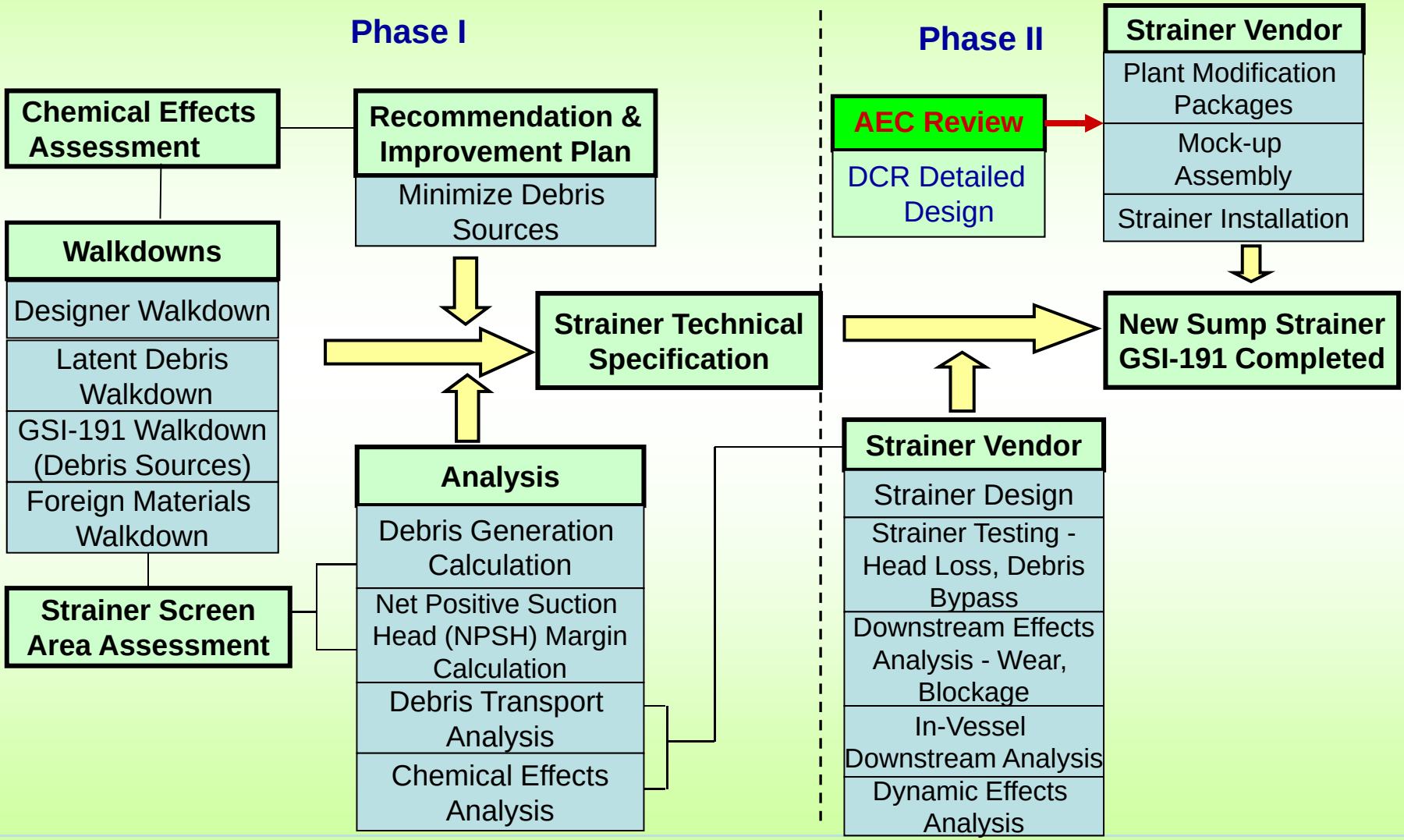
3. Maanshan GSI-191 - Overview

- **Maanshan nuclear power plant (MNPP) is the only PWR plant in Taiwan**
- **MNPP has started evaluating GSI-191 related issues since 2004 in response to GL 2004-02 and the request of Atomic Energy Council (AEC)**
- **MNPP will implement a containment cleaning improvement program reducing debris sources under AEC directions**

