**Utility Advanced Turbine System (ATS) Technology
Readiness Testing and Pre-Commercial Demonstration
Phase 3**

**Quarterly Report
April 1 - June 30, 1996**

Work Performed Under Contract No.: DE-FC21-95MC31176

For
U.S. Department of Energy
Office of Fossil Energy
Federal Energy Technology Center
Morgantown Site
P.O. Box 880
Morgantown, West Virginia 26507-0880

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED HH

By
General Electric Company
Power Generation Engineering
1 River Road
Schenectady, New York 12345

DISCLAIMER

**Portions of this document may be illegible
in electronic image products. Images are
produced from the best available original
document.**

Section 1 Executive Summary	1
Section 2 Technical Progress Reports	2
Section 2.1 (NE) NEPA	2
Section 2.2 (GT) Gas Turbine Design	3
Section 2.2.1 (GTAD) Aerodynamic Design	3
Section 2.2.2 (GTFF) Gas Turbine Flange-to-Flange Design	3
Section 2.2.2.1 (GTFFCP) Compressor Design	3
Section 2.2.2.2 (GTFFCB) Combustor Design	4
Section 2.2.2.3 (GTFFTR) Turbine Rotor Design	5
Section 2.2.2.4 (GTFFTB) Turbine Bucket Design	6
Section 2.2.2.5 (GTFFTS) Turbine Stator Design	7
Section 2.2.2.6 (GTFFST) Structures Design	8
Section 2.2.2.7 (GTFFMS) Mechanical System Design	10
Section 2.2.2.8 (GTFFPP) On-Base and External Piping Design	11
Section 2.2.2.9 (GTFFIT) Instrumentation and Test	11
Section 2.2.3 (GTET) Technology Validation	12
Section 2.2.3.1 (GTETNC) First-Stage Nozzle Design	12
Section 2.2.3.2 (GTETRS) Rotor Steam Transfer	13
Section 2.2.3.3 (GTETSE) Rotor-Bucket Steam Transfer Spoolie	13
Section 2.2.3.4 (GTETRH) Rotational Heat Transfer	14
Section 2.2.3.5 (GTETIH03) Surface Enhanced Internal Heat Transfer	14
Section 2.2.3.6 (GTETEH02/03) Surface Roughness and Combustor-Generated Flow Effects on Heat Transfer	15
Section 2.2.3.7 (GTETCP) LCF Coupon Tests	15
Section 2.2.3.8 (GTETSP) Steam Particulate Deposition	16
Section 2.2.4 (GMT) Materials Technologies	17
Section 2.2.4.1 (GMTSE) Steam Effects on Mechanical Properties	17
Section 2.2.4.2 (GMTSO) Oxidation Due to Steam	18
Section 2.2.4.3 (GMTCE) Corrosion Rate Evaluations of Airfoil Overlay Coatings	18
Section 2.2.4.4 (GMTBV) Compressor Blades and Vanes Materials and Processes	18

Section 2.2.4.5 (GTMTVG) Compressor Variable Guide Vane System Design Support and Process Development.....	19
Section 2.2.4.6 (GTMTCS) Compressor Structural Materials and Processes	19
Section 2.2.4.7 (GTMTRF) Turbine Rotor Forging Materials and Processes	20
Section 2.2.4.8 (GTMTRS) Turbine Rotor Spoolies and Transfer Devices Materials and Processes.....	21
Section 2.2.4.9 (GTMTSB) Structural Bolting.....	22
Section 2.2.4.10 (GTMTTA) Turbine Airfoils Materials and Processes	22
Section 2.2.4.11 (GTMTCB) Combustion Materials and Processes	24
Section 2.2.4.12 (GTMTST) Turbine Structures Materials and Processes	24
Section 2.2.4.13 (GTMTSH) Turbine Shells	24
Section 2.2.4.14 (GTMTSR) Seal Technology	25
Section 2.2.4.15 (GTMTAR) Airfoil Repair	25
Section 2.2.5 (GTTT) Thermal Barrier Coating Technology	26
Section 2.2.5.1 (GTTTSD) Coating System Development.....	26
Section 2.2.5.2 (GTTTRR) TBC Risk Reduction	28
Section 2.2.5.3 (GTTTDD) TBC Design Data and Life Analyses	29
Section 2.3 (CC) Combined Cycle Integration.....	30
Section 2.3.1 (CCSD) Combined Cycle Systems Design.....	30
Section 2.3.2 (CCUA) Unit Accessories.....	31
Section 2.3.3 (CCCL) Controls.....	33
Section 2.3.4 (CCRA) Reliability, Availability, and Maintainability (RAM) Analysis	34
Section 2.4 (MF) Manufacturing Equipment and Tooling.....	34
Section 2.5 (IG) Integrated Gasification and Biomass Fuel.....	35
Section 2.6 (DE) Pre-Commercial Demonstration.....	35
Section 2.7 (PM) Program Management	36

Section 1 Executive Summary

The overall objective of the Advanced Turbine System (ATS) Phase 3 Cooperative Agreement between GE and the U.S. Department of Energy (DOE) is the development of the GE 7H and 9H combined cycle power systems. The major effort will be expended on detailed design. Validation of critical components and technologies will be performed including: hot gas path component testing, sub-scale compressor testing, steam purity test trials, and rotational heat transfer confirmation testing. Processes will be developed to support the manufacture of the first system, which will be sited and operated in Phase 4. Technology enhancements that are not required for the first machine design but will be critical for future ATS advances in performance, reliability, and costs will be initiated. Long-term tests of materials to confirm design life predictions will continue.

This report summarizes work accomplished during the period 2Q96. The most significant accomplishments are listed below:

- 9H compressor component drawings were completed.
- Patterns for major 9H compressor castings were completed.
- 9H compressor rotor and airfoil forgings were delivered.
- 7H compressor aerodynamic design was completed, and aeromechanical design of the rig airfoils was initiated.
- All 9H compressor rig drawings were completed, with rig hardware in the procurement cycle.
- Nozzle cascade test stand nozzle box and nozzle bar designs were completed, and purchase orders were placed.
- 9H transition piece casting development programs with vendors were initiated.
- Preliminary analysis for 9H transition piece heat transfer, low cycle fatigue (LCF), creep, and ratcheting was completed.
- Baseline cold flow diffuser model tests were completed.
- 7H turbine bucket airfoil aerodynamic design and mechanical design were initiated for all four stages.
- 9H turbine bucket detailed design proceeded for all four stages.
- The first detailed 9H turbine nozzle aerodynamic design iteration was completed.
- The 3D finite element analysis of the exhaust frame and forward diffuser has been completed for all mechanical and steady-state thermal effects.
- The inner barrel cavity mock-up was completed and sent to Greenville, SC, to determine final bolting, instrumentation, and flow/thermal features for machine drawing release.

- A revised CAD 3D steam gland solid model incorporating a shorter axial length for improved component interfacing and lower weight/cost was completed.
- Finite element analysis of the #2 bearing housing to evaluate the housing structural integrity under dynamic loading was completed.
- Full- and partial-scale exhaust frame mock-ups, including steam gland and #2 bearing, were shipped to the Gas Turbine Assembly facility in Greenville for use in assembly and maintainability trials.
- A 7H turbine design kickoff meeting was held to establish schedule, requirements, and procedures.
- 9H first-stage nozzle cascade heat transfer test hardware was delivered, and instrumentation lead-out and termination were completed.

Section 2 Technical Progress Reports

Section 2.1 (NE) NEPA

Objective

A draft topical report will be prepared which provides the environmental information associated with Phase 3, Technology Readiness Testing, as specified in the National Environmental Policy Act (NEPA). DOE will use this information to prepare the NEPA documentation for Phase 3. DOE will review the report and advise the participant of the acceptability of the report or the need for additional information. A final report will then be submitted.

A second draft topical report will be prepared which provides the environmental information associated with Phase 4, Pre-Commercial Demonstration, as specified in NEPA. DOE will use this information to prepare the NEPA documentation for Phase 4. DOE will review the report and advise the participant of the acceptability of the report or the need for additional information. A final report will then be submitted.

Technical Progress

There was no activity associated with this task under the ATS Phase 3 Cooperative Agreement during the current reporting period.

Work Planned for Next Report Period

The "generic" Environmental Information Volume (EIV) is complete. After a site is selected, the "site specific" EIV will begin. The date has not been determined at this point.

