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DATE OF MEETING

8/13/01

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Docket Number(s)

Project No 691

Plant/Facility Name

BWROG

TAC Number(s) (if available)

MB 2228

Reference Meeting Notice

8/1/01

Purpose of Meeting  
(copy from meeting notice)

Discuss BWROG, June 22, 2001  
topical on 12/02 Monitors +  
Combustible Gas Control

NAME OF PERSON WHO ISSUED MEETING NOTICE

Robert M Pulsifer

TITLE

Project Manager

OFFICE

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DLPM

BRANCH

PD I-2

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Docket File/Central File  
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DF03

**H<sub>2</sub>/O<sub>2</sub> Monitors  
Combustible Gas Control Systems  
(CGCS)**

**Regulatory Relaxations**

**BWR Owners' Group  
Licensing Topical Report  
Summary Presentation**

**August 13, 2001  
Washington, DC**

# **H<sub>2</sub>/O<sub>2</sub> Monitors, Combustible Gas Control Systems Regulatory Relaxations**

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## **BWROG Committee Participation:**

- **H<sub>2</sub>/O<sub>2</sub> Monitor – 19 of 20 BWR owners**
- **Combustible Gas Control Systems - 17 of 20 BWR owners**

# **H2/O2 Monitors and Combustible Gas Control Systems**

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- **NRC Proceeding on Risk-Informing 10CFR50.44**
  - Long term accident management/mitigation - retain recombiners but put into lower safety category
  - For Mark III – consider new requirement for igniter operability during SBO accident sequence
  - Retain requirements for inerting
  - Hydrogen measurement capability retained, but relax safety classification
- **NRC schedule has been delayed; completion date uncertain**

# **H<sub>2</sub>/O<sub>2</sub> Monitors and Combustible Gas Control Systems Status**

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- BWROG Licensing Topical Report submitted on June 22, 2001
- Demonstrates that Combustible Gas Control Systems (CGCS) and the associated H<sub>2</sub> and O<sub>2</sub> monitoring equipment are not required for realistic design basis accidents

# **H2/O2 Monitors and Combustible Gas Control Systems Regulatory Requirements**

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- Controlling regulations (10CFR50.44 and App. A GDC 41,42,43) do not specify CGCS and associated monitors must be safety grade
- Interpretation of items to be safety grade based on RG 1.7 and 1.97
- Requested relaxations may not require rule change

# **H2/O2 Monitors and Combustible Gas Control Systems**

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Estimated Cost Savings Per Plant Are Substantial if  
Equipment is Downgraded to Non-safety:

- Maintaining of containment air dilution system:  
\$50-100K/year
- H2 recombiners: At least \$25K/year
- H2/O2 monitors: \$40-75K/year
- H2/O2 monitor replacement: At least \$400-900K

# **H<sub>2</sub>/O<sub>2</sub> Monitors and Combustible Gas Control Systems**

- Expected benefits of using non-safety monitoring equipment
  - Existing monitors employ older technologies that are less reliable than newer available technologies
  - Newer design are easier to maintain, pressure and temperature compensated, have lower drift, and simpler calibration procedures
  - Newer designs typically not qualified for safety related use
- Commercial grade H<sub>2</sub> and O<sub>2</sub> monitors expected to improve equipment reliability while reducing maintenance costs
  - Would also allow replacement of selected components of existing systems with commercial grade items



# **H2/O2 Monitors and Combustible Gas Control Systems**

- **Special Treatment Requirements Do Not Increase Reliability for This Equipment**
  - Seismic – not needed to mitigate seismic event and equipment does not perform/ensure any safety-related function
  - Outside containment - not subject to harsh environment
  - All components are purchased or evaluated for their functional requirements and applicable environmental conditions (temp, pressure, radiation) prior to installation
  - Allowing commercial grade equipment would not affect plant safety and is expected to improve reliability

# **H2/O2 Monitors and Combustible Gas Control Systems**

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- BWROG employed deterministic calculations to determine potential need / benefits of Combustible Gas Control Systems
  - Hydrogen recombiners
  - Containment Air Dilution Systems (CAD Systems)
  - Igniters (currently used on Mark III BWRs only)
- Calculations based on BWRs with bounding thermal power / containment free volume to maximize impact of radiolysis
  - Maximum power / smallest containments

