FLAME RADIATION MEASUREMENTS

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BACKGROUND:

One of the fundamental combustion experiments being conducted here at the Lewis Research Center consists of a series of flame radiation measurements on a single JT8D tubular combustor assembled in a cylindrical housing having optical viewing ports at three axial stations.

Preliminary flame radiation data were obtained with the JT8D tubular combustor during August 1979. Technical paper, TP-1722, which was published in February 1981 presents some of the spectral radiation data which shows the relative radiance at three axial locations in the combustor for a few test conditions generally representative of low power settings. Supplementary radiant heat flux data, which were measured with thermopile type heat flux transducers at two axial stations were presented at the LeRC Symposium "Aircraft Research and Technology for Future Fuels", April 1980 (NASA Conference Publication 2146, pp. 153-160). All of these data were obtained with Jet A and ERBS fuels, and were limited to relatively low operating pressures and relatively mild operating conditions. Thus, a continuation and expansion of the previous experimental arrangement is required to include a broader range of operating conditions (P_3, T_3, f/a, fuel type) so that flame radiation characteristics can be mapped more fully.

Since combustion gases, predominantly carbon dioxide and water vapor, emit and absorb radiant energy in discrete spectral bands, calculations of flame temperature and soot concentration can be performed using the experimentally measured spectral radiance profiles. In addition, these spectral radiation data can be used for possible correlations with local liner temperatures and/or the radiant heat flux measurements. Characteristic differences attributed to fuel property variations may also be evident from the spectral radiance signatures. Thus, there is considerable potential for obtaining very valuable data which could improve our understanding of the effects of operating conditions, fuel type, and other variables on total flame radiation.

RESEARCH OBJECTIVES:

1. Improve and develop flame emissivity correlations.
2. Evaluate effects of combustor pressure, inlet air temperature, and reduced fuel hydrogen content on flame radiance.
3. Correlate increases in flame radiance with increases in average liner temperature.

SIGNIFICANCE - APPLICATIONS:

1. Establish a comprehensive flame radiation model.
2. Calculate flame temperature and soot concentration.

PRELIMINARY RESULTS:

Spectral and total flame radiation measurements have exhibited the following characteristics:

1. Radiant heat flux increases substantially with rising combustor inlet air pressure.

2. Fuel atomization characteristics can have substantial effects on radiant heat flux.

3. Tests with ERBS fuel indicate that a reduction in fuel hydrogen content produces a significant increase in radiant heat flux primarily at low combustor pressures. At high combustor pressures (14-20 atm.) fuel effects are less distinct.

REFERENCES:

1. Claus, Russell W.: Spectral Flame Radiance from a Tubular-Can Combustor. NASA TP-1722, 1981.
2. Aircraft Research and Technology for Future Fuels, NASA Conference Publication 2146, pp. 153-160; April 1980.