Section 2.2 (GT) Gas Turbine Design

Section 2.2.1 (GTAD) Aerodynamic Design

Objective

To achieve ATS performance goals, a four-stage turbine will be designed. Advanced aerodynamic technology (sometimes called 3D aerodynamics) pioneered at GE Aircraft Engines (GEAE) will be applied to each stage to maximize performance and meet the mechanical design requirements required by steam cooling technology.

The 7H (60 Hz) and 9H turbines (50 Hz) have similar flowpaths and a common rotor, but require different aerodynamic designs. Performance requirements for the 7H turbine aerodynamics are the same as for the 9H.

Technical Progress

Initial aerodynamic design iterations were completed on all airfoils for the 7H turbine. Turbine performance was reviewed and updated for the final 9H turbine design, as well as for the status 7H design, and incorporated into the latest cycle deck definitions.

Work Planned for Next Report Period

Work will begin on the final aerodynamic design of the 7H turbine airfoils and gas path by utilizing mechanical design information resulting from heat transfer, stress, and aerodynamic performance analyses.

Section 2.2.2 (GTFF) Gas Turbine Flange-to-Flange Design

Section 2.2.2.1 (GTFFCP) Compressor Design

Objective

Mechanical design of the 7H and 9H compressor rotor and stator structure will be performed with the goal of achieving lower cost and greater durability by applying proven GE Power Generation heavy-duty gas turbine design practices. The designs will be based on the GEAE CF6-80C2 compressor. Transient and steady-state thermomechanical stress analysis will be performed to ensure compliance with GEPG life standards. Drawings will be prepared for forgings, castings, machining, and instrumentation for full speed, no load (FSNL) tests of the first unit.

Technical Progress

Drawings for all components of the 9H compressor required to begin component manufacture have been completed. Patterns for major castings have been completed, and castings have been completed or are in the process of being completed. Rotor and airfoil forgings have been completed and delivered. Machining drawings for all components have been initiated and are now in the process of being released.

The 7H aerodynamic design has been completed and the aeromechanical design of the sub-scale compressor test airfoils is now in progress.

All drawings related to the revised compressor rig in the 9H configuration have been completed, with all hardware now in the procurement and delivery cycle. Some of the major hardware is now in the instrumentation cycle prior to delivery to the assembly floor. Due to changes in the rotor configuration design to better define the rotor cooling, clearance control system, and hardware delivery schedules, rig testing is now scheduled to start in February 1997. This revised test program will continue to support both the 9H production and 7H compressor rig and production schedules. The first compressor rig test facility review was done to ensure that all corrections identified during the last rig test and the data system improvements are being incorporated in time to meet the test schedule.

The design and specification of the instrumentation, instrumentation lead-out, telemetry, and data systems requirements for the first full-scale machine have been started. Rig testing, including sub-scale segmented and annular cold flow operation of the high Mach number diffuser has been successfully completed during this period.

Work Planned for Next Report Period

Machining drawings for all 9H compressor components are to be issued in this period with work started in order to complete the instrumentation drawings. The 7H rig airfoil definition and drawings will be completed and procurement started. The full-scale machine airfoil and rotor design will be started as well.

Section 2.2.2.2 (GTFFCB) Combustor Design

Objective

A combustor will be designed based on the commercial DLN2 combustion system, with modifications made for improved use of available air, reduced cooling, and greater load turndown capability. This design will be similar for both the 7H and 9H machines. It will be configured to ensure the ability to use preheated fuel. Rig testing of full-scale and scaled components will be conducted at 7H and 9H cycle conditions. The final configuration will be validated in single-combustor, full-scale tests under full operating conditions.

The premixer-burner design will be optimized to use minimum pressure drop, achieve required fuel/air mixing, maintain stable flame, and resist flashback. The basic design will be developed and evaluated in full-scale single burner tests and then implemented in full-scale combustors. The ability to meet high cycle fatigue (HCF) life goals depends on understanding the effects and interrelationships of all combustion parameters. Existing dynamics models used in parallel with laboratory-scale and full-scale testing will be used to predict combustor dynamic behavior.

Chamber arrangement, casings, cap and liner assemblies, flame detectors, and spark plugs will be designed and analyzed to ensure adequate cooling, mechanical life, and aerodynamic performance. Fuel nozzles will be designed for operation on gas alone or on

gas with distillate as a backup fuel. The transition piece will be designed and integrated with the design of the machine mid-section, transition duct cooling, and mounting.

A full-scale, single-combustor test stand will be designed and fabricated to verify performance of the combustion system. Facility modifications will be made to support the test. These include installation of the test stand, installation of high-temperature stainless steel air piping, an additional air heater, control systems, upgrades to the combustion video system, and tooling.

Technical Progress

Design of the test stand nozzle box and nozzle bars is complete, and purchase orders have been placed. The GEAE facilitation schedule and design review was completed. The test stand startup date was scheduled for August 1, 1997.

Transition piece casting development programs were initiated with vendors for both 9H body shape and aft frame.

9H transition piece preliminary analysis for heat transfer, low cycle fatigue (LCF), creep, and ratcheting was completed. Computational fluid dynamics (CFD) analysis for 30° swirl, internal flow with 2-layer and high Reynolds number models was completed. Cold flow testing of the transition piece model was completed with 4 different inlet swirl/velocity profiles and showed no flow separation.

Baseline cold flow tests of the radial diffuser model were completed, and inner peaked and outer peaked inlet profiles were investigated.

FSNL combustor design and development were placed on hold, and resources were reallocated as permitted by the schedule change for FSNL. Instrumentation of the diffuser for test in the 9FA configuration was completed. The test is not yet scheduled.

Work Planned for Next Report Period

The diffuser will be tested in the 9FA test stand. Transition piece body casting development will be completed and the development part ordered. Aft bracket casting development will begin. Test stand interior baffle design, exhaust duct and water quench design, and gas temperature thermocouple rake design will be completed. Bolting and flanges for flow sleeve and casing mounts to the compressor discharge case will be designed. The combustion development plan for part pressure testing in existing test stand(s) will be updated, and hardware for development testing in these facilities (Schenectady) will be designed. Cold flow testing of the scaled radial diffuser, studying center peaked and flat inlet profiles, will be completed.

Section 2.2.2.3 (GTFFTR) Turbine Rotor Design

Objective

The turbine rotor components (wheels, spacers, aft shaft, transition discs, coolant systems, and fastening devices) will be designed. Transient and steady-state stress analyses will be used to calculate parts lives. Rotor and system vibratory characteristics will be evaluated.

The coolant flow circuit for routing the cooling steam to and from buckets will be designed and performance calculated. Test results will be incorporated concurrently. Drawings and specifications will be developed in preparation for manufacturing.

Technical Progress

An alternative rotor concept was investigated in which the steam delivery to the buckets took a different route through the rotor structure. The advantages and disadvantages of each system were compared to ensure that the best baseline concept had been chosen. After a detailed risk assessment, it was determined that the existing steam delivery concept still offered the best compromise of rotor structure risk vs. steam delivery tubing risk.

Forging drawings for several of the rotor wheels have been completed and some forgings have been produced to schedule. Many steam delivery component analysis trade studies have been completed to narrow down the design choices.

Work Planned for Next Report Period

An initial transient heat transfer analysis for the rotor structure will be completed.

More details of the steam delivery components concepts will be defined. A concept for a test of a full-scale rotating rig for the steam delivery components will be developed.

Section 2.2.2.4 (GTFFTB) Turbine Bucket Design

Objective

Buckets for the four rotating stages will be designed. The heat transfer and material databases for steam-cooled first- and second-stage buckets continue to expand and will be integrated concurrently with the design. Cooling passages will be sized consistently with manufacturing practicalities and the bucket life requirements. Flow variation and consistency will affect life calculations and will be considered. Current practices for thermomechanical steady-state and transient analyses, dynamics and vibration analysis (which can deal with anisotropy), and corrosion/oxidation analysis will be applied throughout. Drawings and specifications will be developed in preparation for manufacturing.

Technical Progress

Aerodynamic design of the 7H turbine bucket airfoils began during this reporting period. Concurrent with the aerodynamic design, mechanical design began for all four stages of buckets.