3. Maanshan GSI-191 - Overview

- **MNPP submitted a sump strainer improvement plan to AEC with two-phase work scopes**
  - Phase I: Perform walkdown activities and provide strainer technical specifications for Phase II open bid
    - **Starting in November 2009**
  - Phase II: Select vendor/manufacturer for strainer design, testing, manufacturing, and installation
    - **Starting in August 2010**

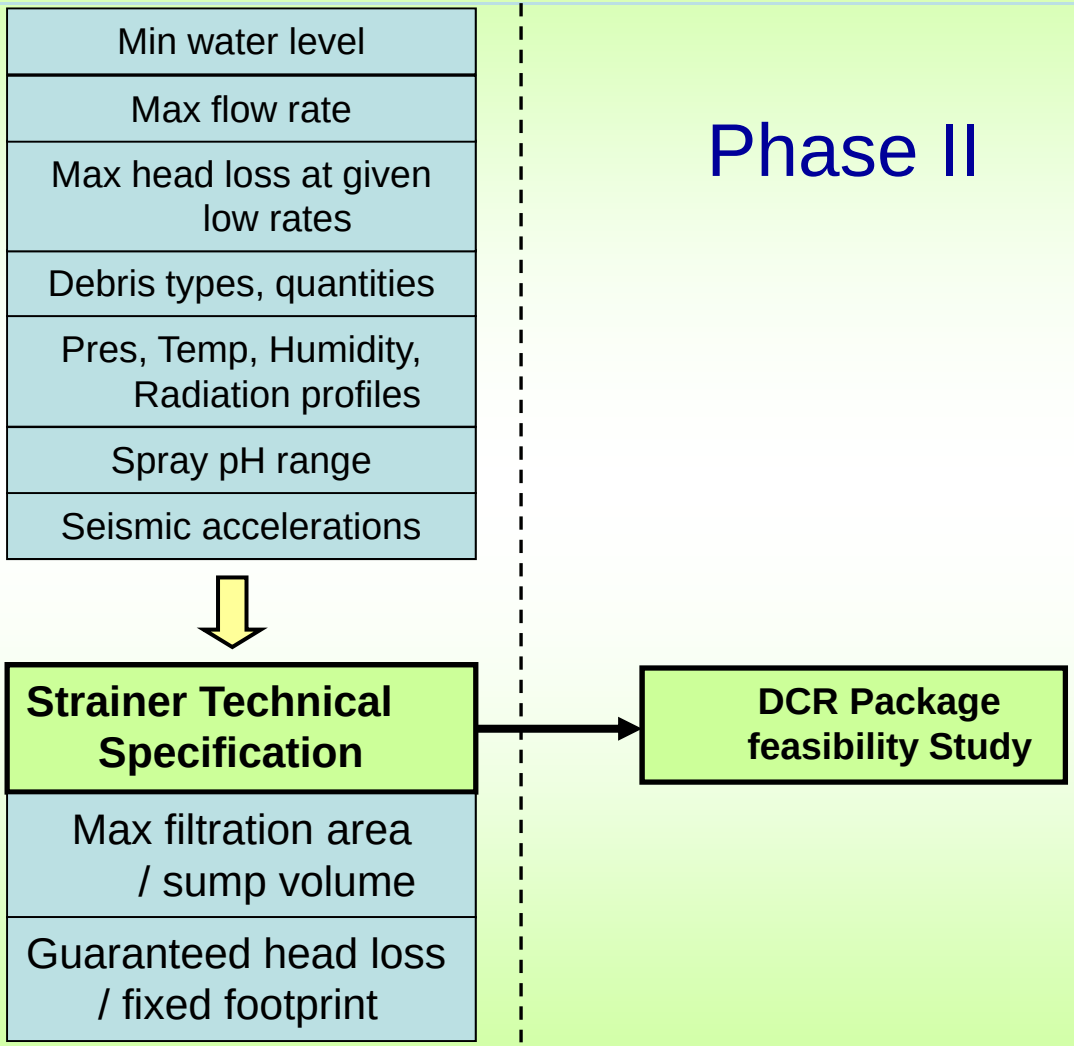
3. Maanshan GSI-191 – Overview (cont.)
Work Flow



