

COMBUSTIBLE GAS CONTROL
AMENDED RULE
IMPLEMENTATION
COMMITTEE

BWROG NRC TSTF-478 MEETING

APRIL 24, 2007

COMMITTEE OVERVIEW

Jim Kenny

COMBUSTIBLE GAS CONTROL
AMENDED RULE IMPLEMENTATION
COMMITTEE

PRESENTATION OBJECTIVE

- * Provide Background
- * Completed Activities
- * Remaining Issues/Concerns
- * Status of Committee Activities

COMBUSTIBLE GAS CONTROL AMENDED RULE IMPLEMENTATION COMMITTEE

* **PURPOSE OF COMMITTEE**

Assist Owners in realizing expected benefits from implementation of the Amended Combustible Gas Control Rule

- Assist Plants in Adopting CLIP
- Resolve Owner Questions on NRC Rule Package
- Establish design criteria for H₂-O₂ monitors
- Seek additional TS relief beyond Rule CLIP
- Assist Mark III Owners in resolving GSI-189

3

COMBUSTIBLE GAS CONTROL AMENDED RULE IMPLEMENTATION COMMITTEE

BACKGROUND

- * Revised CGC Rule & CLIP published Sept. 2003
- * Pilot for Risk Informed Regulation
- * Removes hydrogen concerns from design basis - severe accidents only

4

COMBUSTIBLE GAS CONTROL
AMENDED RULE IMPLEMENTATION
COMMITTEE

Design Criteria and Licensing
Requirement Document

- ◆ Monitors are non-safety related per Rule but considered important for severe accidents
- ◆ Completed Design Criteria Document in 2005
 - Using PRA, defined beyond design basis for monitors for BWR fleet including severe accidents
- ◆ Design Criteria Document submitted to NRC in October 2005 as part of comment to draft RG 1.7 Rev 3
- ◆ RG 1.7 Rev 3 released in March 2007 resolved comments and aligns with the BWROG document

5

COMBUSTIBLE GAS CONTROL
AMENDED RULE IMPLEMENTATION
COMMITTEE

GSI-189 Status

- ◆ Issue involves concerns with loss of power for hydrogen igniters from SBO with core damage for BWR Mark III and PWR Ice Condenser
- ◆ Multiple NRC meetings held with NEI to resolve issues
- ◆ NRC revised Regulatory Analysis
 - Indicates costs exceed benefits for BWRs
- ◆ BWR Mark III Owners have provided letters in 2007 with actions which are expected to provide closure to GSI-189

6

COMBUSTIBLE GAS CONTROL AMENDED RULE IMPLEMENTATION COMMITTEE

Licensing and Tech Spec Issues

- * BWR Owners have adopted original CLIP (TSTF-447)
- * TSTF-478 for beyond CLIP completed and submitted to NRC in April 2005
 - ◆ Eliminate CAD System
 - ◆ Fixes Igniter and Other TS Actions which requires retention of recombiners
 - ◆ O₂ Concentration Relaxations based on removal of hydrogen concern from design basis

7

COMBUSTIBLE GAS CONTROL AMENDED RULE IMPLEMENTATION COMMITTEE

Licensing and Tech Spec Issues

- * Need to resolve review and schedule for TSTF-478
- * TSTF is high priority for BWRs
- * CAD elimination and need to remove recombiners is priority
 - ◆ Duane Arnold is lead for CAD

8

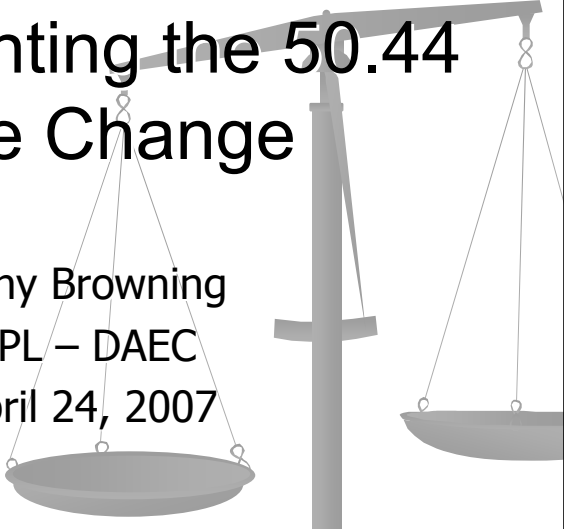
COMBUSTIBLE GAS CONTROL
AMENDED RULE IMPLEMENTATION
COMMITTEE

REMAINING ACTIVITIES

- * TSTF-478 changes.
- * Support BWR Owner closure for GSI-189
- * Closure of Committee after Tech Spec change approval