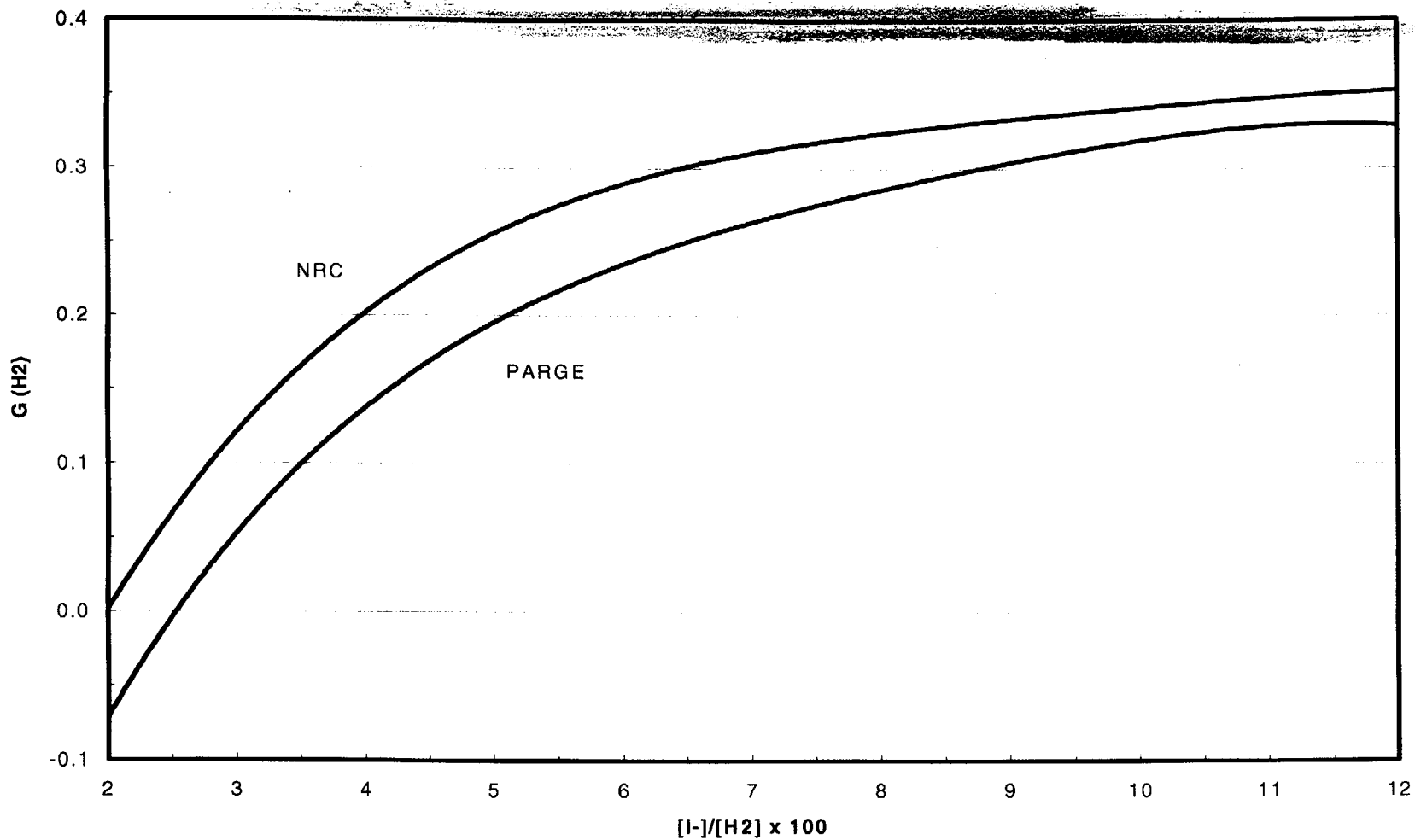
# **Combustible Gas Control Systems**

## **Bounding Parameters for MWt/Containment Volume**

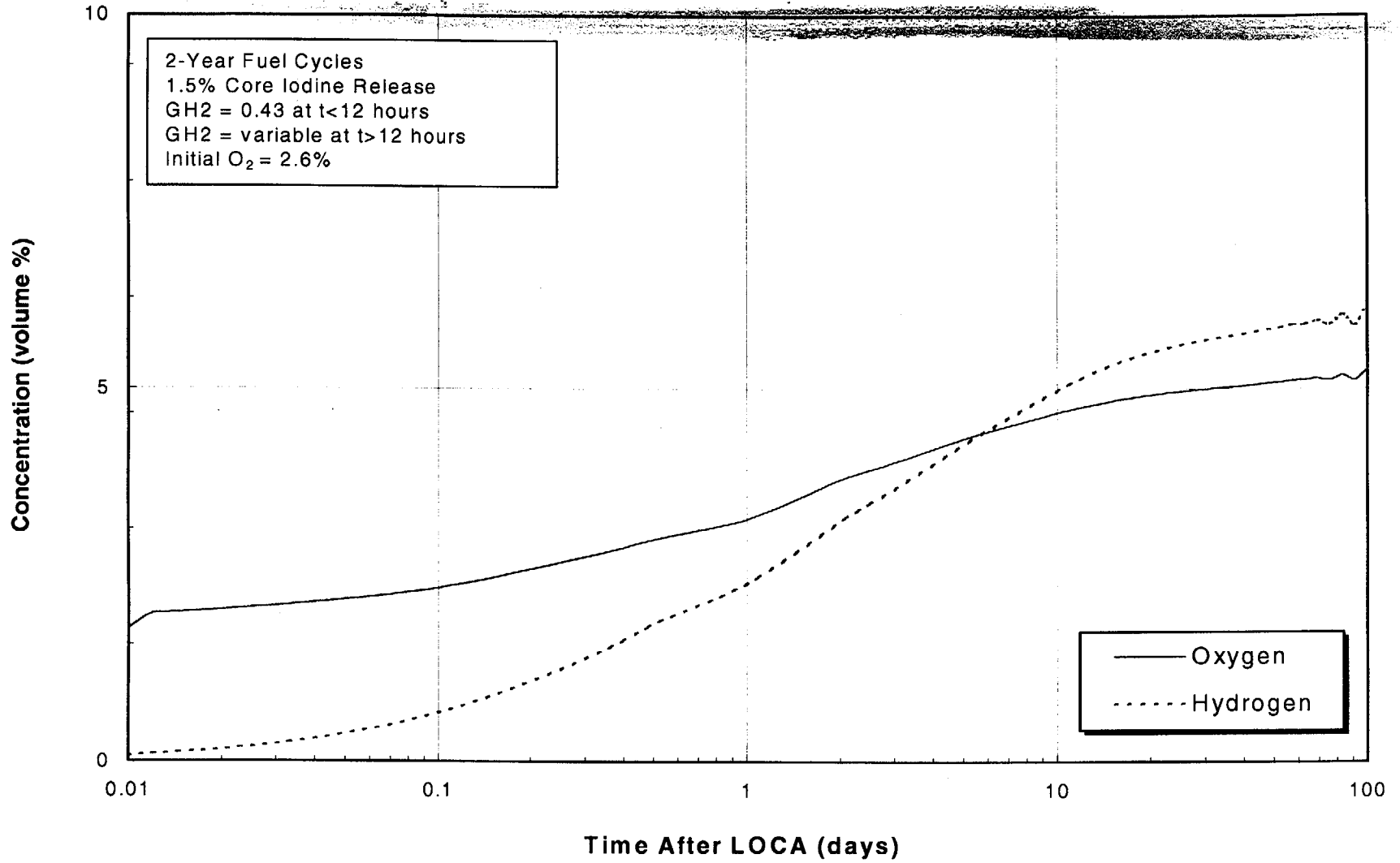
### **Mark I and II / Mark III**

- Rated power 4031/3910  
(includes 20% uprate + 2%)
- DW free vol.- ft<sup>3</sup>  
163,700/270,016
- WW free  
vol.134,800/1,303,888
- Initial DW °F 145/145
- Initial WW °F 95/95
- Boiling G(H<sub>2</sub>) 0.43/0.43  
(molecules/100 ev)
- Non-boiling G(H<sub>2</sub>)  
0.01 -0.43 / 0.01 - 0.43
- Initial DW rel.H 20/20
- Initial WW rel.H 100/100
- Primary coolant boiling  
time 12/12 (hours)
- Core lower bound I  
release (%) 1.5/1.5
- Upper bound I 30/30
- Initial O<sub>2</sub> (%) 2.6/20.9

