NRC FORM 658
(9-1999)

U.S. NUCLEAR REGULATORY COMMISSION

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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): MB2228

Reference Meeting Notice: 8/1/01

Purpose of Meeting (copy from meeting notice): Discuss BWROG, June 22, 2001 topical on H2/O2 Monitors + Combustible Gas Control

NAME OF PERSON WHO ISSUED MEETING NOTICE: Robert M Pulsifer

TITLE: Project Manager

OFFICE: NRR

DIVISION: DLPM

BRANCH: PD I-2

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DF03

H_2/O_2 Monitors Combustible Gas Control Systems (CGCS) Regulatory Relaxations

BWR Owners' Group Licensing Topical Report Summary Presentation

August 13, 2001

Washington, DC

H_2/O_2 Monitors, Combustible Gas Control Systems Regulatory Relaxations

BWROG Committee Participation:

- H_2/O_2 Monitor – 19 of 20 BWR owners
- Combustible Gas Control Systems - 17 of 20 BWR owners

H2/O2 Monitors and Combustible Gas Control Systems

- 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

H2/O2 Monitors and Combustible Gas Control Systems Status

- BWROG Licensing Topical Report submitted on June 22, 2001
- Demonstrates that Combustible Gas Control Systems (CGCS) and the associated H_2 and O_2 monitoring equipment are not required for realistic design basis accidents

H2/O2 Monitors and Combustible Gas Control Systems Regulatory Requirements

- 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

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

H2/O2 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_2 and O_2 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