Detailed design proceeded on all four stages of buckets for the 9H turbine. The second- and fourth-stage bucket modal analyses were completed, and natural frequencies were predicted. Design reviews of the second- and fourth-stage buckets were completed. CAD models of these two buckets were completed and released to initiate production of tooling to make bucket castings. Design and construction of the tooling for first- and third-stage bucket castings were started.

Work Planned for Next Report Period

Initial modal analyses for the 7H second- and fourth-stage buckets will be completed. Initial cooling design of the 7H third-stage bucket will be completed. Material selection for 7H bucket castings will continue. Aerodynamic design of the 7H first-stage bucket will be frozen. Tip cover design and material selection for the 9H first- and second-stage buckets will continue. Production of tooling to make 9H bucket castings will continue.

Section 2.2.2.5 (GTFFTS) Turbine Stator Design**Objective**

The inner and outer turbine shells will be designed, including a turbine stator cooling system to provide rotor/stator clearance control. A closed circuit coolant delivery and return system for the turbine flowpath stator components will be designed. Component, sub-assembly, and assembly flow tests will be incorporated concurrently. Implications for handling equipment (crane and manipulators) will be included in design considerations.

Steam-cooled turbine nozzles will be designed. Thermomechanical transient and steady-state analyses will be performed to determine parts lives. Material, manufacturing, and heat transfer database expansion is planned and will be integrated concurrently.

Shrouds will be designed. Sealing systems will be selected for minimum leakage. Thermal and structural analysis of equiaxed or anisotropic materials will be applied as appropriate.

Calculations will be made of all flow in the cooling systems, including leakage flows, to support performance, thrust balance, and component temperature calculations.

The design of hot-gaspath seals will be based on laboratory tests. Seals developed for transition-piece-to-nozzle-segment and intersegment interfaces will be evaluated in cascade tests. Both sealing and wear performance will be assessed. Manufacturing drawings and specifications will be produced.

Technical Progress

The first detailed turbine nozzle aerodynamic design iteration is complete; further iterations are in progress. The airfoil count for the turbine stator has been defined. The concepts for cooling of the nozzles have been formulated. Preliminary conceptual design of first-stage nozzle steam covers has been completed. Conceptual design and preliminary heat transfer testing of nozzle impingement inserts have been completed. A design of experiment study was initiated to determine key parameters that affect nozzle fatigue life.

Work Planned for Next Report Period

The final work on the turbine 7H flowpath aerodynamic definition will be completed. An initial iteration of coolant flow and stress analysis will be conducted for the stator airfoils. Details of component interfaces will be available for first review. Aerodynamic design reviews for the stator airfoils will be completed.

Section 2.2.2.6 (GTFFST) Structures Design

Objective

The exhaust frame, steam box, and aft bearing housing will be designed. Instrumentation and test plans for component model, factory, and field testing will be prepared.

Technical Progress

Exhaust Frame and Diffuser

The 3D finite element analysis (FEA) of the exhaust frame and forward diffuser has been completed for all mechanical and steady-state thermal effects. A vendor (Patterson Pump, USA) was selected to produce the first exhaust frame and diffusers. Initial Design to Cost/Manufacturability meetings were held at the vendor's facility. Detailed fabrication and casting drawings based on input from the vendor and the GE manufacturing engineer are nearing completion. The inner barrel cavity mock-up was completed and sent to Greenville, where it will be used in determining final bolting, instrumentation, and flow/thermal features that will identify changes in time to meet machining, drawing, release, or fabrication changes. A flow balance model (using GE's YFT analysis tool) was completed for the cooling circuit of the exhaust frame and adjacent cavities; various operating conditions and sensitivities to off-design conditions have been examined. All mechanical sizing studies have been completed. Transient thermal inputs and stresses are still being examined. A preliminary instrumentation plan for design verification on first unit test has been completed.

A field test of a 7F diffuser with tapered struts and acoustic flow splitters was completed and shows encouraging results for design enhancements to reduce noise and improve diffuser life.

Steam Gland

A revised CAD 3D solid model of the steam gland incorporating a shorter axial length to provide more room for interfacing components and to lower weight/cost of the part has been completed. Floating seal leakage design and mechanical analysis of the bolted flanges based on the new geometry have been completed. Steady-state and transient 2D axisymmetric FEA analyses are also complete. A 3D solid finite element model (FEM) of the steam gland current geometry to be used for deflection and detail stress analyses (for LCF analysis) is nearly complete. An initial CFD analysis of the steam inlet scroll with the rotor feed holes was performed to confirm pressure drop calculations for the steam supply entering the rotor cooling circuit. A method to input UG (solid model drafting tool) geometry directly into the CFD analysis tool (NOVAK3D) has been used successfully. The geometry of the rotor inlet holes is now included in the model, and a second geometry iteration for optimizing the geometry has been started. A vendor has been selected for the first unit (Goodwin Steel, UK), and the vendor comments are being incorporated into the design. The steam gland is included in the completed exhaust frame inner cavity mock-up.

Preliminary first unit test instrumentation has been identified.

#2 Bearing Housing

A detailed 2D FEA analysis has been completed to evaluate the structural integrity of the housing under dynamic loading (i.e., shipping and blade out) and incorporates new geometry to maximize the bearing drain cavities. Flow analysis of the oil and air seals is complete with the assumption that rotor temperature and delta temperature across seals will be held to within GE gas turbine experience levels. Mechanical design of supports and bolting is complete. Thermal and flow analysis work will continue on the heat rejection at the bearing resulting from steam supply through the rotor bore and the need for acceptable deflections. A detailed 3D FEM model of the bearing housing has been delayed for detailed dynamic/emergency stress analysis until thermal work is more complete. The bearing housing is included in the exhaust frame inner cavity mock-up. Preliminary first unit test instrumentation has been identified.

Work Planned for Next Report Period

Exhaust Frame and Diffuser

Structural, thermal, and cooling flow analyses of the exhaust frame and forward diffuser will continue. Fabrication and casting drawings will be issued and the vendor will begin material layout and purchase. An inner barrel mock-up meeting will be held in Greenville to develop accessibility and maintainability methods with assembly personnel. The mock-up will be used for instrumentation routing definition and to discuss a possible heat shield in the steam gland area. The mock-up will also be used in determining the best method of placement and support of the telemetry system for turbine rotor instrumentation.

Test setup and components will be completed at CRD for a 1/9-scale model to properly model the effects of diffuser strut vortex shedding and its relationship to acoustic resonance in the duct. Solutions using tapered exhaust frame struts and acoustic "splitter" panels will start to be examined to correlate with field data. Design of the aft diffuser and its interfaces to the high pressure recovery aft (AO42) duct will be started.

Steam Gland

A final geometry CAD 3D solid model of the steam gland will be completed incorporating all aerodynamic/CFD, mechanical, and thermal inputs. 3D solid FEA analyses of the steam gland final geometry for deflection and detail stress levels (LCF analysis) will be completed. Final CFD analyses of the steam inlet scroll with the rotor feed holes will be completed. The casting drawing will be in final review and the vendor will have completed the solidification modeling for the pattern. A steam gland heat shield will be considered using the completed exhaust frame inner cavity mock-up.

#2 Bearing Housing

A final 3D bearing housing CAD layout will be completed and sent to potential vendors for final quotes. A final geometry CAD 3D solid model of the bearing housing will be completed incorporating all interface, mechanical, and thermal inputs. All interfacing conditions will be determined for normal conditions, and off-design conditions will be examined. A 3D solid model will be started for future detail stress work. Bearing instrumentation placement and routing will be determined using the mock-up.

Section 2.2.2.7 (GTFFMS) Mechanical System Design

Objective

System level studies will be performed to optimize cost and performance. Performance, cost, weight, and other system level integration issues will be monitored and tracked. A flange-to-flange cross-section drawing will be maintained, and all mechanical interfaces will be controlled. All gas turbine systems, as well as the technical requirements for accessories, will be defined and specified.

Technical Progress

System level studies continue to be performed to optimize cost, performance, weight, size, maintainability, reliability, and manufacturability. Performance, cost, weight, and other system level and integration issues are being monitored and tracked. The systems review team, which includes engineering, manufacturing, sourcing, and maintainability personnel, continues to meet to review the merit of system issues to determine whether or not design incorporation is feasible.