# Effect of Liquid Phase Iodine and Hydrogen Concentration on Hydrogen Yield



# Mark I or II Drywell Atmosphere with 1.5% Core Iodine

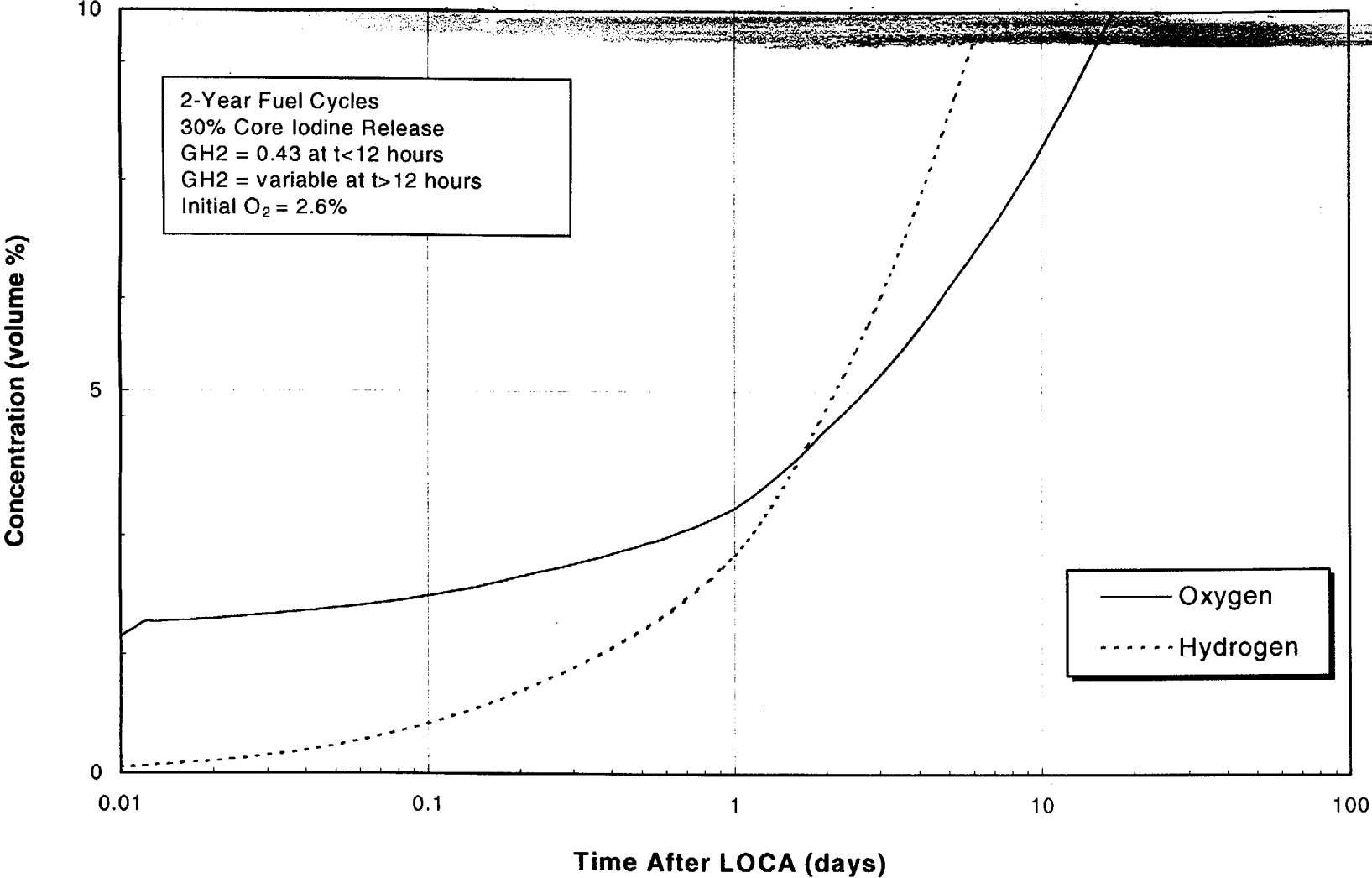


# **Combustible Gas Control Systems**

## **Mark I/II Conclusion for 1.5% Core Iodine Release**

- 1.5% core iodine release is ultra-conservative
  - “Nominal” PCT is approx. 1100 °F
  - UBPCCT is less than 1600° F
  - No fuel damage expected at UBPCCT
- 5% RG 1.7 concentrations not exceeded for 32 days (2.6% initial O<sub>2</sub>)
  - 10 days for 3% initial O<sub>2</sub>
  - Some BWR inert to less than 1%
- No need for CGCS for realistic design basis accident