- 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

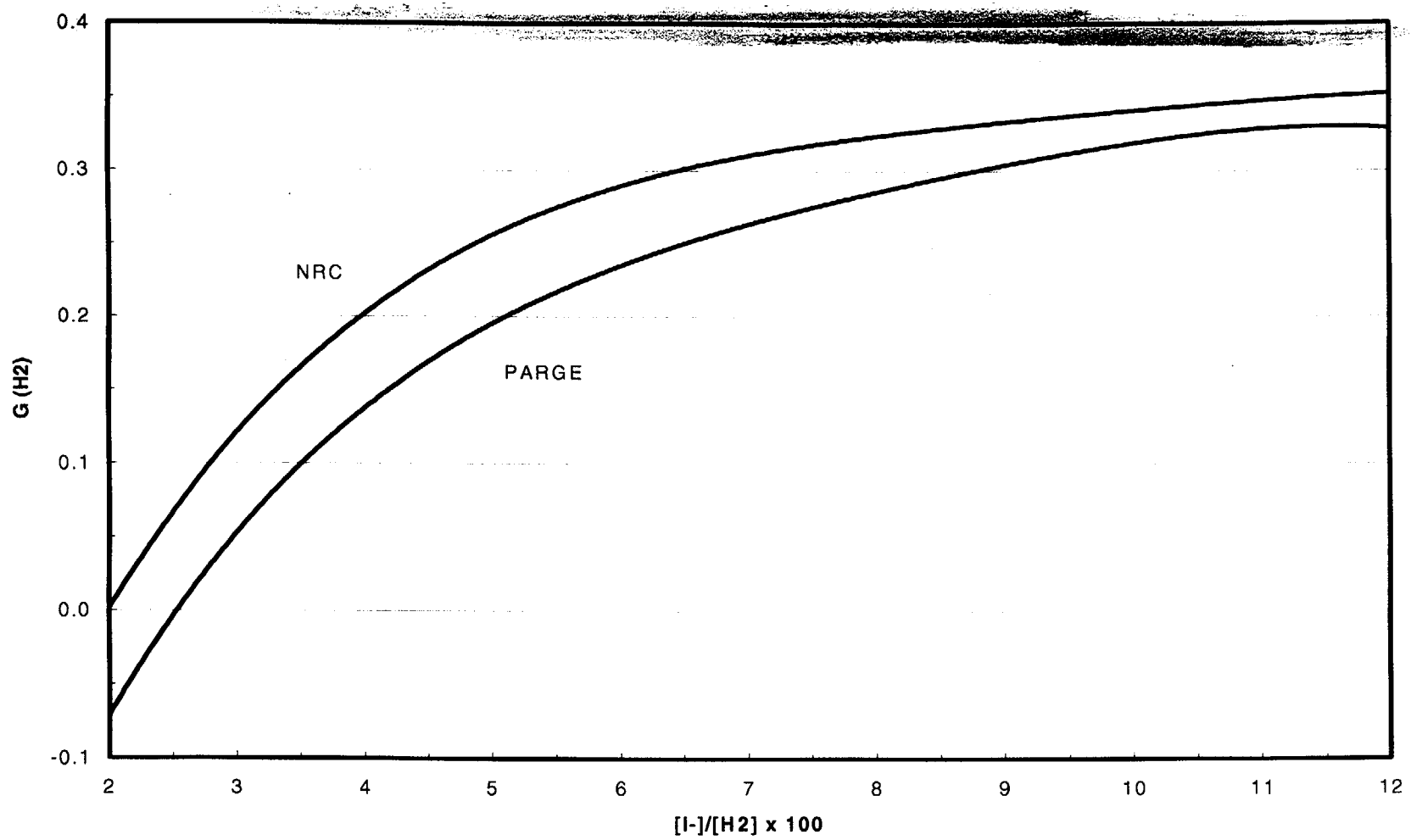
Combustible Gas Control Systems

Bounding Parameters for MWt/Containment Volume

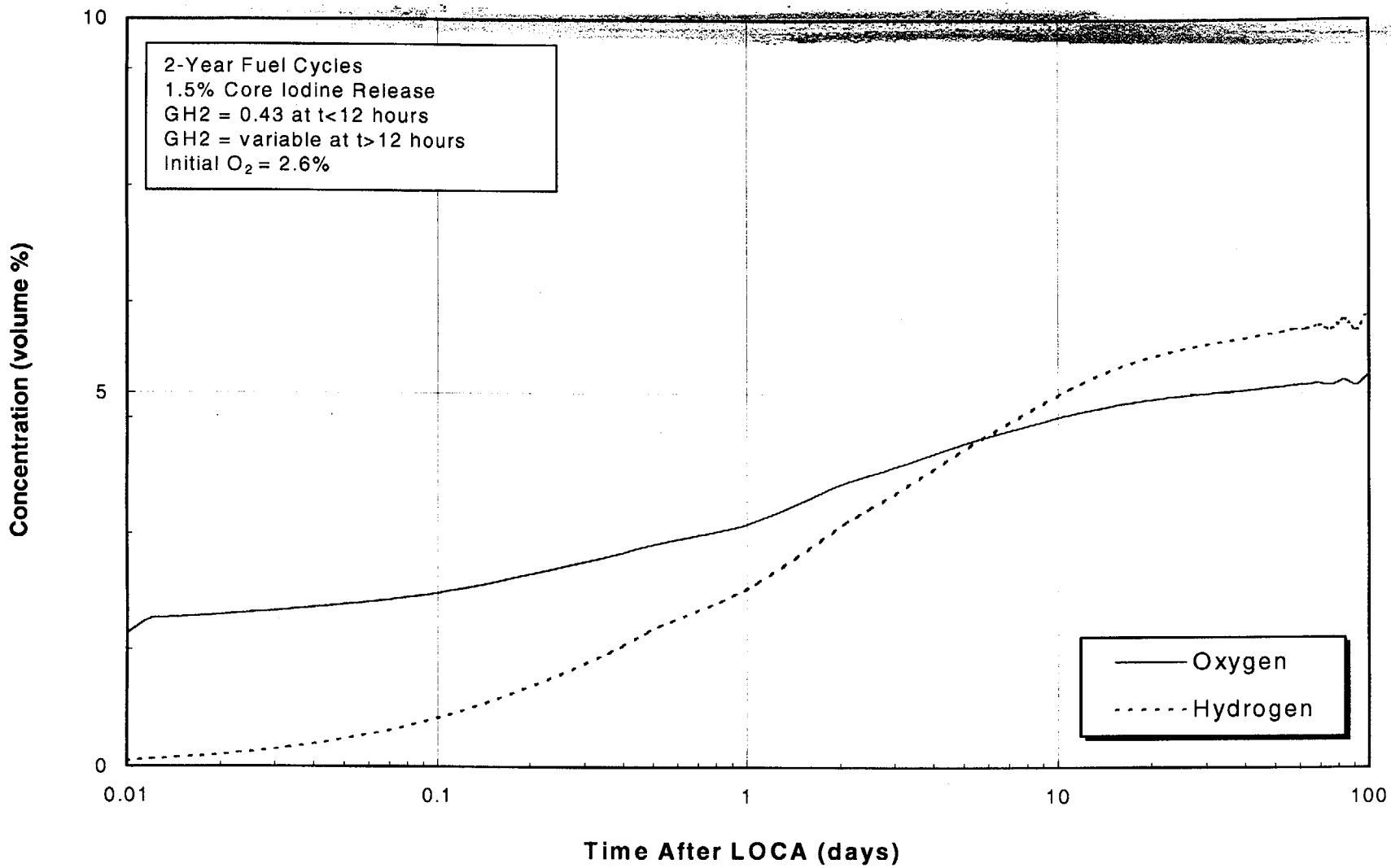
Mark I and II / Mark III

- Rated power 4031/3910 (includes 20% uprate + 2%)
- DW free vol.- ft^3 163,700/270,016
- WW free vol.134,800/1,303,888
- Initial DW °F 145/145
- Initial WW °F 95/95
- Boiling G(H_2) 0.43/0.43 (molecules/100 ev)
- Non-boiling G(H_2) 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_2 (%) 2.6/20.9