TSTF-478

Implementing the 50.44 Rule Change



Tony Browning
FPL – DAEC
April 24, 2007

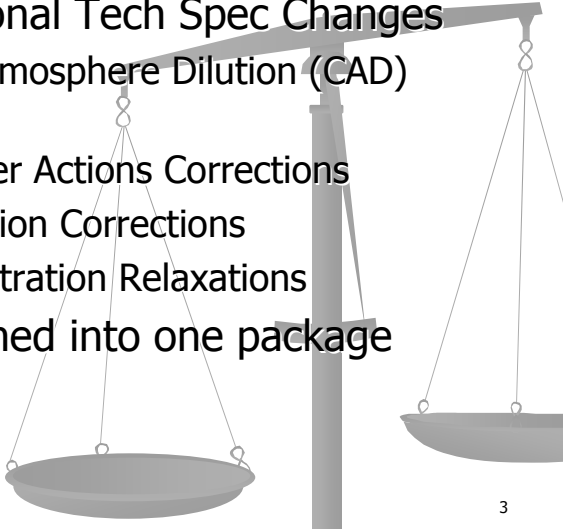
TSTF-478



Purpose of Presentation

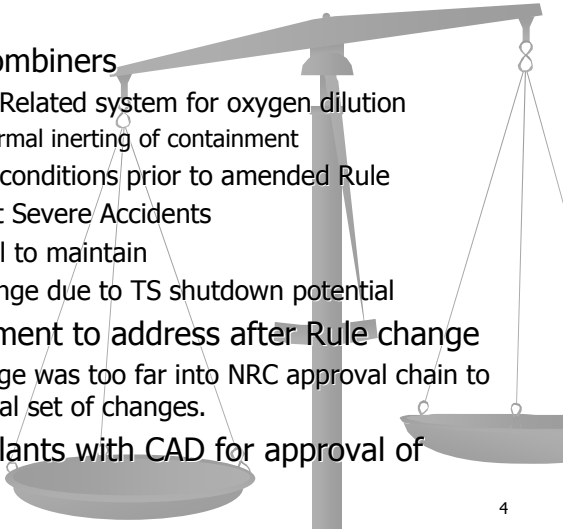
- Discuss the individual Tech Spec changes
- Summarize the NRC RAI and TSTF response
- Discuss open issues

TSTF-478

- Need for Additional Tech Spec Changes
 - Containment Atmosphere Dilution (CAD) Elimination
 - Hydrogen Igniter Actions Corrections
 - Drywell Fan Action Corrections
 - Oxygen Concentration Relaxations
 - Changes combined into one package (TSTF-478)
- 

3

TSTF-478

- CAD Elimination
 - Analogous to Recombiners
 - Dedicated, Safety Related system for oxygen dilution
 - Not used for normal inerting of containment
 - Designed for DBA conditions prior to amended Rule
 - Ineffective in most Severe Accidents
 - Not Cost-Beneficial to maintain
 - Operational challenge due to TS shutdown potential
 - TSICC/NRC agreement to address after Rule change
 - Rulemaking package was too far into NRC approval chain to include with original set of changes.
 - Priority issue for plants with CAD for approval of change
- 

4

TSTF-478

- Hydrogen Igniter TS Action Corrections
 - Fix Bases for inoperable Igniters to no longer require Recombiners to be Operable.
 - Action requires recombiner in one hour and allows operation for 7 days
 - Tie to recombiner was missed in Rule TSTF-447
 - Action tied to SAMG consistent with Rule conclusion as need for severe accidents
 - Change based on Rule conclusion and supporting analysis that recombiners can be eliminated
 - PRA analysis performed
 - Concludes minimal risk impact
 - SAMG actions defined

5

TSTF-478

Drywell Fans Action Corrections

- Delete action for loss of both drywell fans
 - Requires recombiner to be maintained
 - Action requires recombiner in one hour and operation for 7 days
 - Tie to recombiner was missed in Rule TSTF-447
- Change based on Rule conclusion and supporting analysis that recombiners can be eliminated
- PRA analysis performed for loss of fans
 - Concludes minimal impact
- SAMG action defined including use of drywell sprays
- Mixing issue addressed
 - Mark II containment designed for mixing
 - Drywell sprays will assist in mixing