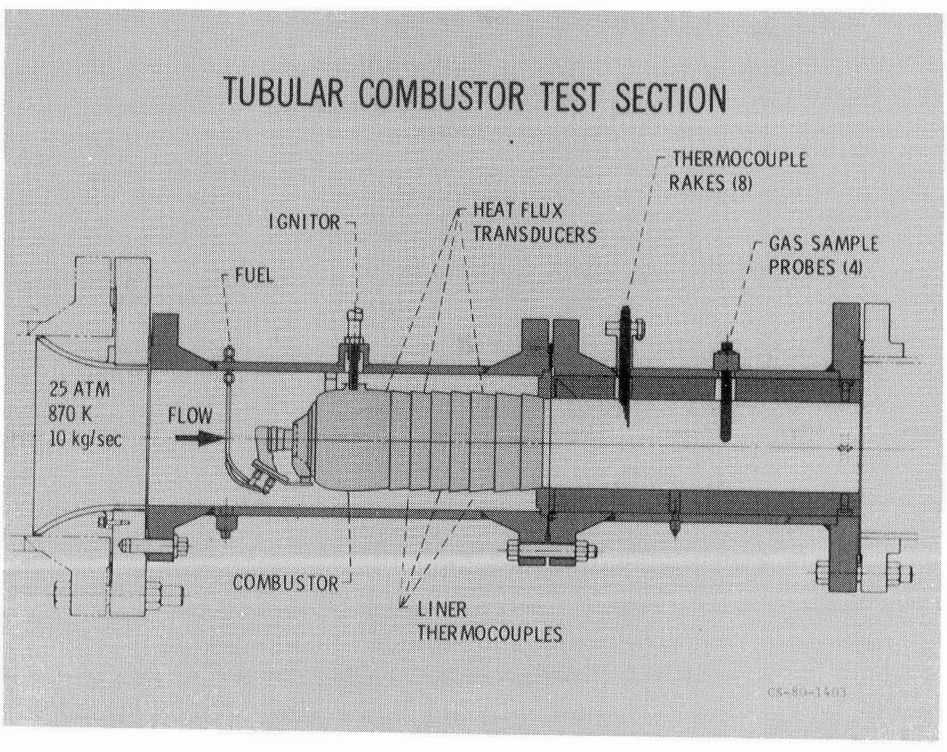
FLAME RADIATION MEASUREMENTS

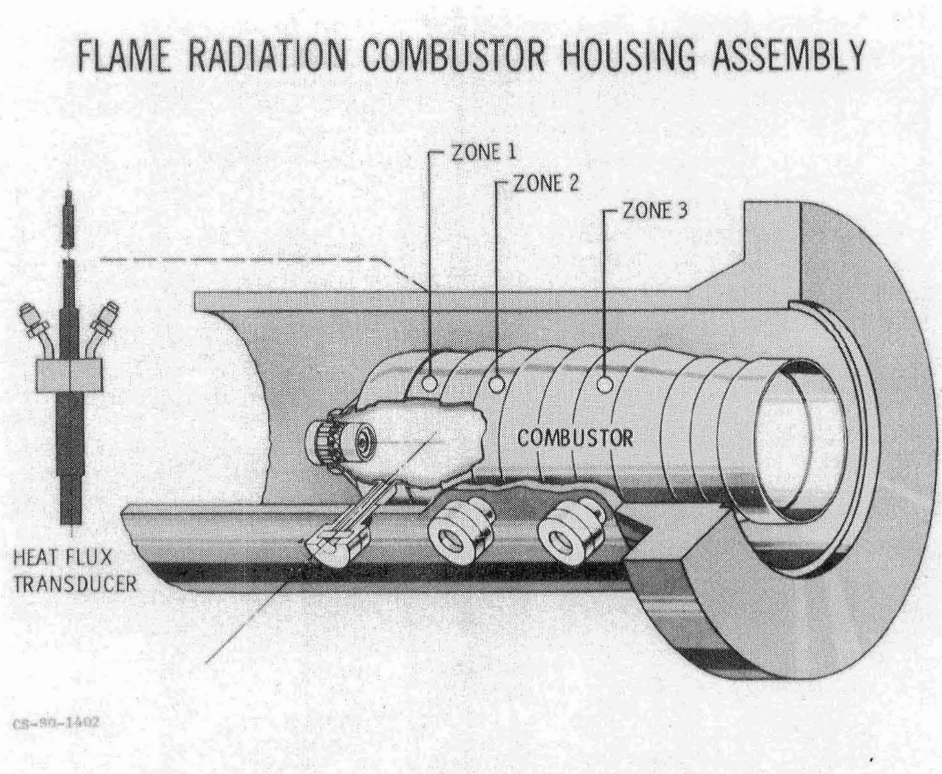
OBJECTIVE: IMPROVE LINER THERMAL ANALYSIS

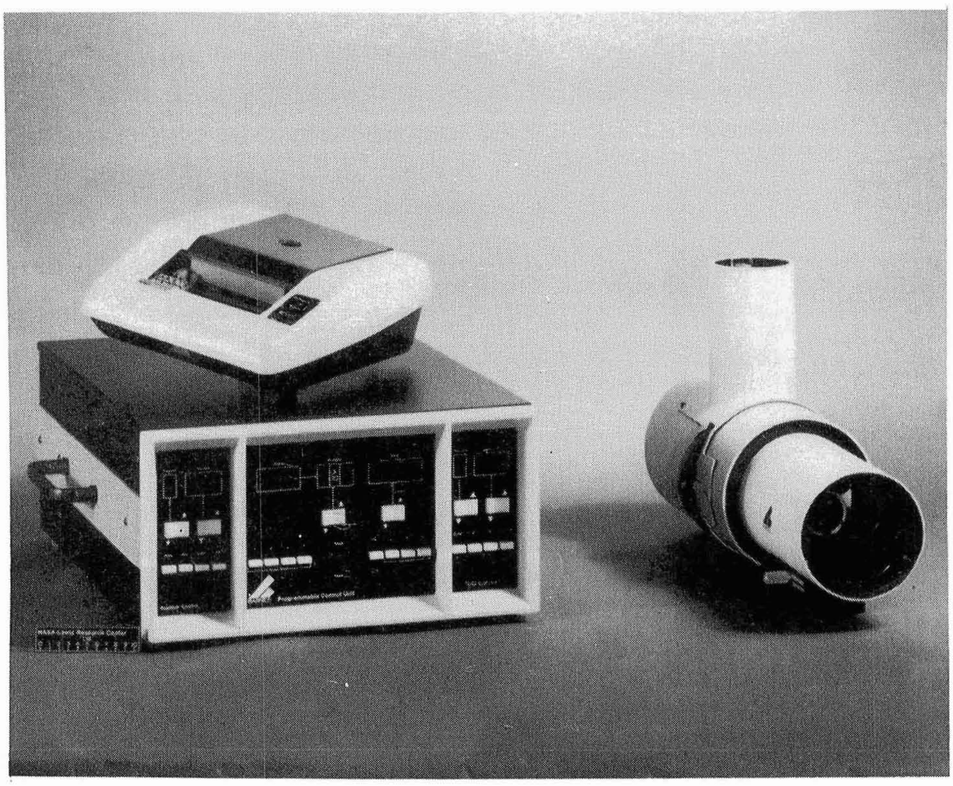
BENEFITS:
- REDUCE DEVELOPMENT COST
- IMPROVE COOLING AIRFLOW DISTRIBUTION
- INCREASE LONG TERM DURABILITY OF LINER