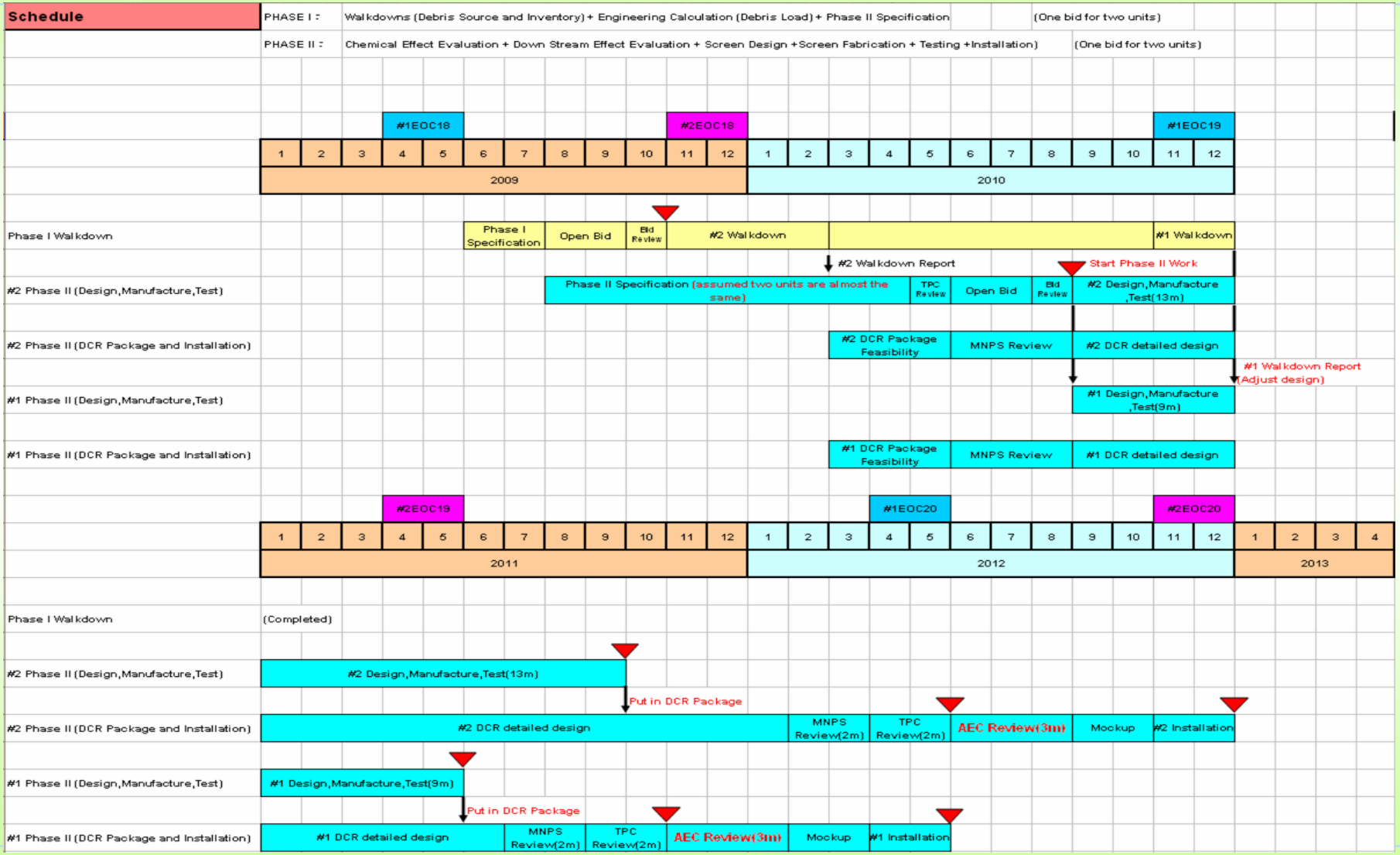
Work Flow (cont.)

