

Radiation Protection  
Management  
and ALARA  
Lessons Learned during TMI  
Steam Generator/Refuel  
Outage

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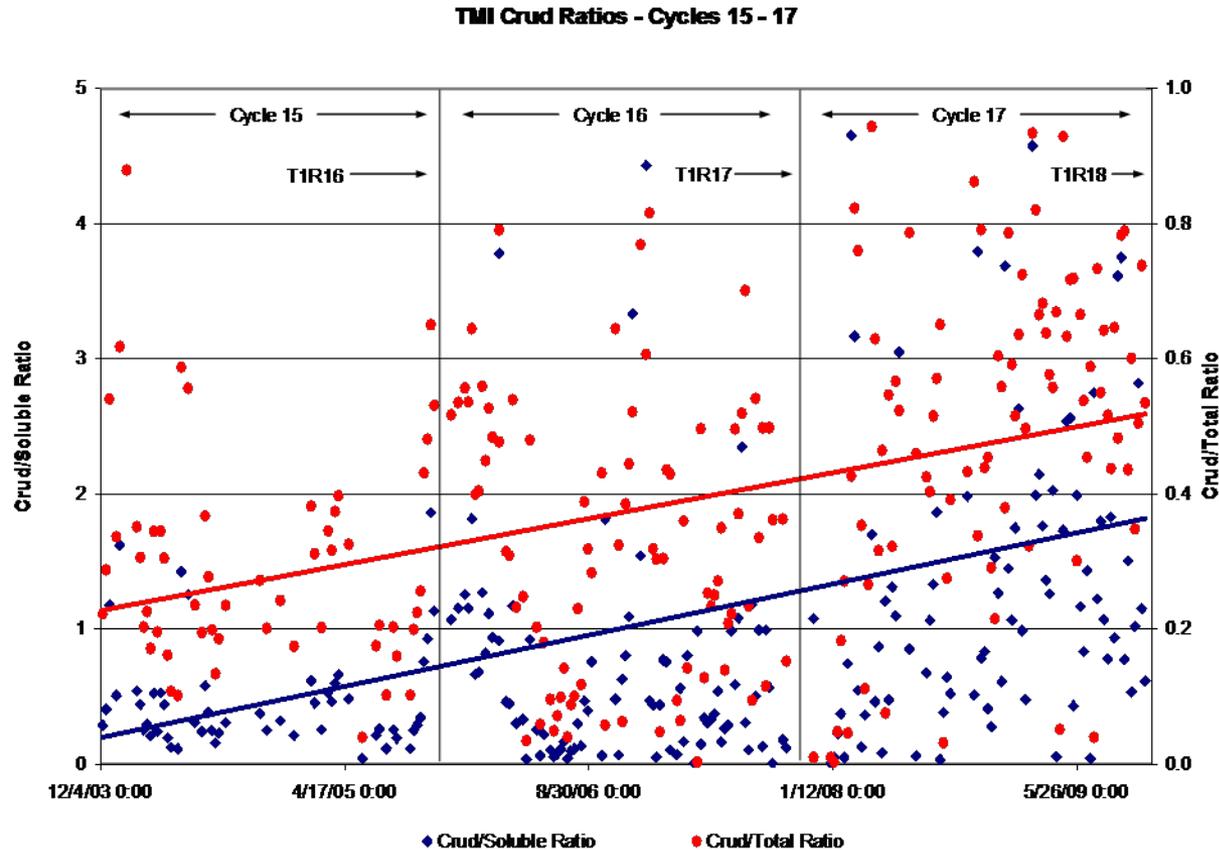
- ✓ **Dose & Activity Impact on T1R18**
- ✓ **Plant Status & Initial Plant Conditions**
- ✓ **Description of the Event**
- ✓ **Cause of the Event**
- ✓ **Immediate Actions Taken**
- ✓ **Impact on Workers**
- ✓ **Lessons Learned**

- ✓ Outage commenced on October 26, 2009
- ✓ Planned for 66 days
- ✓ Outage goal was 194 person-rem on an estimate of 211 person-rem
- ✓ Significant work included:
  - Replacement of Once Through Steam Generators
  - Alloy 600 Weld Mitigation
    - PZR Nozzles
    - Core Flood Nozzles
  - Refuel Floor Activities
- ✓ Forced Oxidation began on October 30, 2009

- ✓ Higher than expected dose rates were observed upon shutdown for T1R18
  - Dose rates were approx 20% higher than expected (compared to T1R17 dose rates)
  - Dose rate increase driven by higher coolant activity level as a result of higher particulates in RCS
  - Increased number of High Radiation Areas in the Reactor Building
  - Mitigating actions were implemented to reduce dose, but can not offset the higher rates
    - Additional shielding packages implemented
    - Additional RP Tech coverage to direct workers
    - Estimated Impact – 28 person-rem

## ✓ Causes of High RCS Activity Levels

- Fuel design changes have increased bundle crud deposition and subsequent coolant activity levels
  - Burnable poison rods (Gd) were added to allow less Boron loading and higher lithium at BOC – allowing better pH management
  - TMI began transition to AREVA HTP (High Thermal Performance) fuel in cycle 16.
  - Both of the above changes impact crud deposition and eventual crud release during shutdown.
- Mechanical Filter Use
  - Letdown and Seal Injection filter sizes may not be optimized to remove efficiently particulates
- Root Cause in Progress



Coolant crud levels have increased over the past two cycles. The fit lines (using linear regression statistical methods) show that the percentage of crud in reactor coolant samples has increased markedly from ~ 20% in cycle 15 to ~ 50% in cycle 17, some of which, as expected, was related to Zinc Injection.