The maintainability, reliability, and serviceability team continues working to ensure that all of the "lessons learned" for field operation are being incorporated into the 7H and 9H designs. A Maintenance/Field Service review was held with the design teams to help this process. Design reviews have been held for most components, ensuring that maintainability, reliability, and serviceability requirements have been incorporated.

Full- and partial-scale mock-ups of the exhaust frame, including steam gland and #2 bearing, have been delivered and shipped to the Gas Turbine Assembly facility in Greenville, SC. They are currently being used for assembly and maintainability trials, with feedback to GEPG Engineering to ensure that assembly and maintainability issues are incorporated into designs prior to hardware procurement. These mock-ups will be utilized to confirm design concepts, assembly and maintainability planning and tool design, combustion transition piece and seal design, and field service/customer training.

The 7H turbine design effort was formally started with a kickoff review familiarizing the team with the program including schedule, requirements, and issues. The engineering milestone schedule for turbine hot flowpath EDRs was completed, consistent with lead times and cycles required to meet the machine assembly schedule.

The Advance Order (AO) Bill of Materials was released for the 7H. This schedules the design and procurement efforts for the power plant equipment, including gas turbine interface requirements.

The mechanical interface drawing, which includes the internal and external mechanical interfaces, continues to be updated and modified as the design progresses toward hardware. This cross-checking and updating will ensure that all interfaces are compatible.

All requirements for accessory and control development and fabrication known to date have been issued for the Design Manual (DM) and will be continually updated as the design matures.

Work Planned for Next Report Period

Mock-ups for the gas turbine midsection, including compressor discharge casing, compressor diffuser, and outer turbine shell, first-stage nozzle and steam piping, and combustor transition piece are expected to be completed.

Final turbine aerodynamic and compressor aerodynamic flowpaths will be completed, allowing the flowpath cross-section drawing to be updated. The turbine and compressor design teams plan conceptual design reviews for each component.

The Engineering Milestone schedule will be updated and correlated with the manufacturing assembly schedule to ensure on-time delivery of component hardware for assembly.

Section 2.2.2.8 (GTFFPP) On-Base and External Piping Design

Objective

Piping will be designed for fuel, air, steam, and oil transfer.

Technical Progress

Development of conceptual designs for piping systems continued. System requirements were defined.

Work Planned for Next Report Period

Systems requirements will continue to be addressed and reviewed. Work on conceptual piping designs will continue. Conceptual turbine base and foundation interface design will continue.

Section 2.2.2.9 (GTFFIT) Instrumentation and Test

Objective

Test plans will be formulated and instrumentation will be specified. Compressor and turbine rotor telemetry systems will be developed and acquired.

Technical Progress

A test plan has been formulated. An initial detailed instrumentation matrix has been developed that specifies the number and type of sensors by engine component. The next step is to refine the list and then use the results of the second iteration to define the instrumentation drawing requirements. Preliminary conceptual designs have been produced for two alternatives for the turbine end telemetry system.

Work Planned for Next Report Period

The instrumentation list will be refined, and the instrumentation drawing requirements defined. A turbine end telemetry system approach will be selected, and the conceptual design completed.

Section 2.2.3 (GTET) Technology Validation

The overall objective of this task is to provide confirmation of critical component design and technology. The validations include hot gas path component testing, sub-scale compressor testing, steam purity test trials, and rotational heat transfer testing. Technology enhancements that are not required for the first machine design but will be critical for future ATS advances in performance, reliability, and costs will be conducted.

Section 2.2.3.1 (GTETNC) First-Stage Nozzle Design**Objective**

A full-scale sector of the first-stage nozzle will be operated at full engine conditions to demonstrate the validity of the design concept. Temperatures will be measured and any distress to the thermal barrier coating (TBC) will be quantified. The combustor exit conditions in the premix combustor mode will be characterized by testing. Internal cooling circuitry conditions and airfoil metal temperature distributions will be determined. Life-prediction models will be validated and low cycle fatigue (LCF) failure mechanisms will be characterized with LCF tests.

Technical Progress

There was no test activity associated with this task under the ATS Phase 3 Cooperative Agreement during the current reporting period. Manufacturing of the heat transfer (metal temperature) is complete. The test module was delivered during the first week of May. Instrumentation lead-out and termination was completed in the last week of June. All conventional machining operations on the LCF hardware are complete. Fabrication of the LCF hardware is continuing.

Work Planned for Next Report Period.

Final preparation for the heat transfer cascade tests, including system and mechanical checkouts, is expected to be completed by early August. A heat transfer test will then be run to provide information on nozzle cooling system performance and metal temperature distribution. After dimensional inspection, the two LCF test pieces will be TBC coated and brazed. The airfoils will then be assembled in the cascade mounting fixture with the end pieces. Final measurements will be taken, and the entire assembly will be shipped. Completion of the manufacturing effort on the LCF nozzle cascade is currently projected for August.

Section 2.2.3.2 (GTETRS) Rotor Steam Transfer**Objective**

Static flow tests will be conducted to validate the steam flows in the circuit to and from the buckets, through the rotor, in order to provide for stable cooling of the turbine buckets. These will establish flow losses for the unique components in the steam delivery circuit.

Technical Progress

Details of the first component test rig for testing of the main bore tube are being established. This test will establish pressure losses for flow entering the rotor from the stator including the first radial turn. These data will be used to help develop the bore tube concept.

Work Planned for Next Report Period.

The bore tube test rig and test plan will be developed and assembly of the rig started. Work on additional test rigs will start as components reach a final stage of concept design.

Section 2.2.3.3 (GTETSE) Rotor-Bucket Steam Transfer Spoolie**Objective**

Rotating air test rig tests will be completed to validate the steam transfer spoolie design concept. (Spoolies are the hollow, spool-shaped ducts that bridge the gap between the steam delivery channels in the turbine rotor and cooling channels in the buckets.) A stationary steam test rig will be used for evaluation of durability and alignment effects on leakage.

Technical Progress

The rotating test in the heated enclosure has been run, but problems with the rig have prevented completion of the program at this time.

Coating durability testing is progressing successfully, with the seals meeting all wear and leakage goals.

Work Planned for Next Report Period

The rotating air test with heated enclosure will be completed.

Coating durability testing will continue through the next reporting period, investigating interference, bore coating, bore base material, and an alternative coating. In addition, a new rig is to be built to enable larger diameter spoolies to be tested for use with the rotor main axial tubes. This rig will be designed to allow testing with steam as well as air.

Section 2.2.3.4 (GTETRH) Rotational Heat Transfer

Objective

Local heat transfer coefficients in a high aspect ratio rectangular duct will be measured in the Rotational Heat Transfer Test Rig. Turbulator geometries will be evaluated.

A limited database exists on the effect of rotation on heat transfer in turbine blade cooling passages. The objective of this task is to construct, install, and test a high aspect ratio cooling passage in a full-scale rotating test rig. A sub-scale test rig will be employed in parallel to evaluate alternate turbulator designs in order to identify the best configuration for subsequent evaluation in the full-scale test rig.

Technical Progress

Assembly of the high aspect ratio duct for the reduced-scale test apparatus is in progress. The first configuration consists of the same turbulator geometry as the configuration tested in the full-scale test rig in order to provide a database.

Work Planned for Next Report Period

Preparation of the first test duct for the reduced-scale test apparatus will continue at a low level since it is more important to complete the data correlation on the rotational pressure drop test activity.

Section 2.2.3.5 (GTETIH03) Surface Enhanced Internal Heat Transfer

Objective

The objective of this task is to evaluate impingement heat transfer coefficient enhancements for validation and improvement of turbine airfoil design.

Tests of enhanced flat-plate surfaces with impingement at moderate pressure levels will be conducted for various impingement jet array parameters, providing both heat transfer performance and pressure loss data. Acrylic test models and liquid crystal techniques will be used to study those surface treatments that give the best performance.

Technical Progress

A thin metallic test plate with a thin-foil heater, a liquid crystal sheet and a plain impingement surface, was prepared for heat transfer tests. The test plate with bumps that will be used in the study of the effect of missing bumps has been ordered but not delivered yet. To investigate the effect of missing bumps, an ANSYS model of the bumpy surface was prepared. The model is being used to analytically investigate the effect of the missing bumps on the metal temperatures with convective boundary conditions that are similar to the actual design conditions.