Phase I

Phase II



3. Maanshan GSI-191 – Overview (cont.)
Time Schedule

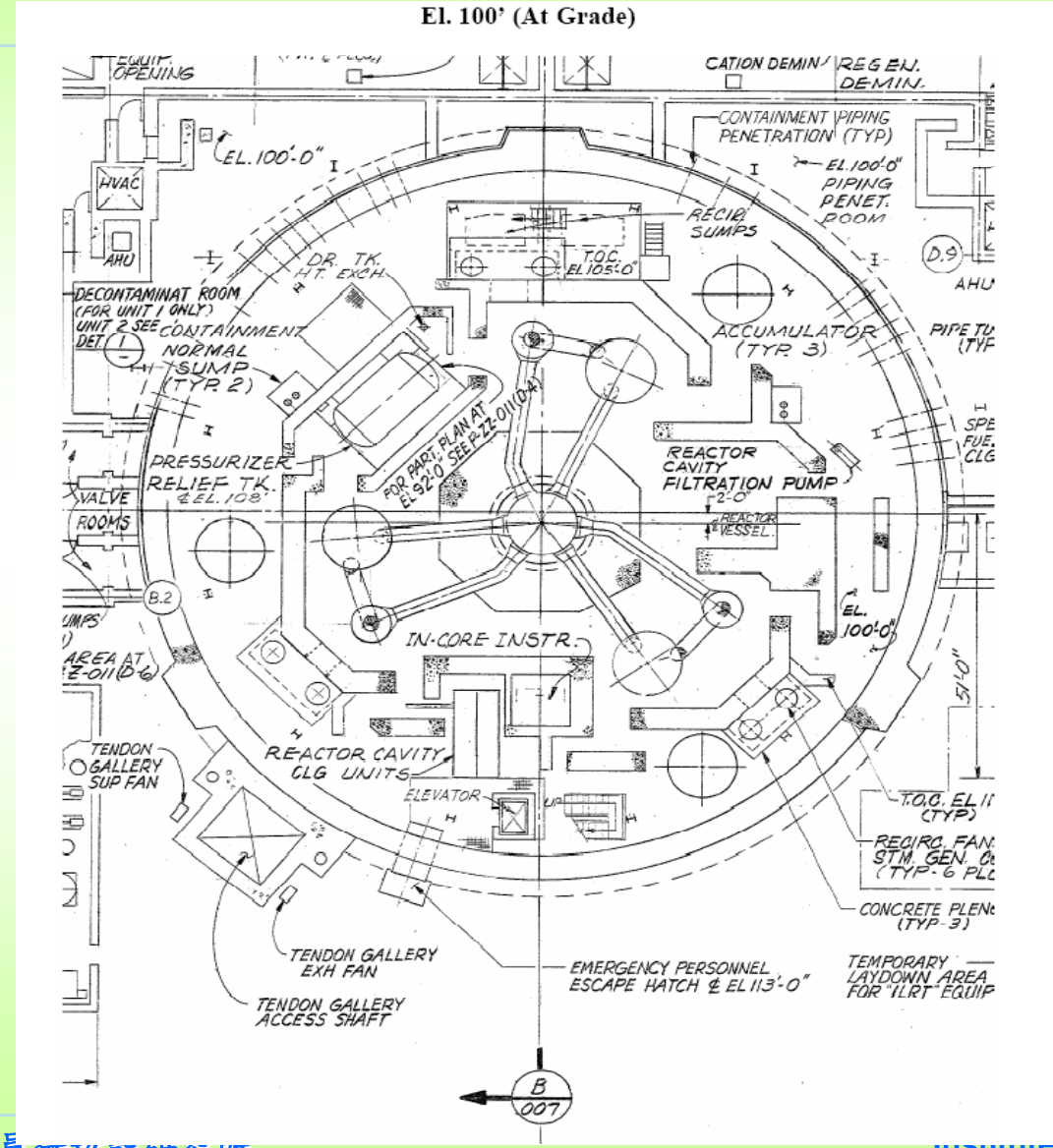


4. Maanshan GSI-191 – Phase I Project

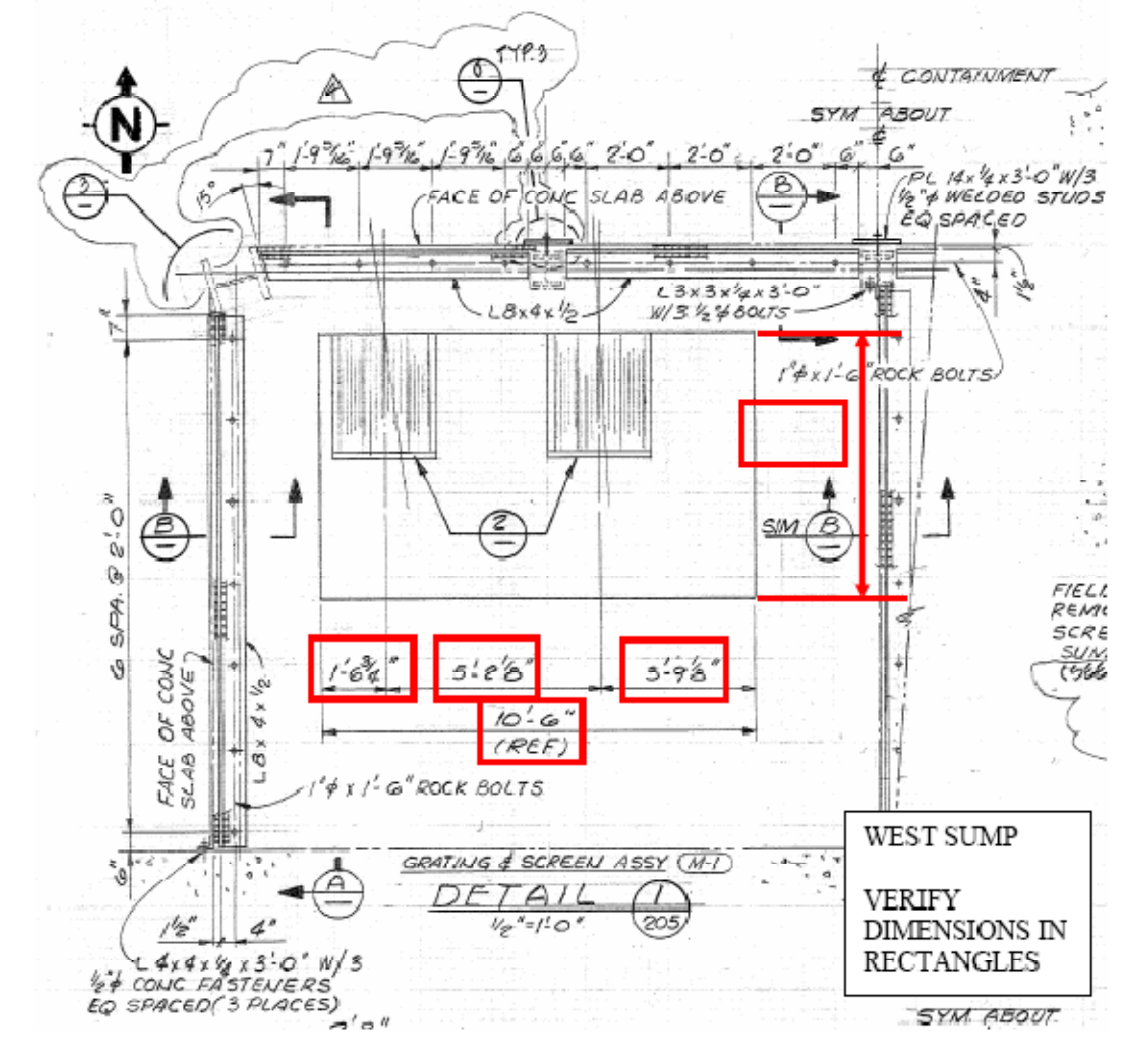
- **To Meet AEC and GL 2004-02 Requests, MNPP Performs the following work under AEC and USNRC/NEI guidance (NEI 02-01, 04-07, Regulatory Guide 1.82 R3)**
  - Preparation for containment walkdown
    - Review and collect plant data, layout/drawings, insulation, coatings, aluminum inventory, seismic accelerations, system design information, design basis documents, etc
- **Phase I Activities**
  - Walkdown Plans
  - Walkdowns
  - Walkdown Report
  - Debris Generation Calculation
  - NPSH Margin Calculation
  - Strainer Technical Specification

