

HOST TURBINE HEAT TRANSFER OVERVIEW

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The HOST Turbine Heat Transfer program is focused on improving methods of predicting airfoil local metal temperatures. Improved methods of predicting airfoil local metal temperatures require advances in the understanding of the physics and methods of analytically predicting the following four aerothermal loads: hot gas flow over airfoils, heat transfer rates on the gas-side of airfoils, cooling air flow inside airfoils, and heat transfer rates on the coolant-side of airfoils. A systematic "building block" research approach is being pursued to investigate these four areas of concern from both the experimental and analytical sides. Experimental approaches being pursued start with fundamental experiments using simple shapes and flat plates in wind tunnels, progress to more realistic cold and hot cascade tests using airfoils, continue to progress in large low-speed rigs and turbines and warm turbines, and finally combine all the interactive effects in tests using real engines or real-engine-type turbine rigs. Analytical approaches being pursued also build from relatively simple steady two-dimensional inviscid flow and boundary-layer heat transfer codes to more advanced steady two- and three-dimensional viscous flow and heat transfer codes and unsteady two-dimensional viscous flow and heat transfer codes. These advanced codes provide more physics to model better the interactive effects and the true real-engine environment.

HOST TURBINE HEAT TRANSFER PROGRAM

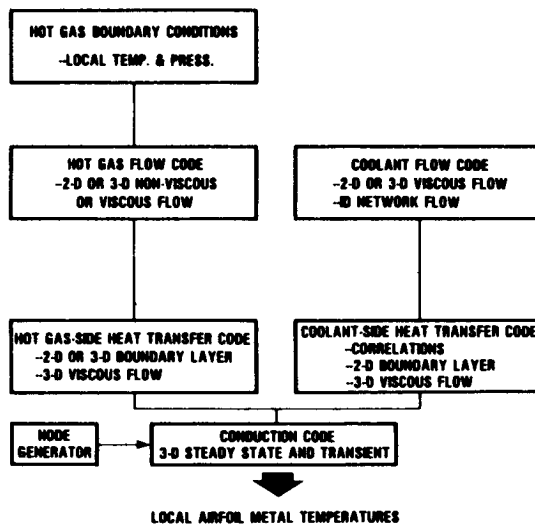
OBJECTIVES:

- OBTAIN A BETTER UNDERSTANDING OF THE PHYSICS OF THE AEROTHERMODYNAMIC PHENOMENA OCCURRING IN HIGH-TEMPERATURE TURBINES
- ASSESS AND IMPROVE ANALYTICAL METHODS USED TO PREDICT THE FLOW AND HEAT TRANSFER IN HIGH TEMPERATURE TURBINE