Work Planned for Next Report Period

A test coupon with a smooth surface is ready for testing with the liquid crystal under pressure. The supply chamber had to be extended to bring the impingement surface closer

to the window for adequate lighting. A thin test plate with a bumpy surface is being manufactured by the vendor who provided the test samples to GEPG.

Section 2.2.3.6 (GTETEH02/03) Surface Roughness and Combustor-Generated Flow Effects on Heat Transfer

Objective

The ATS Turbine Nozzle Cascade test facility will be used to validate design data for external heat transfer coefficients on airfoils with surface roughness. The cascade will incorporate instrumented airfoils with flow conditions representative of the ATS first-stage nozzle geometry. The appropriate non-dimensional parameters for dynamic similarity will be made close to those for the engine's first-stage nozzle. External heat transfer coefficient distributions will be measured through the use of embedded thermocouples, with a constant surface heat flux condition supplied by thin-foil heaters. Surface roughness elements of the appropriate size and distribution will be bonded onto the surface heaters. Data will include various roughness levels, distributions, and types in order to allow for the calibration of predictive methods. Characterization of surface roughness effects includes the interactive nature of roughness with fluid dynamic conditions such as acceleration.

The cascade will also be used to assess the effects of transition piece wake shedding on airfoil heat transfer.

Technical Progress

Tests have been completed for modeled airfoil suction side spallation in the ATS Turbine Inlet Nozzle Cascade. Previous tests focused on modeling spallation in the airfoil leading edge region, as well as the pressure side. The current results deal with modeled spalls in the leading edge, midchord, and aftchord regions of the suction side. All results are reported as enhancement factors relative to the heat transfer without spalling.

Work Planned for Next Report Period

This task is now complete. There are no plans to continue testing in the current configuration of the ATS Turbine Inlet Nozzle Cascade.

Section 2.2.3.7 (GTETCP) LCF Coupon Tests

Objective

LCF durability of TBC for first-stage nozzles will be evaluated under simulated ATS conditions. Specimens will duplicate the alloy, coating, and principal mechanical features. Testing will be performed using the electron-beam (E-beam) High Thermal Gradient Test Facility. The facility will be modified for the use of steam as an alternative cooling medium for the coupons. The coupons will be geometrically representative of a section of the turbine first-stage nozzle airfoils. The test rig will be refitted for the new test piece geometry. Coupons will be instrumented for evaluation of the thermal conditions during

testing. Tests will be performed to evaluate various TBCs as well as metal durability. Post-test evaluations of the TBC and metal will be performed.

Technical Progress

Tophat specimens DR1, DR2, and DR3, which are being used to test the crack initiation and propagation differences between diffusive and air plasma sprayed (APS) bond coats, have all completed E-beam test exposures. Each specimen received 1500 cycles of exposure, the first 500 of which were at reduced conditions, followed by 1000 at elevated conditions.

Specimen LCF #3 has completed destructive evaluations. The specimen was cut into a fatigue sample along the same direction as LCF #2, and then cycled under mechanical load until failure. The exposed surface was examined under scanning electron microscope (SEM) and showed two clear "thumbnail" regions that were identified as cracked surfaces and a section where numerous cracks had merged together.

Work Planned for Next Report Period

Specimen DR3 will be partially etched, or electrochemically polished, to determine the crack orientations in the substrate metal before it is mechanically fatigued until the crack propagates all the way through. Specimens DR1 and DR2 will also be fatigued along the direction indicated by DR3 until the crack propagates all the way through. Destructive evaluations will also continue on LCF #4. Howmet will deliver the single new mold of tophats cast to LCF-test dimensions.

Section 2.2.3.8 (GTETSP) Steam Particulate Deposition

Objective

Tests will be performed to verify the adequacy of the steam purity system. Long exposure at near-7HI steam conditions will be used to evaluate performance of steam filters under various steady-state and transient conditions, verify power plant steam purity assumptions and deposition characteristics, and evaluate performance of steam delivery components. An additional objective of this task is to measure the rate and location of steam particulate deposition in bucket tip turns.

Technical Progress

The centrifugal deposition rig was assembled and tested but had an excessive steam leak rate from the rotary shaft seals. Otherwise the centrifugal deposition rig operation during initial hot spin-up went very well, with no imbalance issues and sufficient evacuation of the rotor housing to reduce windage power requirements.

The reason for the increased leakage was determined to be cooling by the close-mounted oil bearings keeping the shaft temperature more than 150°F cooler than expected. This large steam leakage flow also caused the lube oil to pick up water through the inboard labyrinth seals, causing a lube oil overflow due to water addition. The oil has since been decanted. It is expected that the seal repair will reduce the quantity of water that is introduced.

The impingement specimen has been operating satisfactorily during approximately one month of exposure. Flow system operation has had to stop a number of times due to plant operations. A cold restart has been required each time with the possibility of water contact on the specimens, but the overall system operation has been satisfactory.

A progress report on this task was made to DOE staff in a video conference on June 21, 1996.

Work Planned for Next Report Period

The filter and impingement specimens will be inspected when the steam seals are replaced and the new specimen is installed. This will be the first inspection of the static specimen.

Section 2.2.4 (GTMT) Materials Technologies

Section 2.2.4.1 (GTMTSE) Steam Effects on Mechanical Properties

Objective

This task will be conducted to evaluate any effects on the operation in a steam environment of candidate turbine materials. Tests of materials that are exposed to steam will be performed to measure fatigue crack propagation, low cycle fatigue, and creep. Additional tests deemed necessary to meet design criteria will be performed. Comparisons will be made with data collected with air exposure. Where necessary, the program will evaluate the roles of alternate heat treatments and/or surface treatments.

Technical Progress

Thirty additional compact tension (CT) specimens from the prototype turbine forging were received during this period, bringing the total number to 129. Fatigue crack propagation (FCP) tests of these specimens are being conducted with a current objective of understanding the temperature-dependence of FCP at different locations in the prototype forging under different environmental conditions. Characterization of the microstructure at different locations of the forging and for different heat treatment conditions is being conducted concurrently with the FCP tests, which are being performed in both steam and air at three different temperatures. The microstructure is being evaluated using a combination of light optical microscopy (OM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM) techniques.

Testing to determine the environmental dependence of LCF crack initiation in the prototype forging is ongoing. LCF specimens were machined and have been tested at three cyclic strain ranges at one temperature in a steam environment. Creep testing on all steam-exposed materials also is continuing in order to expand the data set.

Work Planned for Next Reporting Period

FCP testing to determine material properties as functions of temperature and stress intensity will continue. All samples will be analyzed after testing for evaluation of the dependence of structure on material properties as well as to aid in the understanding of the

crack growth mechanism. LCF testing will continue, with various hold times added to the testing.

Section 2.2.4.2 (GTMTSO) Oxidation Due to Steam

Objective

Testing of ATS materials in steam will be performed to evaluate the long-term oxidation responses to this environment. Specimens will be subjected to steam exposure in an autoclave and removed at specified intervals for examination of oxidation characteristics.

Technical Progress

A laboratory was selected, and test program requirements for conducting the steam exposure testing were communicated in June.

Work Planned for Next Reporting Period

Specimen machining will be completed, and the next phase of steam exposure tests will begin.

Section 2.2.4.3 (GTMTCE) Corrosion Rate Evaluations of Airfoil Overlay Coatings

Objective

To evaluate the performance of ATS materials in potentially corrosive environments, initial evaluations of various overlay coatings and substrate materials will be performed in small burner rigs with known contaminants. This will allow ranking of the corrosion rates of materials and coatings. Subsequent testing will be performed in facilities that better simulate gas turbine service conditions, including high gradients, for confirmation of burner rig results.

Technical Progress

An additional 2100 hours of exposure time in the high temperature corrosion rigs was accumulated on most coated and bare samples during this period. A few samples were removed for sectioning and evaluation.

Work Planned for Next Reporting Period

Additional time will accumulate on the samples in test. At set intervals, samples will be removed for evaluation of corrosion characteristics.

Section 2.2.4.4 (GTMTBV) Compressor Blades and Vanes Materials and Processes

Objective

Although material selections have been completed, this task will examine potentially less expensive materials for use in blades and vanes in the latter stages of the ATS compressor. These evaluations of alternate materials will be based on results of tests of mechanical properties, with emphasis on high cycle fatigue properties. For materials that have been

selected, tests of critical properties will be conducted under ATS-specific conditions. Component tests of selected parts will be conducted for life verification purposes and establishment of final manufacturing parameters.