Sump Pictures

4. Phase I Project (cont.)



4. Phase I Project (cont.)



4. Phase I Project (cont.)

- **Designer walkdown (2 days)**
  - Gather information regarding ECCS sump pit to assist in design of replacement strainer such as available space and dimensions
- **Latent debris walkdown (3 days)**
  - Take samples from various surface types to determine the mass of dust, lint, loose fibers in containment
- **GSI-191 data collection & validation walkdown (5 days)**
  - Document condition of insulation and coating, identify potential flow chokepoints and water holdup areas
- **Foreign materials walkdown (2 days)**
  - Determine surface area of non-outage related foreign material in containment (e.g. tape, signs, labels, placards)
- **Panel discussion after walkdowns (1 or 2 days)**
  - Planned configuration changes, chemical assessment, walkdown results, recommendations, etc.
- **Preliminary assessment of chemical effects**
- **Strainer screen area assessment**

4. Phase I Project (cont.)

- **Debris generation calculation**
  - Calculates amount and types of debris generated by LOCA in order to determine required replacement strainer size
  - Incorporates input from:
    - Walkdown reports
    - Plant documents (piping isometrics, insulation drawings, coating logs)
    - Guidance documents (NEI 04-07, NRC SER of NEI 04-07, NUREGs)
  - Calculation of debris is dependent on knowing where targets (insulation & coatings) are prior to LOCA and making informed decisions about which breaks will be bounding
- **Net positive suction head (NPSH) margin calculation**
  - Calculation will estimate head loss expected based on results of debris generation calculation
  - Based on current plant ECCS hydraulic calculation, will determine NPSH margin
    - Depending on results, a revision to the ECCS hydraulic calculation may be beneficial
  - Suction piping losses
  - Minimum transient flood height
  - Containment sump transient temperature
  - Maximum ECCS flow from sump during recirculation (hydraulic limit, not runout)
  - Initial air pressure in containment (pre-accident) can be credited per USNRC Safety Guide 1
  - Increased NPSH margin at lower sump temperatures

4. Phase I Project (cont.) - Initial Walkdown Results

- **Designer Walkdown**
  - Sump dimensions are as shown on drawings
  - Curb surrounding sump is beneficial
  - Best transport path for strainer components appears to be via Polar Crane drop through stairwell above sump
  - Congested areas surrounding sump may hold-up some debris

4. Phase I Project (cont.) - Initial Walkdown Results

- **Latent Walkdown**
  - Four samples were taken from surface types vs. three samples recommended in NEI 04-07
  - Nothing seen during walkdown appears out of ordinary
  - Mass of latent debris will be calculated in walkdown report

Latent Debris Measuring

4. Phase I Project (cont.) - Initial Walkdown Results

- **GSI-191 Debris Sources Walkdown**
  - Most insulation and jacketing is in good condition
  - Insulation appears to be primarily RMI, as designed
  - Chilled water system is jacketed fiberglass
    - Some segments of fiberglass or jacketing are in need of repair
  - Nothing seen during walkdown so far appears out of the ordinary
  - Walkdown report will document condition of insulation
  - Quantity of debris will be determined by Debris Generation calculation