6

TSTF-478

- Oxygen Concentration Relaxations
 - Based on conclusions of 50.44 that hydrogen production was not risk significant for design basis
 - UFSAR analysis of hydrogen/oxygen eliminated
 - Proposed change is an operational enhancement
 - Simplify Applicability to MODE 1 only vs. 15% power
 - Revise Completion Time to 72 hours
 - Add LCO 3.0.4.c Note to allow MODE changes (startup) in Action Statement
 - Add Bases allowance to enter Actions during Shutdowns

7

TSTF-478

- Oxygen Concentration Relaxations (cont)
 - Significant improvement in Startup/Shutdown flexibility
 - Allows containment access during startup
 - Permits inerting after reaching steady state
 - PRA work performed to support 72 hours
 - Concludes acceptable risk impact
 - Minor increase in deinerted time expected for "normal" startup as inerting is not critical path
 - Minor impact expected on shutdown

8

TSTF-478

- TSTF-478 Open Issues
 - Single TSTF #478 used to package changes
 - Issues appear to be with time deinerted and hydrogen igniters
 - Need to reach agreement on risk impacts

9

TSTF-478

RAI RESPONSE AND TSTF REVISION

- RAI provided on November 9, 2006 with response on February 7, 2007
- Revision to TSTF-478 provided eliminating request for drywell purge change
- RAI's provided on
 - Extending the period of deinerted operation from 24 to 72 hours
 - Retaining the Completion Time for Restoring Systems including igniters
 - Mixing impacts for drywell fans and drywell purge
- No RAI issues on CAD change

10

Probabilistic Risk Sensitivity Cases To Examine TSTF-478 Changes

E.T. Burns (BWROG)
April 24, 2007

Purpose

- Provide risk insights to decision-makers for TSTF-478
- Examine the range of uncertainties and modeling assumptions as they affect:
 - Mark I & II Plants: Extending the deinerted duration per shutdown
 - Mark III Plants: Retaining the Completion Time for Cases with both igniter divisions unavailable

Methodology

- Provide range of sensitivity cases to support input to decision-makers
- Use available PRA information for accident sequence frequencies
- Use deterministic calculations to characterize plant conditions, accident timing, radionuclide release magnitude
- Incorporate insights from external event risk contributors

C102070003-7636 / 3

Treatment of External Events

- RG 1.174 expects consideration of external events
- Currently, no PRA Standard for Fire PRAs
- Currently, no Seismic PRA meets ANS Seismic PRA Standard
- Comparing the level of detail and quality of the Internal and External Events PRAs indicates the conservative biases that are introduced in the external events analysis

Conclusion:

- Comparing the calculated risk metrics must be done with care recognizing the biases

C102070003-7636 / 4

Mark I & II Plants

Time Deintered at the Shutdown and
Startup for Outages

Risk Metrics

- Implement RG 1.174 Guidelines
- Time deintered does not affect CDF
- Time deintered may impact LERF for a subset of the accident spectrum
 - Short term core damage events (referenced as "early" or "fast")
 - No mitigation available
- Δ LERF compared with Acceptance Guidelines

RG 1.174 Guidelines

- In the context of **integrated decision making, the acceptance guidelines should not be interpreted as being overly prescriptive.** They are intended to provide an indication, in numerical terms, of what is considered acceptable. As such, the numerical values associated with defining the regions in Figures 3 and 4 of this **regulatory guide are approximate values that provide an indication of the changes that are generally acceptable.**
- Because of the way the acceptance guidelines were developed, the appropriate numerical measures to use in the initial comparison of the PRA results to the acceptance guidelines are **mean values.**

C102070003-7636 / 7

RG 1.174 Guidelines (cont'd)

- Consistent with **the viewpoint that the guidelines are not to be used prescriptively,** even if the calculated Δ CDF and Δ LERF values are such that they place the change in Region I or II, it may be possible to make a case that the application should be treated as if it were in Region II or III if, for example, it is shown that there are unquantified benefits that are not reflected in the quantitative risk results.