- ✓ **Replacement of Both Once Through Steam Generators (OTSG's)**
- ✓ **Reactor Defueled**
- ✓ **Containment Construction Opening (26' x 23') in place to allow OTSG Movement in/out Reactor Building**
- ✓ **On 11/21/09, the "A" and "B" Reactor Coolant System Hot/Cold legs were severed and the "A" OTSG had been removed from the D-Ring.**
- ✓ **The "C" and "D" cold leg were severed and the cuts were taped.**
- ✓ **Workers were performing "A" cold leg cleaning to allow the pipe to be machined for the new OTSG**

- ✓ At approximately 1550 on Saturday 11/21/09, plant workers evacuated the Unit 1 Containment due to a confirmed Air Monitoring System Alarm (AMS-4)
- ✓ Several significant work activities were in progress at the time of the event, including:
  - Final severance of the “C” and “D” Cold Legs
  - Core Flood valve maintenance
  - Cleaning/vacuuming of the “A” Cold Leg
- ✓ A ventilation system lineup change (in progress at the time of the event) exacerbated the situation by distributing the fine particles of contamination throughout the reactor building.
- ✓ Approximately 175 workers were in the reactor building at the time of the event.
- ✓ 145 personnel were found to be Potentially contaminated internally (would not initially pass the PM-7)
- ✓ 17 were contaminated externally.
- ✓ Containment construction opening radiation monitors showed elevated readings - total effluent as a result of this event were .11 mrem additional dose to the public ( 0.7% of TMI’s annual limit of 15 mrem)