Insulation Pictures

4. Phase I Project (cont.) - Initial Walkdown Results

- **Foreign Materials Walkdown**
  - Inventory of non-outage related foreign materials in containment
    - Primarily concerned with tags, labels, stickers
    - Also document tape, paper, construction materials, miscellaneous debris
  - Nothing seen during walkdown so far appears out of the ordinary
  - Walkdown report will calculate area of foreign materials in containment

Foreign Material Pictures

4. Phase I Project (cont.) - Recommendations

- **Minor changes that could prove beneficial to Maanshan include**
  - Reductions of latent debris and foreign materials could be achieved by more rigorous adherence to containment cleaning procedure
  - Reduction of latent debris could be achieved by repairing damaged fibrous insulation jacketing
  - Reduction of foreign materials could be achieved by removal of duplicate/repetitive/redundant labels
  - Currently installed aluminum equipment tags should be replaced by stainless steel tags before the new strainer is installed
  - Miscellaneous aluminum should be removed from containment before the new strainer is installed

4. Phase I Project (cont.)

- **Recommendation and implementation plan which AEC is concerned with**
  - MNPP will eliminate all aluminum inventory
  - MNPP will replace all labels, tags with new stainless steel plates (10cmx6cm)
  - MNPP will use stainless steel RMI (Reflective Metal Insulation) replacing other types of insulation

RMI

Stainless Steel Plate

- Minimize the debris sources term in containment to optimize strainer size

4. Phase I Project (cont.)

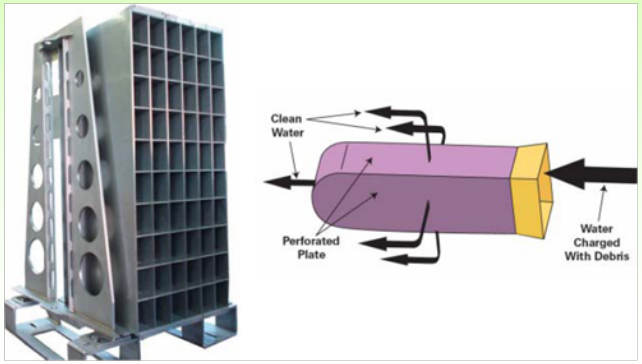
- **Primary strainer design input from plant data, Unit 2 walkdowns, and debris generation and NPSH analyses**
- **Strainer technical specification**
  - Based on findings of Designer Walkdown and results of Debris Generation and NPSH calculation a Specification will be prepared to allow for procurement of replacement strainer
  - Establish the minimum requirements for the design, fabrication, testing, cleaning, packaging, and delivery of the sump strainers
  - Guaranteed head loss under fixed footprint area
  - Maximum filtration area of sump volume

5. Maanshan GSI-191 – Phase II Project

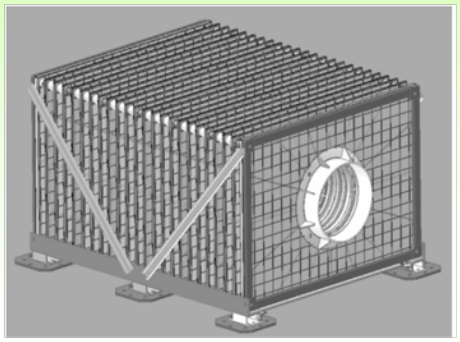
- **Strainer vendor selection – open bid**
- **Strainer design – must meet the strainer technical specification and beyond**
- **More analyses & tests needed to meet AEC, USNRC/NEI and industry guidance**
  - Debris transport analysis
  - Chemical effects analysis (WCAP-16530-NP-A)
  - Downstream analysis (WCAP-16406-P-A)
  - In-vessel downstream analysis (WCAP-16793-NP)
  - Minimum flood level analysis
  - ECCS/CS hydraulic analysis
  - Perform head loss/bypass testing
  - Strainer Installation Modification Package
- **AEC will review the strainer DCR detailed design before installation**
- **Strainer installation & related plant modifications**