Effect of Liquid Phase Iodine and Hydrogen Concentration on Hydrogen Yield



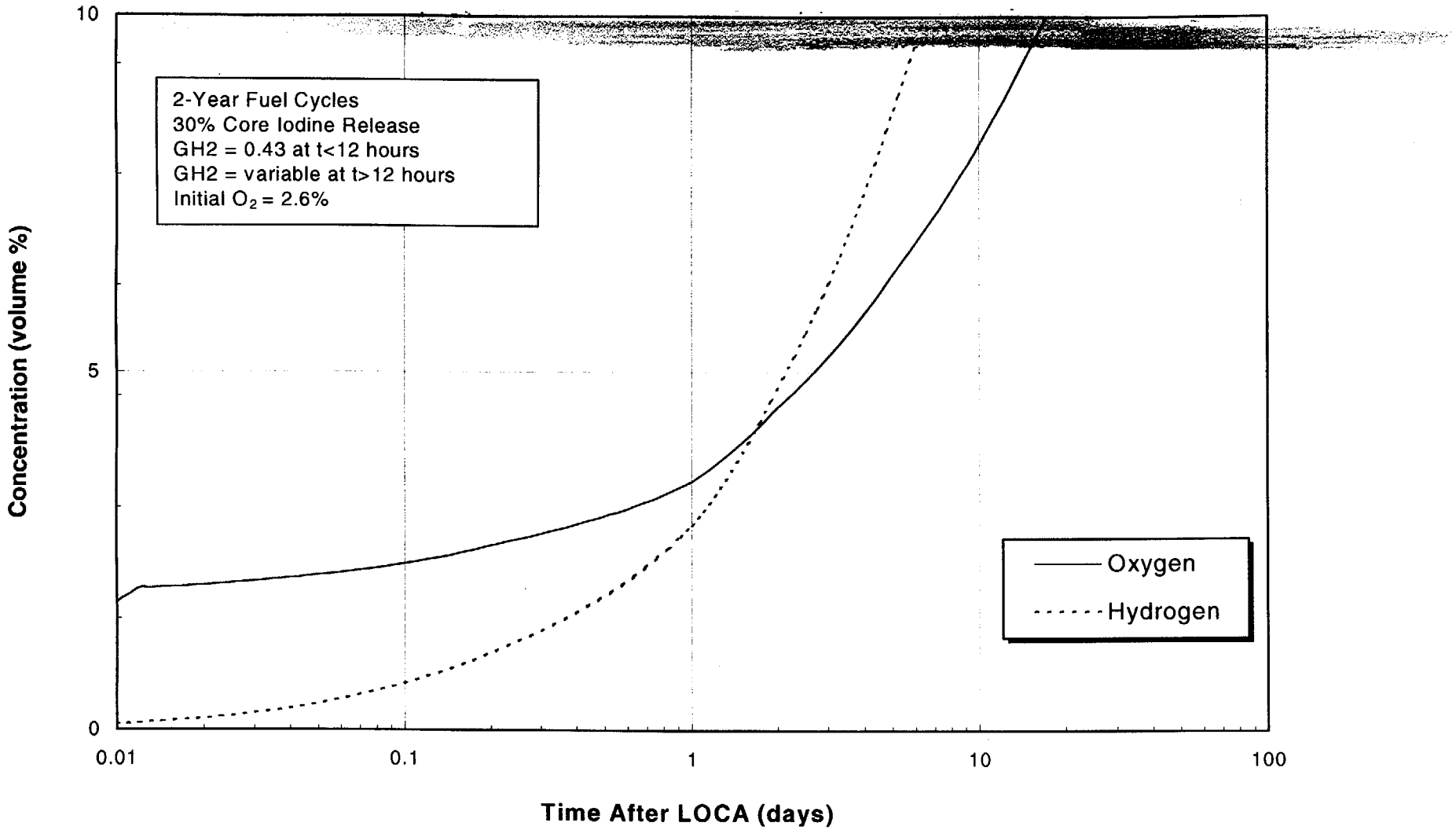
Mark I or II Drywell Atmosphere with 1.5% Core Iodine



