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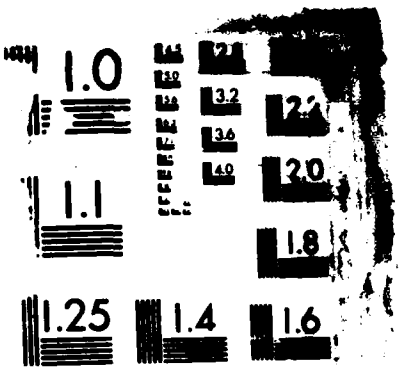
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This grant supported an AFRAPT trainee in conjunction with an ongoing research program supported by Cummins Engine Company on turbocharger stall to investigate system dynamics, unsteady effects and detailed flow instabilities in a centrifugal compressor.

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September 8, 1986

AFOSR/PKD
Building 410
Bolling AFB, DC 20332-6448

Attn: Anne G. Sprunt

Subject: Final Technical Report AFOSR-84-0343

Dear Ms. Sprunt:

This is a letter report covering the work done under the AFRAPT program during the period 9/1/84-8/31/85 on the topic of Unsteady Flow Phenomena in Centrifugal Turbomachinery. The work was supported by Grant AFOSR-84-0343.

This grant was established solely for the support of an AFRAPT trainee, David A. Fink in conjunction with an ongoing research program supported by Cummins Engine Company on Turbocharger Stall.

The research is an experimental investigation of system dynamics, unsteady effects, and detailed flow instabilities in a centrifugal compressor. The surge line, which marks the onset of instability and hence limits the minimum stable operating regime, is a primary design constraint in matching the compressor to downstream turbine and combustor (gas turbine gas generator) or diesel engine (turbocharger). The ultimate goal of this research is a thorough understanding of the events occurring in the compression system which cause surge. The first portion of the research dealing with facility development and initial unsteady data was documented in the S.M. thesis of Mr. Fink in May 1984.

The work for the Ph.D. thesis concentrates on time-resolved measurement of compressor parameters (static pressures, massflow, speed, and temperature) during surge. Time-resolved compressor parameter data taken recently during deep surge operation is shown in Figure 1. Most notable, as shown in the upper trace, is the relatively slow growth in massflow instability prior to flow reversal, which gives encouragement to prospects for attenuation or elimination of these oscillations by active control. The second trace in Figure 1 shows the instantaneous system parameter B during deep surge. This system parameter which governs the post-stall behavior of axial compressor has been found to be a major parameter in the surge behavior of centrifugal compressors. During the approach to flow reversal, the B-parameter is found to be increasing due to increasing rotor speed. At a critical value of B, the compressor massflow reverses.

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The B-parameter determines the major placement of the surge line. As B is reduced by decreasing compressor speed or downstream volume for example, the surge line is shifted favorably to the left and the system should operate stably to nearly shutoff conditions. Use of a small B system would allow measurement of low flow compressor characteristics which are inaccessible in most practical compressor installations. The curvature of these characteristics as well as the detailed fluid dynamic processes (diffuser and impeller stall) which determine their shape is most important in modelling surge behavior and is currently being explored in the most recent work of Mr. Fink. The data consists of both time resolved and time averaged measurements. The results of these experiments will appear in Mr. Fink's Ph.D. thesis in Spring 1987.

Please let me know if any further information is needed.

Sincerely,

Edward M. Greitzer

Edward M. Greitzer

Enclosure

cc: Dr. McMichael/NA
Mr. J.G. Mahoney, OSP 95420
Ms. H.E. Rathbun

EMG/dm

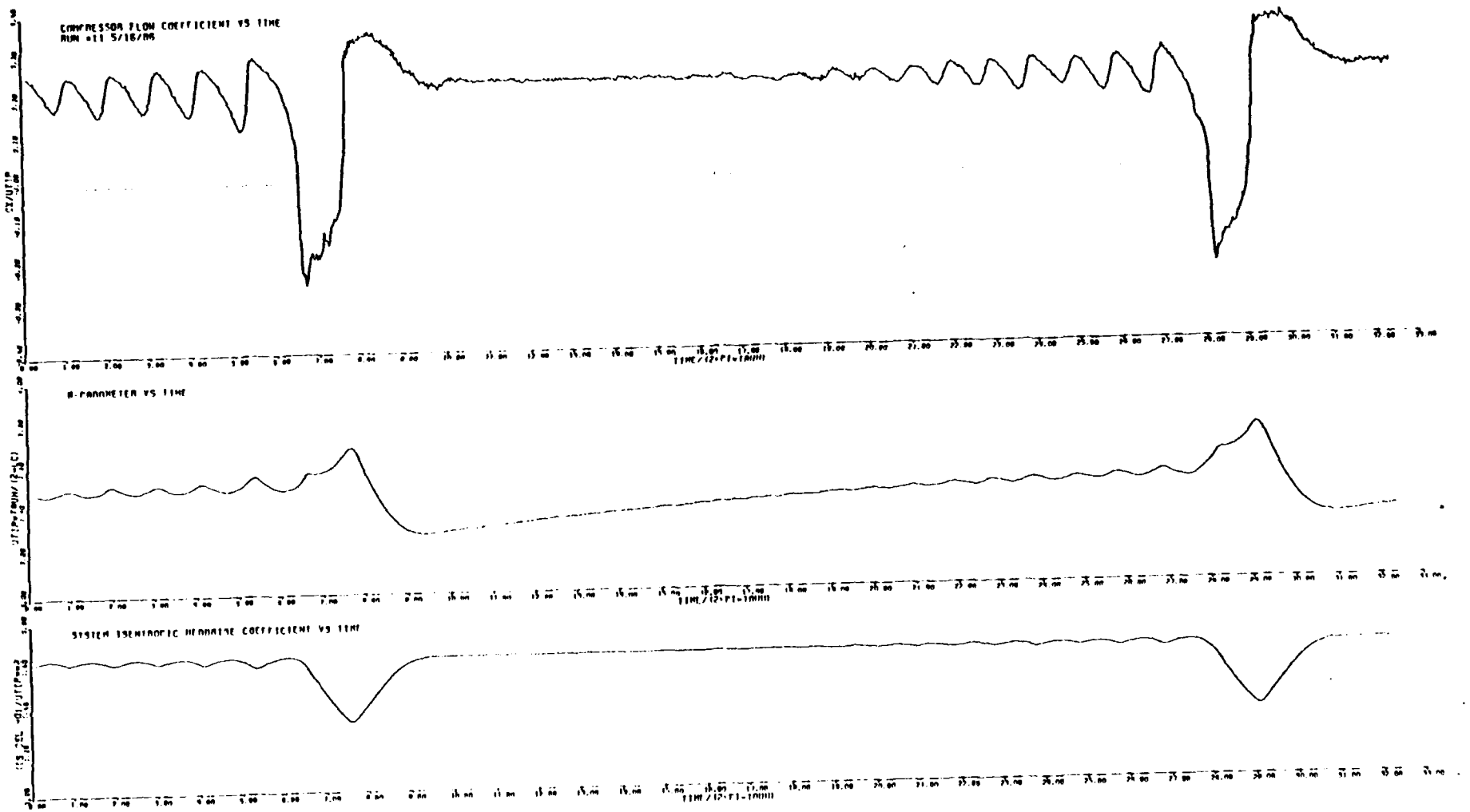

FIGURE 1

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