5. Maanshan GSI-191 – Phase II Project Strainer Type Available

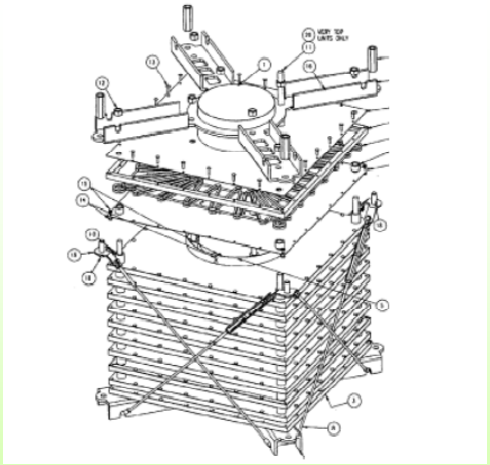
Finned



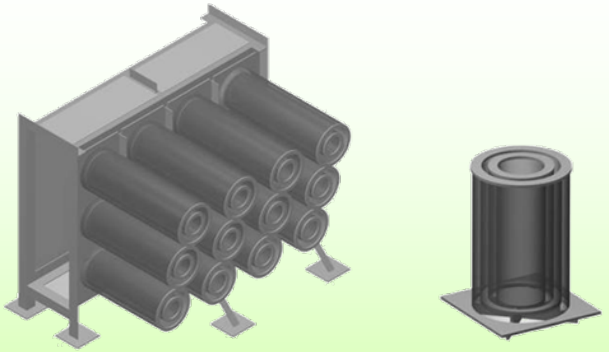
Pocket



Disk



Sure Flow



Top Hat

5. Maanshan GSI-191 – Phase II Project Strainer Type Available (cont.)

- **PWR Strainer Vendors in USA:**
  - Finned type strainer: 7 units
  - Pocket type strainer: 20 units
  - Top Hat type: 14 units
  - Disk type: 11 units
  - Sure Flow type: 17 units
- **Total: 69 PWR units in USA**

6. Future Work – BWR Strainer Blockage Issues

- **1992~2001, US NRC raised the BWR sump performance issues**
- **All US BWR licensees have performed evaluations and installed larger strainers**
- **New information and knowledge gained from GSI-191 & GL 2004-02 led US NRC to re-examine BWR strainers dated on 4/10/2008**
  - Chemical Effects
    - BWR not addressed
    - PWR addressed
  - Downstream Effects
    - Wear, erosion, clogging of pumps and valves
      - BWR not addressed
      - PWR being addressed

6. Future Work – BWR Strainer Blockage Issues (Cont.)

- Downstream Effects
  - Blockage in core
    - BWR not addressed
    - PWR being addressed

- **BWR owners group is determining whether changes are needed to BWR guidance submittal in 2010 and plan plant specific evaluations in 2012**
- **US NRC will review the BWR topical reports and plant specific evaluations**
- **ROC AEC will review and evaluate the new USNRC issues regarding the BWR strainer performance**

6. Future Work – BWR Strainer Blockage Issues (Cont.)

- **BWR Nuclear Power Plants in Taiwan**
  - Chinshan 1978
  - Kuoshen 1981
  - Lungmen (ABWR) 2011
- **Strainer performance for all three BWR plants in Taiwan may need reassessment very soon**

7. Concluding Remarks

- **Maanshan Unit 2 containment appears typical**
  - No observations during walkdowns thus far are cause for concern
  - After the Walkdown Report, Debris Generation Calculation and Strainer Specification are completed, there will be a clearer idea of the path forward for Maanshan
- **ROC AEC will oversee MNPP sump strainer project closely including containment improvement, schedule, and DCR review**
- **New BWR strainer blockage issues may need be re-considered in very near future**
- **Benefits from two phases of MNPP GSI-191 project**
  - Better understandings of strainer specifications and screen area required
  - Better for containment improvement – reducing debris sources
  - Better control of strainer manufacturing cost
  - Better for strainer vendor selection
- **Good lessons learned for future new PWR units and further BWR strainer improvement**

Thank you very much

敬請指教