Technical Progress

Forward blade and vane material smooth bar, notched bar, and salt environment high cycle fatigue (HCF) testing has been completed. The smooth bar, air environment results show the proposed processing of this material will increase the HCF endurance limit above that provided by existing handbook data. Curves were generated for tensile and low cycle fatigue (LCF) properties of aft end blade and vane cost-reduction material. Creep and HCF testing of this material was initiated.

Work Planned for Next Reporting Period

Curves will be generated for the forward blade and vane material behavior in various environments to reflect the results of the test data collected recently. The aft end blade and vane material HCF tests have begun again with completion scheduled for next reporting period. The creep tests will continue to accumulate time at temperature and stress.

Section 2.2.4.5 (GTMTVG) Compressor Variable Guide Vane System Design Support and Process Development

Objective

Information to support selection of materials for the variable guide vane bushings and thrust washers will be gathered to support a robust and reliable design. Testing will be conducted to confirm materials selections, cover any parameters outside of existing data, and gather data for new materials.

Technical Progress

All candidate bushing and washer materials have been received. Pounding wear tests were initiated on the first set of potential bushing and washer materials being evaluated for durability improvements. Fixturing for oscillating wear tests was designed and procurement was initiated.

Work Planned for Next Reporting Period

Pounding wear test cycle accumulation will continue. Oscillating wear tests will be initiated.

Section 2.2.4.6 (GTMTCS) Compressor Structural Materials and Processes

Objective

Mechanical and physical property tests will be performed on ATS compressor structural materials to provide an expanded mechanical and physical property database for design validation and enhancement. Material processing parameters for prototype manufacturing of the components will be selected based on design requirements and discussions with

vendors. When necessary, material and processing specifications will be modified or new ones written.

Technical Progress

A visit was made to the supplier of the inlet case. Topics covered included: cold weld repair procedures and qualification, solidification simulation and solid model translation, manufacturing process plan details, and cast-in pipe requirements. An inspection of the pattern was conducted.

A visit was made to the supplier of the compressor discharge casing (CDC) to have a rigorous review of the casting process to mitigate any potential risk associated with the manufacture of this component. An inspection of the pattern was conducted. Topics covered included: review of cores and core reinforcement details; identifying casting features of the CDC presenting the greatest challenges with respect to castability, inspection, and repair; and correlation of solidification simulations with actual experience on other CDC designs.

In support of the compressor rotor, test matrices were completed for high cycle fatigue (HCF) testing of the rotor materials at precise ATS conditions for design validation. Quotes have been received, and mechanical testing vendors have been selected for tests. Scrapped compressor wheels have been machined to remove material for tests.

A test matrix for the evaluation of diffuser material has been completed. Material for test specimens has been acquired to confirm expected properties for this component. Quotes from test vendors have been received, and a vendor has been chosen to perform the testing. Half of the specimens scheduled for machining have been completed.

Work Planned for Next Reporting Period

Machining of HCF specimens from the compressor material will be completed. Most of the HCF testing is scheduled for completion, and an analysis of the data will be initiated as it is received. Diffuser material HCF testing is scheduled for completion along with an analysis of the data and a report of results.

Section 2.2.4.7 (GTMTRF) Turbine Rotor Forging Materials and Processes

Objective

Processing parameters of forged large turbine rotor components will be optimized to achieve the desired forging attributes. These parameters include chemistry and processing temperatures as well as post-processing surface treatments. Sub-size and full-size forgings will be produced to verify and evaluate the processing approaches, and forging supplier process plans will be developed for all components. Forging acoustic properties will be determined by ultrasonic testing on test block and prototype parts. The attenuation, anisotropy, frequency bypass, and signal-to-noise ratio will be measured and used in fracture mechanics analyses to support rotor design. Optimized inspection methods, any necessary software, and scan plans will be developed based on the work with prototype parts. Property evaluations will be conducted to ensure that material behavior models used

for design accurately reflect properties in parts made by the chosen manufacturing process.

Technical Progress

Melting of all production ingots plus one backup ingot was completed. Four ingots were forged into billets during one campaign to demonstrate that these large ingots can be effectively forged into billets in groups. One component was inspected by the forging supplier after machining and found to have no defects and low acoustic noise. Mechanical property testing and microstructure evaluation were also completed by the supplier for confirmation. The effects of forging and heat treating temperatures on grain size were evaluated for the nominal chemistry and two additional chemistries to evaluate the robustness of the material and processing. The nondestructive inspectability of these components is also being evaluated at the supplier and by GE. Initial assembly of the system necessary to inspect the ATS-geometry forgings has been completed by the vendor. Check-out of the system and modifications of techniques from existing systems is in the final phase. The testing site is currently in preparation.

Work Planned for Next Reporting Period

Evaluation of full-size and laboratory parts to assess the robustness of the process and any potential improvements will be continued. The progress of the production components will be followed. Installation of the inspection system will be completed and testing will begin.

Section 2.2.4.8 (GTMTRS) Turbine Rotor Spoolies and Transfer Devices Materials and Processes

Objective

Although material selections for the cooling system delivery systems have been completed, this task will perform testing to verify properties and identify potentially better materials. Any applicable or needed coatings or joint materials will also be identified. Procedures for joining delivery components together and inspecting them will be evaluated.

Technical Progress

Potential suppliers of the spoolies and cooling system devices have been identified. Key material characteristics of these parts have been defined. Test matrices were drafted and potential laboratories investigated. Investigation of wear coatings and lubricants to enhance the dynamic fit-up interfaces was begun.

Work Planned for Next Reporting Period

Final definition of test matrices and candidate materials will be completed, and a test laboratory for wear coatings and lubricants will be selected. Wear coating and lubricant testing will begin.

Section 2.2.4.9 (GTMTSB) Structural Bolting**Objective**

Mechanical and physical property tests on high strength bolting materials will be conducted at ATS turbine conditions. If required, manufacturing trials will be conducted to optimize forming processes.

Technical Progress

More than 7,000 hours of relaxation tests for one bolt material and just under 7,000 hours of relaxation tests for a second bolt material at ATS conditions have been completed utilizing material produced in the same manner as the bolting to be used in the turbine. Machining of additional test specimens for a second bolt material was completed from a second heat of material for statistical improvement of the data.

Work Planned for Next Reporting Period

Relaxation testing of the second heat of material will begin. Time will continue to accumulate on samples currently in test.

Section 2.2.4.10 (GTMTTA) Turbine Airfoils Materials and Processes**Objective**

Microstructure and mechanical properties will be evaluated for full-size castings processed in this program. A comprehensive program will yield final specifications with appropriate heat treatments, and will quantify the effects of ATS airfoil geometry and structure/property variability. Casting processes will be developed for all airfoils utilizing developmental casting trials. Critical nozzle and bucket long-term material properties will be measured at elevated temperatures. Metallic coating systems will be developed for internal and external oxidation protection of the airfoils. Samples will be coated using various techniques for optimization studies and process verification.

Technical Progress

Additional critical property mechanical tests were conducted on turbine bucket and nozzle alloys at various temperatures and stresses to cover a range of operating conditions expected for ATS components. These included low cycle fatigue (LCF), thermal-mechanical fatigue (TMF), and creep. Various material property design curves were issued.

Tensile tests were conducted on specimens removed from the shanks of the latter-stage buckets of three material types. Eight tensile tests were conducted on each of the three alloys at four temperatures. These tests are being conducted to assure that the components will possess currently expected properties. Various microstructural evaluations on prototype latter-stage buckets were completed. Porosity levels, heat treatment microstructure, and dendrite arm spacings were investigated. Recrystallization studies were conducted and completed on one bucket material.

Solidification processing experiments were completed. The experiments were designed to cover a range of processing conditions, typical of those observed in large bucket and nozzle castings, to define the optimum processing window. The chemical compositions of the castings were analyzed at various locations along the length. The four castings were macroetched at GE and analyzed for surface defects; primary dendrite arm spacings (PDAS) were also measured.