# Mark I or II Drywell Atmosphere with 30% Core Iodine

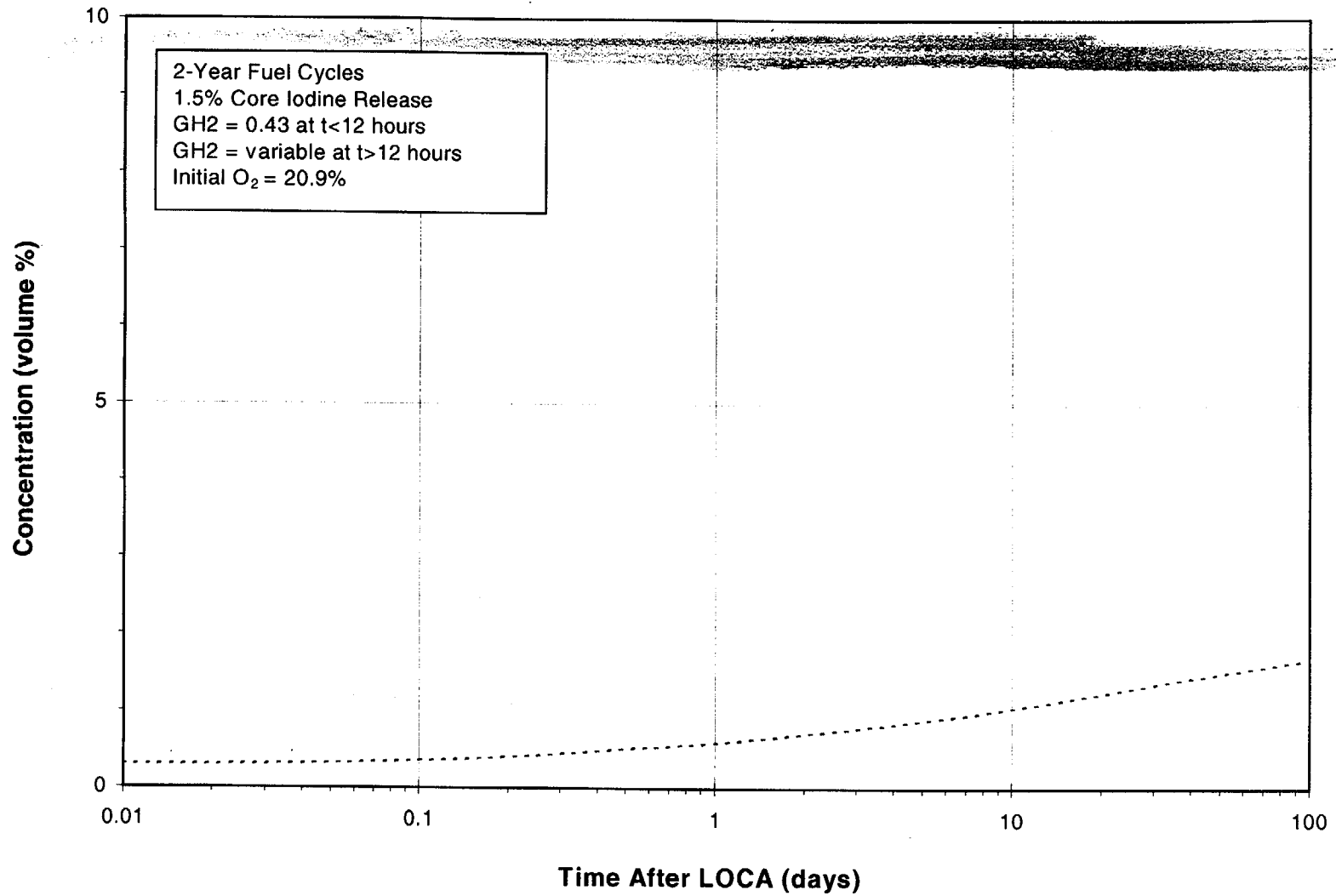


# **Combustible Gas Control Systems Mark I/II Conclusion for 30% Core Iodine Release**

- 5% RG 1.7 concentrations exceeded at 3.6 days (2.6% initial O<sub>2</sub>)
- CGCS could be beneficial for severe accidents
  - Not needed until O<sub>2</sub> concentration approaches 5%
- Hydrogen from metal-water reaction at time zero is not a concern because containment is inerted