APPROACH: EXPERIMENTALLY ESTABLISH THERMAL MODEL PARAMETERS THROUGH DIRECT MEASUREMENT OF:

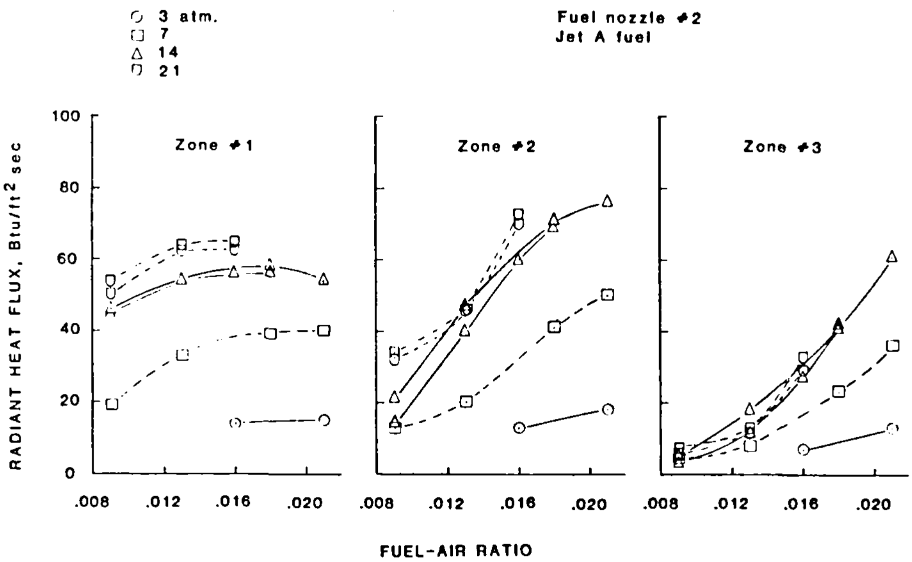
1. SPECTRAL FLAME RADIANCE
2. TOTAL RADIATIVE HEAT FLUX