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Figure 1

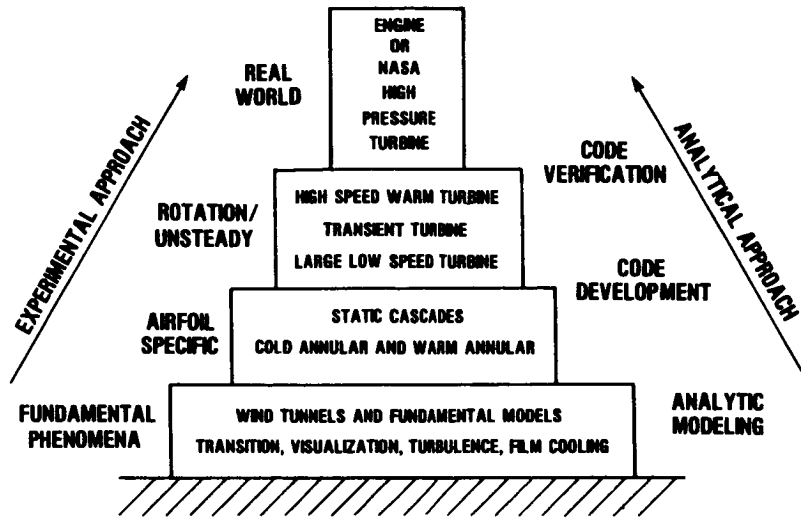
TURBINE AEROTHERMAL DESIGN SYSTEM



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Figure 2

BUILDING BLOCK AEROTHERMAL TURBINE RESEARCH APPROACH



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Figure 3

ASSESS TURBINE AEROTHERMAL DESIGN SYSTEM

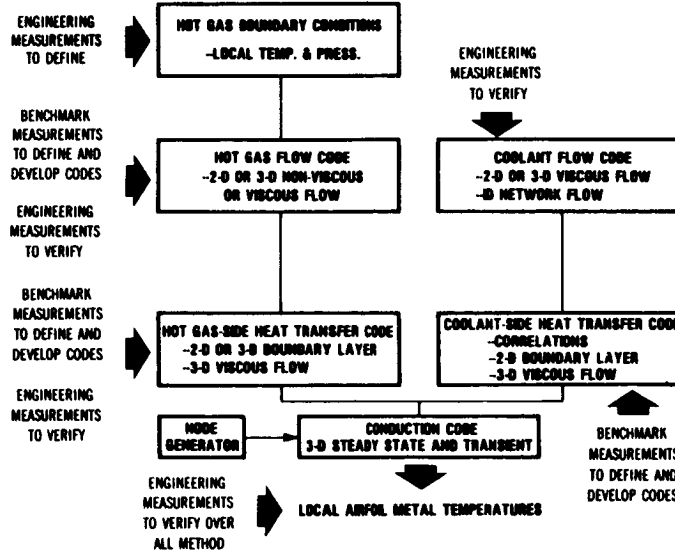


Figure 4

RANGE OF TURBINE AEROTHERMAL DESIGN SYSTEM CODES

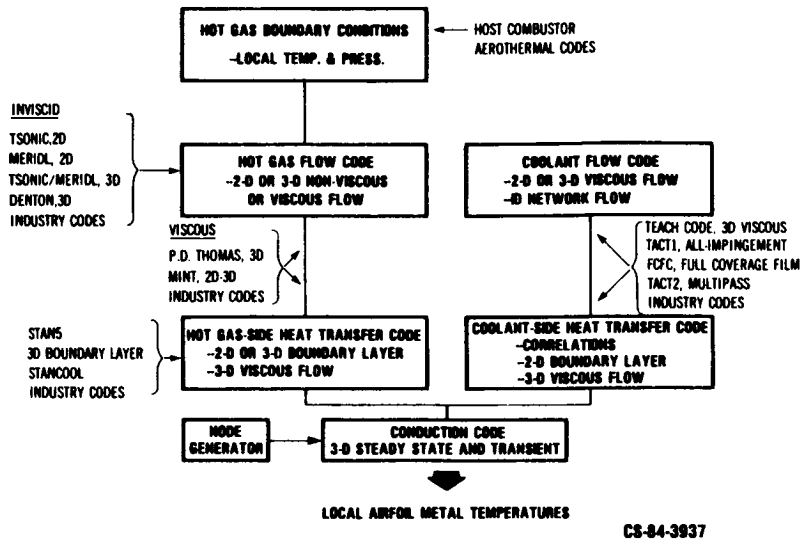


Figure 5

TURBINE HEAT TRANSFER SUBPROJECT SCHEDULE

ELEMENT	FY	81	82	83	84	85	86	87	EXPECTED RESULTS	
GAS-SIDE HEAT TRANSFER WITH AND WITHOUT FILM COOLING		—————								DETERMINE INFLUENCE OF VARIABLES ON BOUNDARY-LAYER TRANSITION ON AIRFOILS AND IMPROVED MODELS
GAS-SIDE HEAT TRANSFER WITH ROTATION				—————				-----	DETERMINE INFLUENCES OF ROTATION AND UNSTEADY FLOW ON GAS-SIDE HEAT TRANSFER	
THREE-DIMENSIONAL FLOW AND HEAT TRANSFER IN A CURVED DUCT			—————						OBTAIN BENCHMARK QUALITY AEROTHERMODYNAMIC DATA AND IMPROVED THREE-DIMENSIONAL VISCOUS FLOW CODES	
THREE-DIMENSIONAL BOUNDARY-LAYER-TYPE HEAT TRANSFER ANALYSIS				—————					ASSESS 'ZONAL' APPROACH TO PREDICT HEAT TRANSFER IN LOCAL REGIONS OF THE FLOW-PATH	
COOLANT-SIDE HEAT TRANSFER WITHOUT ROTATION		—————							IMPROVED HEAT TRANSFER MODEL/CORRELATIONS FOR IMPINGEMENT COOLING ARRAYS	
COOLANT-SIDE HEAT TRANSFER WITH ROTATION			—————					-----	HEAT TRANSFER CORRELATIONS, INCLUDING EFFECTS OF ROTATIONS, ENTRANCE GEOMETRY, TURNS AND TURBULATORS	
EFFECTS OF TURBULENCE AND VORTICES ON HEAT TRANSFER				—————				-----	DETERMINE THE INFLUENCE OF FREE-STREAM TURBULENCE AND VORTICES ON TURBULENT BOUNDARY-LAYER HEAT TRANSFER AND IMPROVED MODELS	
WARM TURBINE FLOW MAPPING (IN-HOUSE)		□						—————	MAP THE 3-D FLOW FIELD THROUGH A TURBINE STAGE AND ASSESS 3-D VISCOUS FLOW CODES	
REAL-ENGINE-TYPE AEROTHERMAL TESTING					—————			-----	OBTAIN MEASUREMENTS OF THE REAL-ENGINE-TYPE HOT GAS FLOW OVER AND HEAT FLUXES INTO AIRFOILS	

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Figure 6

TURBINE HEAT TRANSFER SESSION AGENDA

GAS-SIDE HEAT TRANSFER	E. TURNER, ALLISON B. WEINBERG, SRA
GAS-SIDE HEAT TRANSFER IN A TURBINE STAGE WITH ROTATION	R. DRING, UTRC
EFFECTS OF HIGH TURBULENCE AND VORTICES ON HEAT TRANSFER	R. MOFFAT, STANFORD
THREE-DIMENSIONAL VISCOUS FLOW AND HEAT TRANSFER	R. CRAWFORD, UTSI
ASSESSMENT OF THREE-DIMENSIONAL BOUNDARY LAYER CODE	O. ANDERSON, UTRC
COOLANT-SIDE HEAT TRANSFER WITH ROTATION	F. KOPPER, P&W

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Figure 7