# Mark III Containment Hydrogen with 1.5% Core Iodine



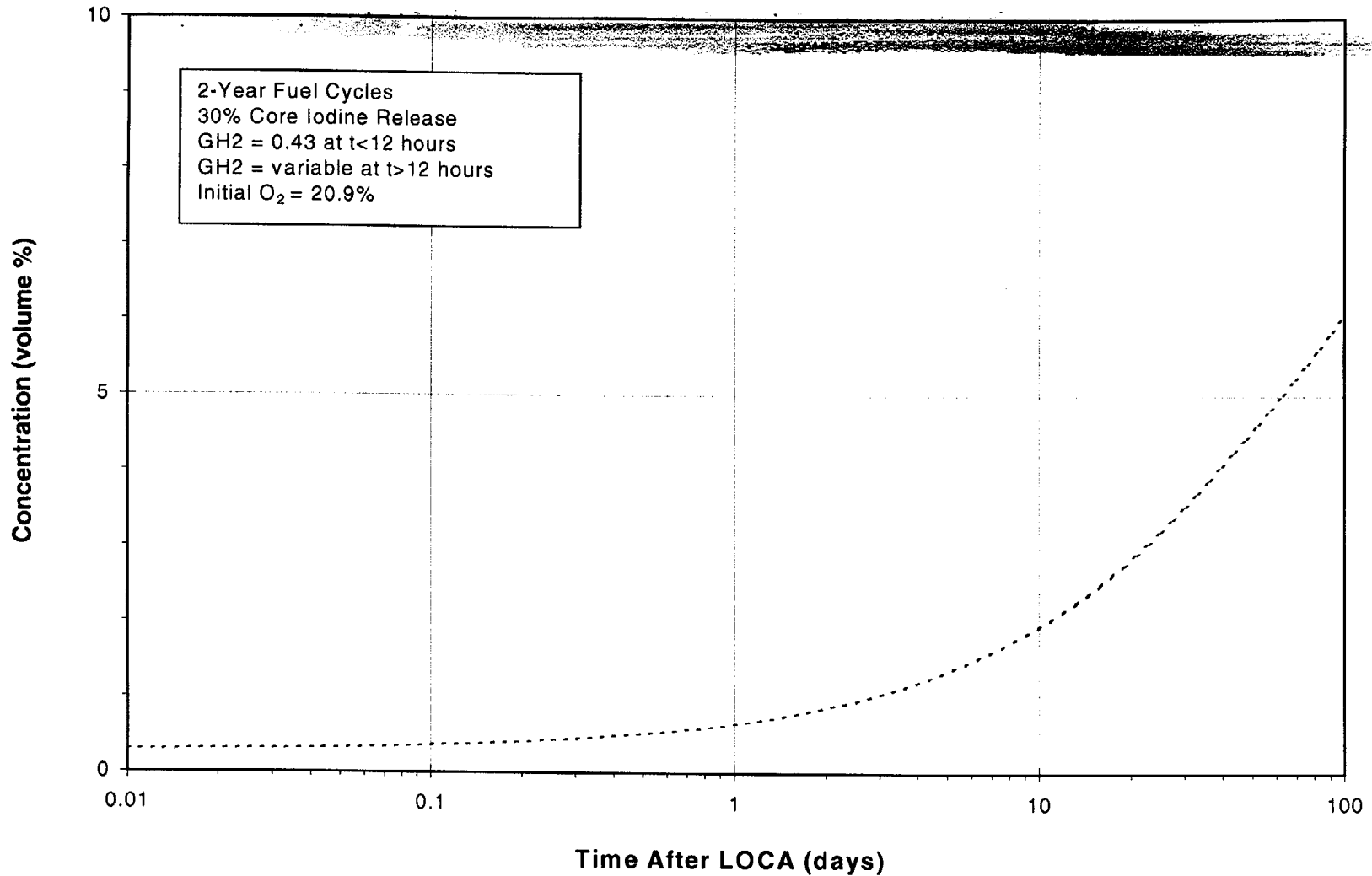
# **Combustible Gas Control Systems**

## **Mark III Conclusion for 1.5%**

### **Core Iodine Release**

- Unlike Mark I/II BWRs, Mark III flammability control is on H<sub>2</sub> not O<sub>2</sub>
- Because of large containment, H<sub>2</sub> concentration does not exceed RG 1.7 limit of 4% within 200 days
  - Only 1.7% at 100 days
- No need for CGCS for realistic design basis accident

# Mark III Containment Hydrogen with 30% Core Iodine



# **Combustible Gas Control Systems Mark III Conclusion for 30% Core Iodine Release**

- H<sub>2</sub> concentration does not exceed RG 1.7 limit of 4% until after 38 days; therefore, recombiners not required to address radiolysis
- H<sub>2</sub> from severe accident metal-water reaction at time zero is a concern because containment is not inerted
- Igniters employed to address H<sub>2</sub> from metal-water reaction
- Recombiners are of no value for Mark III containments and should be removed
  - Not redundant to igniters due to low capacity

# **Combustible Gas Control Systems Conservatisms Employed**

- Fraction of gamma energy absorbed in coolant
  - 10% used
  - For boiling better estimate is 2% for fast neutrons and less than 5% for gamma
  - For non-boiling 10% is still somewhat conservative
- Decay power over-estimated by 20%
- Length of boiling period
  - 12 hours versus 2-3 hours actual
- Containment leakage neglected
- NRC radiolysis model G-values are 10-20% higher than more rigorous PARGE model
- No metal-water reaction for Mark I/II