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
  - UBPCT is less than 1600° F
  - No fuel damage expected at UBPCT
- 5% RG 1.7 concentrations not exceeded for 32 days (2.6% initial O_2)
  - 10 days for 3% initial O_2
  - Some BWR inert to less than 1%
- No need for CGCS for realistic design basis accident

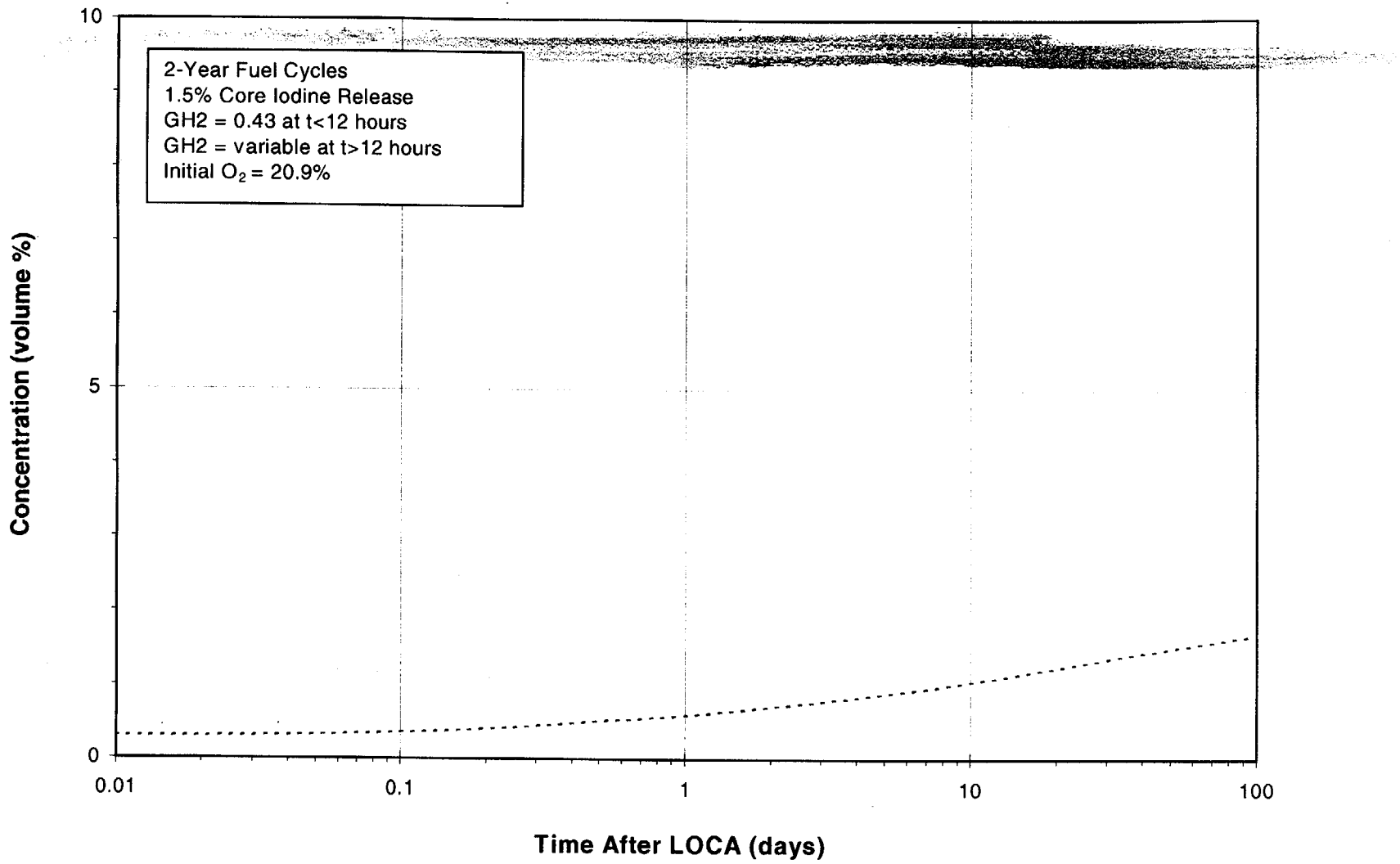
Mark I or II Drywell Atmosphere with 30% Core Iodine



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_2)
- CGCS could be beneficial for severe accidents
  - Not needed until O_2 concentration approaches 5%
- Hydrogen from metal-water reaction at time zero is not a concern because containment is inerted

