

ASSESSMENT OF SCALING
ADEQUACY FOR 1/20TH
SCALE TEST

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OBJECTIVES OF SCALE MODEL FIRE TESTS

- CRITERIA FOR FIRE/FLAME OCCURANCE

[DIFFUSIVE VS PUFF BURNING]

- IF DIFFUSIVE, PREDICT:

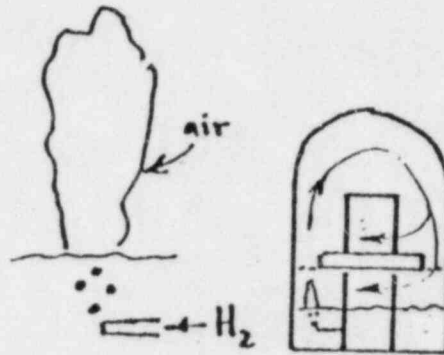
- FLAME GEOMETRY

- ASSOCIATED THERMAL ENVIRONMENT

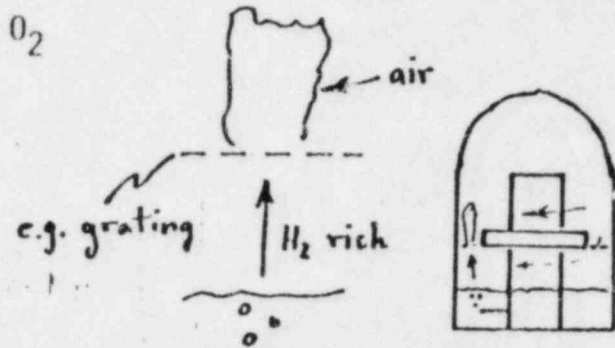
E.G. T_g , h_c , q_{rad}

FIRE/FLAME CLASSIFICATION

- DIFFUSIVE
 - PRIMARY - DIRECTLY OVER POOL



- SECONDARY - INSUFFICIENT O_2
DIRECTLY OVER POOL - FIRE
STABILIZES HIGHER



- PREMIXED - PUFF BURNING

PRIMARY AND SECONDARY FIRE SCALING CONCEPTS

- MOLECULAR TRANSPORT "UNIMPORTANT"
- COMBUSTION IS DIFFUSION - (AS OPPOSED TO RATE-) CONTROLLED
 - $V \propto L^3$
 - $T \propto L/V \propto L^2$
 - $\dot{M} \propto L^2 V \propto L^{5/2}$
- IGNITION CRITERION - CRITICAL CONCENTRATION
- ① CONDITIONS FOR VALIDITY
 - FULL TURBULENCE - BASICALLY A SIZE REQUIREMENT
 - NO PRE-MIXING - UBIQUITOUS IGNITION SOURCES,
HIGHLY IMPERFECT MIXING

PRIMARY FIRES - SCALING MARGIN

● TURBULENCE

- WITH IGN. - $D_{EFF} > D_{CR} \approx 1 \text{ FT.}$
(PROBABLY LESS FOR H_2 AT BASELINE FLOW)
- W/O IGN. - D_{CR} SLIGHTLY HIGHER

● CONCENTRATION

- CRITICAL LOW \dot{M}_{FUEL}
 - CRITICAL LOW "LOCAL AMBIENT" O_2
- } INDEPENDENT OF D_{EFF}
IF $D_{EFF} > D_{CR}$

SECONDARY FIRES - SCALING MARGIN

● PER PRIMARY FIRE

- + ● $L_{EFF} > L_{CR} \approx 1 \text{ FT.}$

PRIMARY FIRES - CONSEQUENCES OF $D_{EFF} < \approx 1$ FT.

- LOWERS CRITICAL LOW \dot{M}_{FUEL} VIS A VIS FULL TURB. SCALING

EST. ERROR RANGE FOR $D_{EFF} \approx 5''$: 20%

- INCREASES FLAME HEIGHT

EST. ERROR RANGE : 30%

- OVERALL CIRCULATION SLIGHTLY RETARDED

SECONDARY FIRES - CONSEQUENCES OF $D_{EFF} < \approx 1$ FT.

- PROBABLY DELAYS PRIMARY \rightarrow SECONDARY TRANSITION

EST. ERROR RANGE : 20%

- PROBABLY DELAYS SECONDARY FIRE EXPIRATION

EST. ERROR RANGE : 20% SECONDARY FIRE LIFETIME

PREMIXED BURNING

● ONSET PROBABLY SCALABLE (PROBABLY SLIGHTLY

LATE IF LENGTH SCALE IS TOO SMALL)

● PUFF DYNAMICS NOT SCALED

I.E. S/V NOT PRESERVED

PRESERVATION OF T - OVERALL CHIMNEY FLOW COOLDOWN

- COLD-WALL BOUNDING EST. OF FLOW ENERGY LOSS

$$\frac{d \ln \Delta T}{d (x/D)} = \frac{P D}{A_x} ST \approx \frac{P D}{A_x} \frac{F}{8} \ll 1$$

REYNOLDS ANALOGY

WHERE A_x = X-SECTION AREA, D = EFFECTIVE DIAM, P = EFFECTIVE PERIMETER

SCALING CONSIDERATIONS . PD/A_x IS LOW IN MODEL BY FACTOR UP TO "SEVERAL"

. F IS HIGH IN MODEL BY SMALLER FACTOR

<u>ESTIMATES OF $(PD/A_x) (F/8)$</u>	<u>1/20</u>	<u>PROTOTYPE</u>
	0.02	0.05

- CREDIT FOR WALL TEMP. RISE: $(PD/A_x) (F/8)$ SHOULD BE DIVIDED BY

$$1 + \frac{F}{4} \underbrace{\rho C V / (\rho_s C_s K_s / T)}^{1/2}$$

THERMALLY THICK

- 0(1) FOR PROTOTYPE

- SCALING REQUIRES $\rho_s C_s K_s \propto L^{3/2}$

SUMMARY

1/20TH SCALE TEST PROVIDES A MODESTLY CONSERVATIVE REPRESENTATION OF THE EXPECTED THERMAL ENVIRONMENT (RESULTING FROM DIFFUSION FLAMES) IN A MK III CONTAINMENT FOR THE NO SPRAY CASE.