Creep testing of the second-stage bucket material with three different heat treatments continued in order to further evaluate the effect of heat treatment on creep behavior. Fourteen of the samples ruptured during this reporting period. Four tests continue to run. Creep comparison plots were updated to evaluate the possibility that changes in heat treatment can enhance the creep behavior of the material. Additional creep testing was completed on specimens designed to better evaluate geometry effects of material with standard heat treatment. This testing was run at four different temperatures.

The initial phase of LCF tests, both pressurized and non-pressurized, on bucket and nozzle material samples containing intentional defects was completed this reporting period. To date 19 tests have been run. SEM fracture surface analysis was completed on all 19 tested specimens, 6 in this reporting period. Defect sizes were measured from SEM micrographs for each specimen. More than 700 measurements were documented. The program scope for a more comprehensive test program to evaluate defects was defined. This program was formulated to achieve better understanding of the effect of defects on the LCF properties at ATS conditions. Purchase orders were placed with two casting vendors for test specimens and slabs with specific defect requirements. Test vendors were contacted regarding specific test requirements for this program.

The 49 buckets with candidate improved coating systems were installed in a 6B being run at Mission Energy's Sargeant Canyon, California, facility for a field test this reporting period and the test was started. The final group of strain-to-crack specimens were coated and post-coat processing was started. These specimens will be tested to evaluate processing parameter effects on coating properties. Results from these tests will eventually be compared with the results that will be coming from the field test. Correlation of field and laboratory test results will be of great value in future coating development efforts.

First- and second-stage bucket and first-stage nozzle castings were made to evaluate the optimum processing of these components.

Work Planned for Next Reporting Period

Long-term and ATS-specific critical property testing will continue, with additional LCF and TMF tests being completed. Microstructural evaluations will be conducted on ATS first- and second-stage buckets for confirmation of the process. Long-time aging of one latter-stage bucket material will continue for subsequent evaluations. Castings from the solidification experiment will receive microstructural evaluation with subsequent correlation with process parameters. Creep testing of the remaining four second-stage bucket samples will continue to further investigate the effect of heat treatment on creep behavior. Microstructural evaluation of the creep damage will begin as creep samples are returned from the test vendor. Processing of the samples for defect testing will begin.

Processing of the remaining strain-to-crack specimens will be completed and testing will begin.

Section 2.2.4.11 (GTMTCB) Combustion Materials and Processes

Objective

Properties of materials for combustion components will be evaluated at ATS conditions. Where necessary, trial components will be made in order to acquire material of the appropriate size using full-scale manufacturing processes.

Technical Progress

There was no activity associated with this task under the ATS Phase 3 Cooperative Agreement during the current reporting period.

Work Planned for Next Reporting Period

Metallurgical and manufacturing evaluations of castings produced previously will be conducted.

Section 2.2.4.12 (GTMTST) Turbine Structures Materials and Processes

Objective

Producibility evaluations for the turbine structures will include selection of materials processing parameters and chemistry, and preparation of material and process specifications. Processing trials will be used to confirm producibility and verify capabilities of suppliers. Testing will be conducted where necessary to evaluate the materials under ATS conditions.

Technical Progress

A review of the processing capabilities, material response, and post-cast processing limitations and requirements was conducted for the steam gland in support of final design efforts.

Work Planned for Next Reporting Period

Final acceptance requirements will be set for the steam gland, and applicable specifications will be revised or new ones written if needed. Producibility requirements will be set and final process selections will be made for the exhaust end components.

Section 2.2.4.13 (GTMTSH) Turbine Shells

Objective

Materials and processes will be identified for the production of the turbine shells. Specifications will be produced after material property testing and process verification/optimization trials are conducted to achieve the best quality part to meet all design criteria.

Technical Progress

Final materials selection and producibility, inspection, and repairability requirements for the inner and outer turbine shell were reviewed and approved. Specifications were written for part requirements for the inner turbine shell. The coefficient of friction/wear testing on the outer/inner turbine shell was completed according to the plan. Quotes from vendors for mechanical testing of the turbine shell material were obtained for most of the testing to confirm properties at ATS conditions.

Work Planned for Next Reporting Period

Further wear testing of additional inner shell material combinations will be conducted to verify final design options. An anti-wear coating for the shells will be investigated, with the amount of protection and ease of application among the criteria.

Section 2.2.4.14 (GTMTSR) Seal Technology**Objective**

Improved gas path seals will be developed for the ATS turbine using seal technology from aircraft engine components where applicable. The technology will be evaluated using developmental hardware and samples. These advanced seals will provide evolutionary advances in machine performance.

Technical Progress

Nozzle seal procedures for attachment methods were developed and demonstrated on the nozzles for the cascade test. The manufacturing sequence and procedures were refined by this activity. Methods for repair rebraze were also successfully demonstrated on a nozzle. E-beam weld trials of coupons simulating shrouds were performed with acceptable results.

Work Planned for Next Reporting Period

Processes found to be acceptable will be documented, and applicable specifications will be drafted.

Section 2.2.4.15 (GTMTAR) Airfoil Repair**Objective**

Existing techniques will be evaluated and adapted for the material/geometry combinations unique to the ATS turbine airfoils to extend component life.

Technical Progress

Efforts were initiated to examine the repair of single crystal alloys. A matrix of candidate materials for filler material was selected after research on previous repair methods for superalloys. An initial set of samples was prepared for subsequent trials. Included in the sample preparation was a study to examine the surface condition. These samples will be used to assist in determining the necessary surface preparation for actual components.

Work Planned for Next Reporting Period

Studies will continue to evaluate repair methods for single crystal alloys. Mechanical property evaluations of repairs will be added to assess the effects of repairs on the base metal.

Section 2.2.5 (GTTT) Thermal Barrier Coating Technology**Section 2.2.5.1 (GTTTSD) Coating System Development****Objective**

Plasma spray TBC processes will be developed for specific ATS combustion and turbine components. Both axisymmetric and non-axisymmetric plasma gun and part motions will be developed. The approach will be to conduct iterative spray trials using specimens, coupons attached to the part, and trials on the part. Coating evaluations will consist of metallography, property measurements, and thermal cycling exposure. Thick thermal barrier coatings will also be evaluated in rig tests and full-scale combustor tests. Improved process monitoring will be developed to increase process repeatability and control.

The TBC Manufacturing Technologies portion of the task will focus on integration and compatibility between TBC processing and other component manufacturing steps. Techniques to prepare components for spraying will be defined. Fixturing and masking will be developed. Surface finishing techniques will be developed for the first-stage bucket and first- and second-stage nozzles.

The TBC Process and Diagnostics portion of the task will focus on achieving a better fundamental understanding of the TBC application process. Specific robot control algorithms and process conditions critical to the thickness and properties of the TBC system will be evaluated. Continuing work will focus on improving robot path planning accuracy and identifying Key Control Characteristics (KCCs) for the ceramic top coat and metallic bond coat. The KCCs will be those directly controllable aspects of the coating process that most strongly influence process variability and TBC quality.

The TBC Nondestructive Evaluation (NDE) portion of the task will develop NDE techniques to measure attributes and properties of TBCs on turbine hardware that are relevant to manufacturing. The primary focus will be on development of methods to measure coating thickness.

Technical Progress

A laser measurement system was developed to monitor and record robotic motion (e.g., tool position, velocity, and acceleration) during TBC application. Five motion control strategies were evaluated. Of the five strategies evaluated, two were selected for further development. Both are a form of inverse time motion control (ITMC), which permits the simultaneous movement of both the robot (i.e., tool) and the workpiece, allowing for direct program control of relative velocity and position. One form of ITMC is commercially available from the robot OEM and is considered "general purpose." The second form is the result of a joint study by GE and the robot OEM to develop a "high

performance" method of motion control. Both methods are in the final stages of evaluation for motion performance, programming complexity, and overall costs.

Five approaches for developing bond coats with improved oxidation properties under conditions of local TBC spallation are being evaluated. Specimens were produced for evaluations of ceramic adherence and bond coat oxidation using static and dynamic thermal exposure tests and mechanical tests.

TBC Manufacturing Technologies

Five surface finishing techniques are being investigated: (1) dry grit blasting, (2) CNC grinding, (3) flexible brush grinding, (4) position-controlled vibratory tumbling, and (5) gravity-assisted shot peening. Dry blasting trials were unsuccessful as a result of poor control of material removal rate and incident angle.