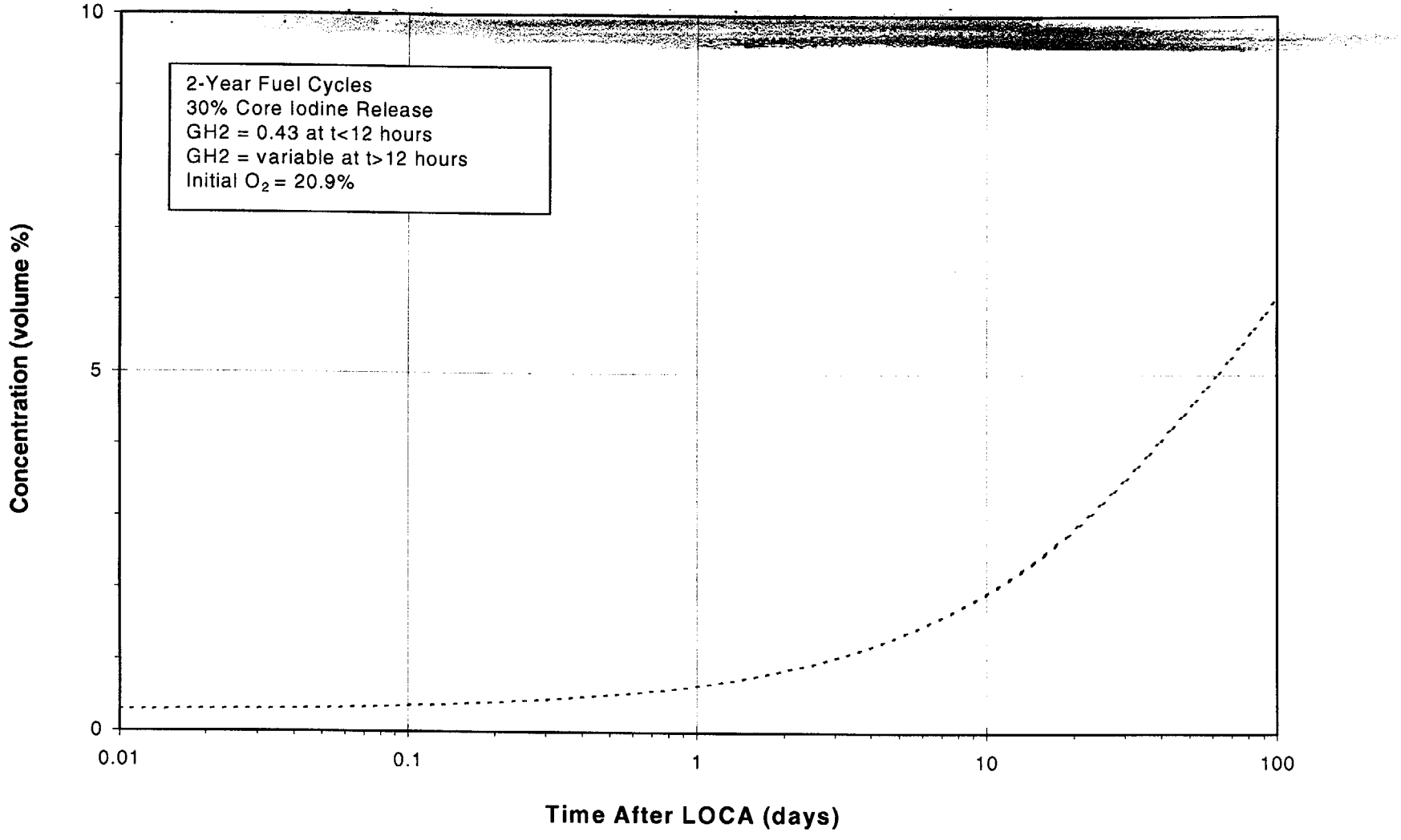
Mark III Containment Hydrogen with 1.5% Core Iodine



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_2 not O_2
- Because of large containment, H_2 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_2 concentration does not exceed RG 1.7 limit of 4% until after 38 days; therefore, recombiners not required to address radiolysis
- H_2 from severe accident metal-water reaction at time zero is a concern because containment is not inerted
- Igniters employed to address H_2 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_2 dilutes O_2 generated by radiolysis

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

- 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

- 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

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

- H_2 / O_2 Monitors
  - Eliminate requirements for O_2 monitors for Mark III plants
  - Eliminate safety related classification for H_2 and O_2 monitors
    - Needed for severe accidents and core damage assessment
    - Commercial grade acceptable
  - Remove H_2 and O_2 analyzers from the Post Accident Monitoring Standard Technical Specification requirements