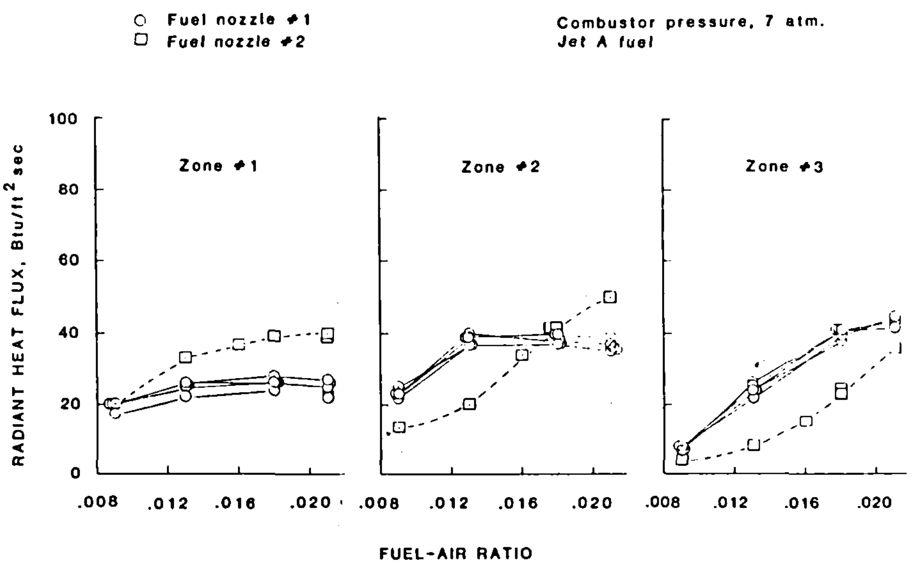

FLAME RADIATION COMBUSTOR HOUSING ASSEMBLY
ZONE 1
ZONE 2
ZONE 3
COMBUSTOR
HEAT FLUX
TRANSDUCER
CS-80-1402



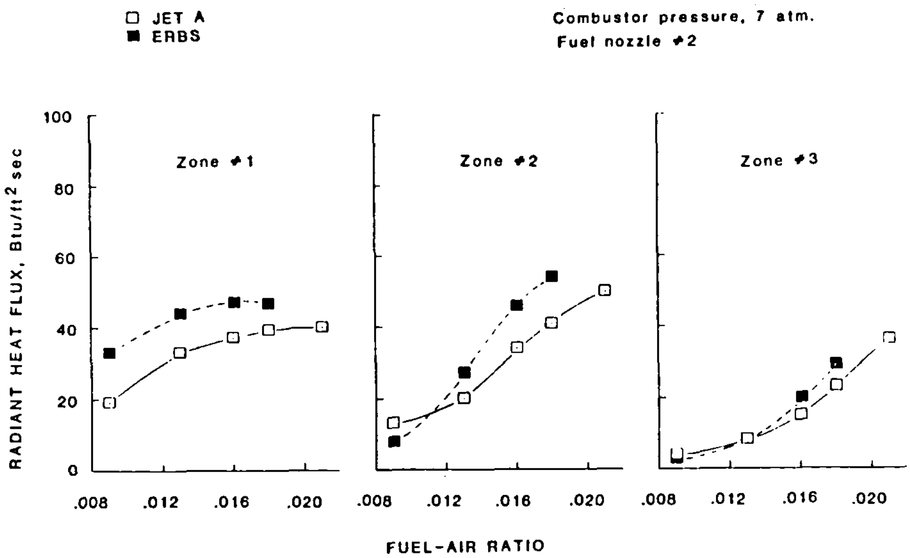
EFFECT OF COMBUSTOR PRESSURE



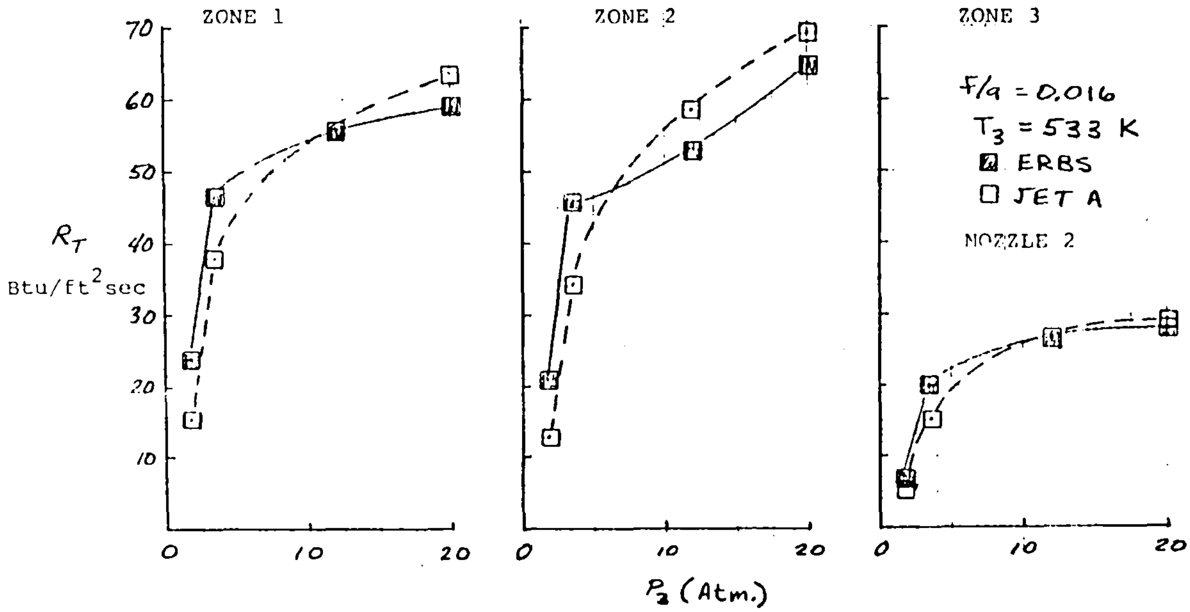
EFFECT OF FUEL ATOMIZATION



EFFECT OF FUEL TYPE



EFFECT OF PRESSURE ON TOTAL FLAME RADIATION
FOR TWO DIFFERENT FUELS.



EFFECT OF PRESSURE ON SPECTRAL
FLAME RADIANCE.