C102070003-7636 / 8

Qualitative Basis for Increase in Deinerted Allowance

- The change in allowed deinerted time is considered acceptable given the following:
 - The change is desirable from an operations standpoint
 - The change is consistent with the conclusion of the Combustible Gas Rule that hydrogen production is not risk significant for design basis events
 - The change recognizes the significant improvement in plant operations that have reduced the number of outages and scrams per year that require deinerted operation and this trend is expected to continue
 - The change recognizes that refuel outages are occurring less frequently due to longer fuel cycles

C102070003-7636 / 9

Conservatisms Introduced for Bounding Case

- Assumes that total deinerted time is always used for Shutdowns and Startups.
 - The maximum deinerted time of 72 hours is not expected to be used unless operational problems arise for startup
 - No significant change is expected from current Shutdown practices for deinerting
 - Not all shutdowns result in containment deinerting
- No credit for lower power levels during the shutdown and start up process which would reduce the CDF, i.e., the challenges to a LERF

C102070003-7636 / 10

Conservatisms Introduced for Bounding Case (cont'd)

- No credit for potential mitigation of deinerted conditions following core damage
- External event contributions are based on analyses that are conservatively biased: No External Event PRA has been performed using a Standard to ensure level of detail and quality to the same level of realism as the Internal Events PRAs.

C102070003-7636 / 11

Results of Extending the Deinerted Duration

Acceptable Results for Increased Deinerted Times

Δ LERF Range of Sensitivity Calculations ⁽¹⁾	Δ LERF Regulatory Guide 1.174 Criteria for Region	
6.0E-8/yr to 2.8E-7/yr	III <1E-7/yr	Very Small Risk Change
	II <1E-6/yr	Small Risk Change

⁽¹⁾ Includes internal and external event contributors

C102070003-7636 / 12

Extending the Deinerted Duration Per Shutdown (Includes External Events)

Acceptable Risk Changes

Case	No. of Refuel /yr	No. of Forced Outages/yr	No. of Trips/yr	Deinerted (Hours/yr)			Δ LERF	RG 1.174 Region
				Base	Sensitivity	Δ		
Base ⁽²⁾	1	0	0	48	144	96	6.2E-8	III
S0 ^{(2), (3), (4)}	0.5	1	1	96	216	120	7.6E-8	III
S7 ^{(1), (3)} (Bounding)	0.5	1	1	124	310	240	2.87E-7	II

- (1) No credit for mitigation of severe accident with deinerted containment conditions.
 (2) Minimal credit for use of combustible gas control per SAMGs.
 (3) Cases S0 and S7 are judged to be conservative because not all trips or forced outages will result in deinerting the containment as assumed in these cases.
 (4) Shutdown deinerted time is limited to 24 hours for refuel and forced outages.

C102070003-7636 / 13

Deinerted Risk Change By Hazard Contributor

Extending the Deinerted Duration Per Shutdown

Case	Δ LERF				Meet Acceptance Guideline RG 1.174	
	Internal	Fire ⁽¹⁾	Seismic ⁽¹⁾	Total	Very Small Risk	Small Risk
Base	1.4E-08	3.7E-08	1.1E-08	6.2E-08	Yes	Yes
S0	1.7E-08	4.6E-08	1.3E-08	7.6E-08	Yes	Yes
S7 (Bounding)	6.5E-08	1.7E-07	5.0E-08	2.87E-07	No	Yes

- (1) External event contributions are based on analyses that are conservatively biased: No External Event PRA has been performed using a Standard to ensure level of detail and quality to the same level of realism as the Internal Events PRAs.

C102070003-7636 / 14

Deinerted Risk Change (Internal Events)

Extending the deinerted duration per shutdown is within the “Very Small Risk” change regime for all sensitivity cases

Case	Δ LERF	Meet Acceptance Guideline RG 1.174 Very Small Risk
	Internal	
Base	1.4E-08	Yes
S0	1.7E-08	Yes
S7	6.5E-08	Yes

C102070003-7636 / 15

Extending the Deinerted Duration Per Shutdown

- The proposed deinerted time extension from 24 hours to 72 hours meets the very small risk change region of RG 1.174 for the expected cases of shutdowns during any given year.
- Considering the conservatisms in the analysis the proposed change is judged to be within the very small risk change region of RG 1.174.