# A D-Ring - Vacuum in Background

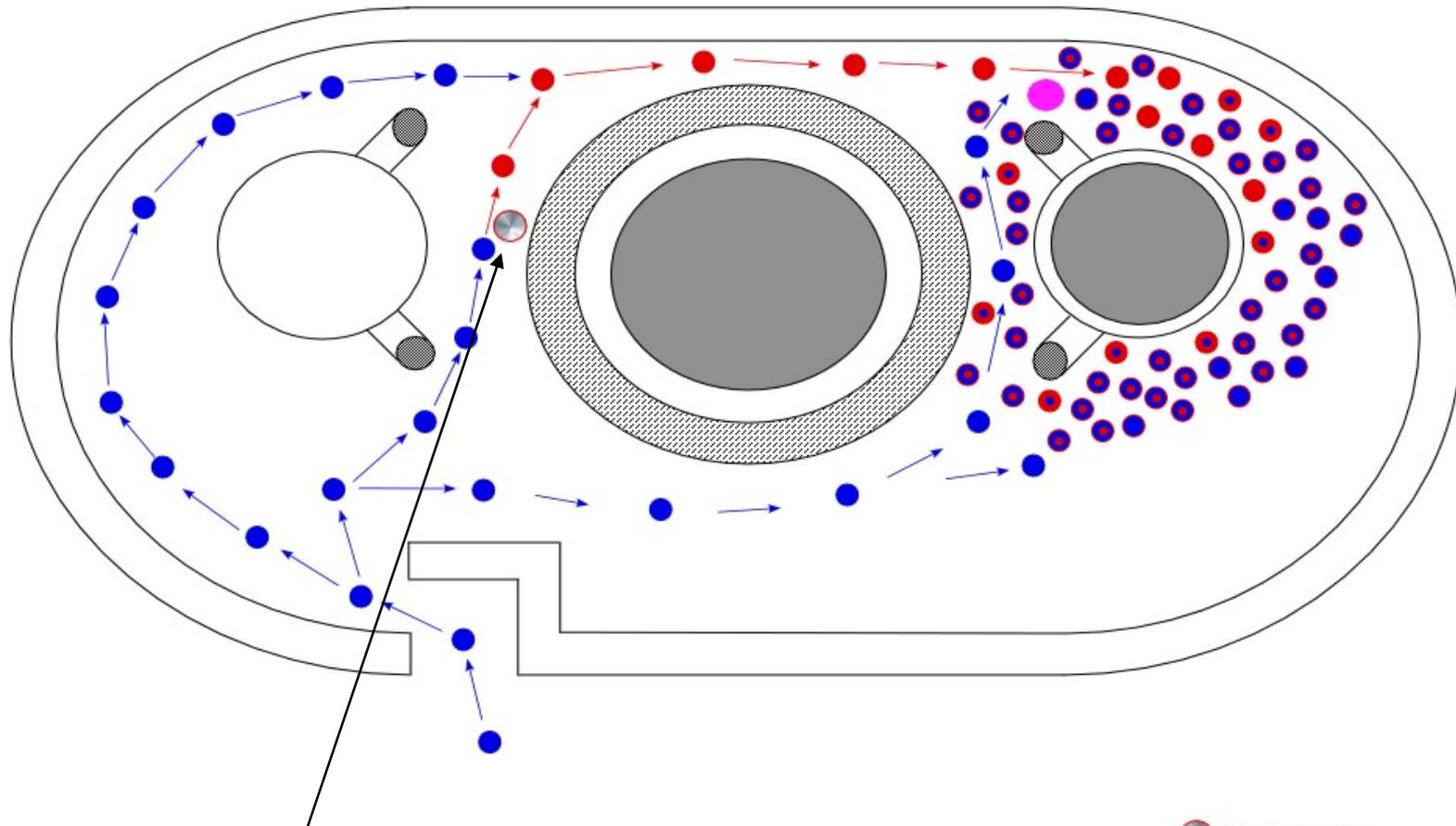


Vacuum  
SGR#1

“A” Cold  
Leg



**“A” Cold  
Leg Drain  
Line**



**Vacuum SGR#1**

-  SGR-1 Wet Only
-  Blue Contains No Contaminates
-  Red Contains Contaminates
-  Multi Color = Air in Vertical Movement
-  Solid Color = Air in Horizontal Movement
-  AMS-4

## ✓ The Root Cause of the event:

- Control of RCA wet vacuum cleaners
- Determined that the vacuum used to remove debris from the cold leg was a non-HEPA filtered wet vacuum.
- Site specific procedure guidance allowed the use of this type of vacuum for specific situations – specific for use to vacuum liquid.

## ✓ The Contributing Causes to the event:

- Oversight
- RP Tech Procedure Use/Adherence
- ALARA Pre-job Brief

- ✓ All wet vacs were removed from the RCA or disabled.
- ✓ Controls and barriers were implemented on the purge supply and exhaust fans.
- ✓ All RWP's were reviewed to ensure that the proper radiological controls (including the proper use of vacuums and HEPA's) were in place prior to resuming work.
- ✓ Field verification of radiological controls on all work associated with RCS components were performed and senior management approval granted prior to start of work.
- ✓ An independent review of the root cause team data and conclusion regarding direct cause of the event (i.e.; the wet vac) was conducted.
- ✓ Technician covering work was disqualified.
- ✓ Augment TMI staff with Fleet resources – 7 RPM or previous, 4 additional supervisors, 10 RP Technicians, and 2 ALARA

- ✓ **17 level 1 PCE's (personnel contamination's) occurred**
  - Level 1 is the lowest level of PCE (> 1000 dpm, < 50,000 dpm)
  - All 17 workers were decontaminated immediately following the event
  
- ✓ **145 workers initially alarmed the PM-7**
  - The highest initial whole body count dose was 38 mrem
  - Dose Calculations still in progress – external independent review
  - Expect less than 10 personnel expected to have dose assigned

## ✓ Communication Actions

- Plant Manager and Senior Management communications to workers at group meetings
- Personal letters to all 145 workers
- Multiple site-wide communications (news flash, SVP letter, TMI newsletter)

## ✓ Additional Actions

- Follow-up Whole Body Counts for all workers
- One-on-one interviews with all workers
- Independent review by Industry Expert
- Multiple independent technical reviews of personnel exposure data and basis for assigned dose

- ✓ Ensure that the site RP Manager reviews ALL internal and external Exelon communications involving radiological events to validate accuracy of the information
- ✓ Develop a corporate RP triage procedure to supports actions to take when dealing with a large number of personnel contamination events
  - Address creature comforts
  - screening methods
  - Corporate and site notifications
  - Rapid callout of additional support
  - Tracking of workers
- ✓ Evaluate addition of talking points (Q&A) to be added the Personnel Contamination Event procedure.
- ✓ Develop a backup method to quickly ascertain if workers are externally contaminated or have internal contamination in order to evaluate allowing workers to leave site and come back in 24 hours for a WBC instead of waiting for multiple hours for WBC when dealing with large groups.

- ✓ Develop criteria in the Personnel Contamination Event procedure to allow workers to be released from the RCA without passing a PCM or PM-7 in order to use the restroom.
- ✓ Evaluate replacement of NaI whole body counters.
- ✓ Evaluate addition of procedure guidance to the Bioassay Procedure for release of WBC printout sheets to workers.
- ✓ Validate that WBC libraries are appropriately established based on both on-line and shutdown.
- ✓ Validate that RP technicians get appropriate ALARA briefings and review and understand procedures

- ✓ Outage is still in-progress
- ✓ Replace Steam Generators in place
- ✓ Construction Opening Closed
- ✓ Refuel Core in Progress
- ✓ Delays encountered with weld overlay for core flood nozzles
- ✓ 264 person-rem on a re-estimate of 291 person-rem (accounts for scope growth and increased dose dose rates)
- ✓ NRC inspection into airborne event ongoing with an estimated exit week of 1/18/2010.

# Questions?