  - H<sub>2</sub> dilutes O<sub>2</sub> generated by radiolysis

# **H2/O2 Monitors and Combustible Gas Control Systems Summary and Conclusions**

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- Radiolysis from realistic design basis scenarios will not result in combustible gas concentrations above RG 1.7 limits
- CGCS not required for realistic design basis events
- CGCS only beneficial for low probability severe accident events
- For low probability severe accident events, regulations do not require safety grade equipment designs

# **H2/O2 Monitors and Combustible Gas Control Systems Summary and Conclusions**

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- **Combustible Gas Control Systems**
  - Eliminate safety related classification requirements for recombiners
  - For Mark IIIs, eliminate requirements for recombiners and rely exclusively on igniters
  - Eliminate safety related classification for vent and purge systems (Containment Air Dilution Systems)
  - Delete primary containment hydrogen recombiner Standard Technical Specification requirements

# **H<sub>2</sub>/O<sub>2</sub> Monitors and Combustible Gas Control Systems Summary and Conclusions**

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## ■ H<sub>2</sub> / O<sub>2</sub> Monitors

- Eliminate requirements for O<sub>2</sub> monitors for Mark III plants
- Eliminate safety related classification for H<sub>2</sub> and O<sub>2</sub> monitors
  - Needed for severe accidents and core damage assessment
  - Commercial grade acceptable
- Remove H<sub>2</sub> and O<sub>2</sub> analyzers from the Post Accident Monitoring Standard Technical Specification requirements