C102070003-7636 / 16

Mark III Plants

Completion Time for Both Igniter
Divisions Unavailable

Risk Metrics

- Implement Guidelines from:
 - RG 1.174
 - RG 1.177
- Igniter availability does not affect CDF
- Igniter availability may impact LERF for a subset of the accident spectrum
 - Short term core damage events (referred to as "early" or "fast")
 - Events at low RPV pressure
- ICLERP and Δ LERF compared with Acceptance Guideline

Summary of Mark III Deterministic Calculation Insights

- Stoichiometric mixtures result in pressure that can just barely exceed the failure pressures of both the drywell (compression) and the containment
- The radionuclide release for low pressure failures occurs at times that are in the non-LERF regime
- The deterministic calculations indicate radionuclide releases less than "high" for the coincident DW and WW failures (conservatively not included in probabilistic sensitivity assessment)
- An NRC sponsored MELCOR sensitivity calculation⁽¹⁾ indicates higher conditional containment failure probabilities without igniters

⁽¹⁾ NRC sponsored MELCOR Deterministic Calculation used as basis for inputs to this probabilistic calculation (MELCOR calculation has not been reviewed by BWROG, only results identified to BWROG).

[Memorandum to Nuclear Regulatory Commissioners from L.A. Reyes (EDO), STATUS OF STAFF ACTIVITIES TO RESOLVE GENERIC SAFETY ISSUE 189, "SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT", dated June 14, 2005.]

C102070003-7636 / 19

NRC Sponsored MELCOR Calculation⁽¹⁾ Appears Conservative

- No spontaneous or spark induced hydrogen ignition when combustible mixtures are present unless it fails containment and DW (Page 22) ⁽¹⁾
- H₂ ignition occurs when deflagration would cause containment and drywell failure for the no igniter case
- Result is 100% of the cases without igniters result in containment and drywell failure (High CCFP)⁽²⁾

⁽¹⁾ NRC sponsored MELCOR Deterministic Calculation used as basis for inputs to this probabilistic calculation (MELCOR calculation has not been reviewed by BWROG, only results identified to BWROG).

[Memorandum to Nuclear Regulatory Commissioners from L.A. Reyes (EDO), STATUS OF STAFF ACTIVITIES TO RESOLVE GENERIC SAFETY ISSUE 189, "SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT", dated June 14, 2005.]

⁽²⁾ A high CCFP does not mean a LERF. Timing of Low Pressure Events that lead to release are generally not within LERF definition.

C102070003-7636 / 20

Retaining Completion Time: Both Igniter Divisions Unavailable (With External Events)

No.	Case	ICLERP	ICLERP RG 1.177 Criteria
1	Base Case	3.5E-8	<5E-8
2	MELCOR ⁽¹⁾ Sensitivity	1.46E-7	
3	Modified MELCOR ⁽¹⁾ Case	4.6E-8	

⁽¹⁾ NRC sponsored MELCOR Deterministic Calculation used as basis for inputs to this probabilistic calculation (MELCOR calculation has not been reviewed by BWROG, only results identified to BWROG).

[Memorandum to Nuclear Regulatory Commissioners from L.A. Reyes (EDO), STATUS OF STAFF ACTIVITIES TO RESOLVE GENERIC SAFETY ISSUE 189, "SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT", dated June 14, 2005.]

C102070003-7636 / 21

Contributors to the ICLERP for the Three Cases (Internal Events)

Case	ICLERP (RG 1.177)	
	Internal Events	Meet RG 1.177 Guideline
Base Case	1.0E-08	Yes
MELCOR ⁽¹⁾	4.53E-08	Yes
Modified MELCOR ⁽¹⁾	1.37E-08	Yes

⁽¹⁾ NRC sponsored MELCOR Deterministic Calculation used as basis for inputs to this probabilistic calculation (MELCOR calculation has not been reviewed by BWROG, only results identified to BWROG).

[Memorandum to Nuclear Regulatory Commissioners from L.A. Reyes (EDO), STATUS OF STAFF ACTIVITIES TO RESOLVE GENERIC SAFETY ISSUE 189, "SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT", dated June 14, 2005.]

C102070003-7636 / 22

Retaining Completion Time for Cases with Both Igniter Divisions Unavailable

- The Completion Time of 7 days meets the RG 1.177 Acceptance Guideline of ICLERP $<5E-8$ using best estimate calculations.
- The Completion Time of 7 days meets the RG 1.174 Acceptance Guideline for Region III on Δ LERF for all cases.