TBC Process and Diagnostics:

Deposit experiments to evaluate the effect of gun velocity on TBC properties were performed. Evaluations of mechanical properties and furnace cycle test (FCT) life showed that the TBC process is relatively robust over the range of gun velocities used to coat ATS turbine components.

A comparison between plasma process gas flowrates at the GEPS and CRD TBC development facilities was begun.

TBC Nondestructive Evaluation:

Coating of GE TBCs with a range of substrate curvatures and coating thicknesses was completed.

Optical measurements of vendor coating thickness on flat and curved specimens using a scanning microscope with image analysis capability were completed. A computer program to perform the image analysis was written and tested. Comparisons were made between the image analysis results and measurements made using a measuring microscope.

The Fischer instrument was used to complete a set of eddy current measurements on the concave and convex vendor specimens. A gauge study for measurement reproducibility and repeatability was initiated.

Work Planned for Next Reporting Period

Installation of the improved robot equipment at three GE manufacturing and development sites will begin. Deposition trials using similar equipment at GE Aircraft Engines will be completed.

Selection of prime surface finishing processes will be made.

The accuracy of the optical TBC thickness measurement technique will be determined. Measurement of bond coat thickness and electrical conductivity will begin.

Section 2.2.5.2 (GTTTRR) TBC Risk Reduction

Objective

TBC durability will be evaluated under conditions very similar to the surface temperature, thermal gradient, and stress state of TBCs in ATS applications. An E-beam rig capable of inducing high thermal gradients will be used to assess the relative durability of various TBCs, and the controlling mechanisms of TBC failure will be characterized. TBCs with a spectrum of microstructures will be tested to determine the role of TBC thickness on stress development and failure mode in high thermal gradient conditions, the failure modes of various TBCs of differing microstructures and deposition techniques, the role of number of cycles and hold times at high temperature on TBC failure mode, and the role of bond coat composition and roughness on TBC life and failure mode. The effects of environmental contaminants on TBC performance in high thermal gradient conditions will be investigated. Numerical modeling will be used to determine the stress, strain, and thermal gradient conditions in the various TBCs during the tests.

Technical Progress

A second TBC-coated sample with pre-deposited environmental contaminant was tested. The sample was tested for 20 cycles at full conditions. The conditions were set such that the contaminant should have penetrated to approximately one-half of the TBC thickness, where the TBC spall should terminate. During testing, the E-beam power level was increased incrementally until surface melting of the contaminant was observed. E-beam power was controlled via surface temperature feedback, which was measured using an optical pyrometer. However, due to changing surface emissivity during melting of the contaminant, E-beam power was not constant during the test.

Complete TBC spallation occurred in the region affected by the contaminant, but in a manner that was not characteristic of similar TBC degradation observed on gas turbine hardware. Metallographic examination indicated that the contaminant did not infiltrate completely to the bond coat. It is not clear whether the TBC spalled completely due to processing defects or to inadequate control of the thermal gradient during the test. Subsequent tests will be conducted such that the E-beam power is controlled directly, which will give better control of the thermal gradient through the TBC.

One TBC-coated sample was tested under full ATS conditions for 100 hours. No observable change to the TBC occurred. Two additional samples will be tested in similar fashion. Four samples were furnace aged to 50% and 75% of TBC life (as determined from FCT tests) prior to E-beam endurance testing. Two samples were aged with thermal cycling and the other two samples were aged without thermal cycling. These tests will address TBC response to ATS conditions after various fractions of TBC life.

Work Planned for Next Reporting Period

The next environmental contaminant sample will be tested either in an E-beam power level control mode or using a bare TBC region for optical surface temperature measurement and control.

One additional unaged TBC endurance sample will be tested at full conditions. The four furnace-aged samples will be tested at full conditions. Four fillet samples (which were TBC coated in Phase 2, Task 8.3.1 - TBC Testing and Analysis) will be tested. A 15 μ m pyrometer (which was tested and calibrated in Phase 2, Task 8.3.1 - TBC Testing and Analysis) will be installed and tested in the E-beam rig.

Section 2.2.5.3 (GTTTDD) TBC Design Data and Life Analyses

Objective

Thermomechanical failure modes in advanced TBCs will be identified, classified, and defined using empirical methods. Experiments will be performed to find key relationships among plasma spray processing variables, coating microstructure, coating physical and mechanical properties, and coating performance under simulated ATS conditions.

Numerical analyses will be performed to determine TBC stress states expected in ATS turbine components and in laboratory thermal cycling tests. The influence of the TBC stresses on TBC failure modes will be examined. Specially developed finite elements will be used for modeling the behavior of the interface cracks and free-edge stress singularities. The effects of bond coat roughness on TBC stress state, crack driving forces, and delamination failure will be examined. Parametric studies to determine the effects of bond coat and top coat properties on the TBC stress states will be performed.

Evaluation of the spatial and run-to-run variability of TBC thermal conductivity will be performed. Improved understanding of this variability is essential because variations in TBC microstructure result in variations in TBC thermal conductivity that can be several times greater than the variations seen in metals. Various methods of measuring thermal diffusivity and conductivity on flat and curved samples will be evaluated. The gas pressure dependence of thermal conductivity as a function of temperature will be measured. The results will be used to estimate the thermal conductivity of TBCs at ATS conditions.

Information from this task will be used as input to other tasks. Appropriate data and modeling results from parallel GE programs will be incorporated. Design guidelines will be developed for TBCs on ATS components. Ultimately, a TBC life analysis methodology and a life-predictive model will be developed. This will include effects of long-term exposure on top coat and bond coat physical and mechanical properties.

Technical Progress

The effect of gases on thermal conductivity of TBCs was computed using a model in the literature (McPherson, 1984). The model parameters used were those that fit previous measurements on CaO-stabilized zirconia TBCs. The model predicts increases in thermal conductivity for increasing temperatures; at room temperature for nitrogen at one atmosphere, an increase of approximately 10% compared to the value in vacuum is predicted. As a function of gas pressure, the increase achieves a maximum of approximately 40% at pressures greater than approximately 100 atmospheres.

Two APS TBC runs were performed to provide samples for thermal conductivity measurements. Sample disks were removed by water jet and the metal was removed by

etching. The samples were then polished on both sides. Sample density was determined by dry weight and dimensions as well as by weight immersed in water with a correction for porosity.

Measurements of thermal diffusivity were made by the laser flash method at Oak Ridge National Laboratory (ORNL) as part of a user agreement resulting from an earlier proposal. Multiple measurements under fixed conditions (200°C and nitrogen at one atmosphere) were made to estimate measurement variability (same sample and measurement location) and point-to-point spatial variability due to TBC microstructural differences. The ratio of thermal conductivity in one atmosphere of nitrogen to that in vacuum was measured at 208°C and 505°C. The thermal conductivity increases by a measurable amount in the presence of gas as calculated by modeling, and the effect increases at higher temperatures as predicted.

Work Planned for Next Reporting Period

Measurements of the effect of nitrogen on thermal conductivity will be used to fine tune previous model calculations and extrapolate the results to conditions of interest (i.e., high temperatures and pressures).

Thermal conductivity of samples from the second APS run will be measured to evaluate run-to-run variability in thermal conductivity.

Methods for preparing curved samples, including their density determination, will be developed. The validity of the laser flash method for curved samples will be tested by using samples of fully dense zirconia with various radii of curvature.

Section 2.3 (CC) Combined Cycle Integration

Section 2.3.1 (CCSD) Combined Cycle Systems Design

Objective

Optimization analyses will be performed and the combined cycle system will be configured to optimize cost/performance characteristics of the total plant. Steady-state modeling will be used to calculate the detailed plant performance. Dynamic modeling of load change sequences (e.g., startup and load rejection) will be used to specify control system design. Operability will be assessed.

Technical Progress

Part-load and non-ISO ambient condition cycle data generated by the 109H integrated steady state performance model (SSPM) have been released for design.

Preliminary simulation results have been released for the hot start, warm start, and cold start, and normal shutdown. Simulation output is being evaluated for continued refinements of control logic and algorithms.

The preliminary 109H heat recovery steam generator (HRSG) functional specification has been released for supplier evaluation and cost reduction purposes.

Work Planned for Next Reporting Period

109H simulation data will be released for general design purposes. The 7H gas turbine cycle deck will be updated and incorporated with an updated steam bottoming cycle model into the first major update of the 107H reference plant SSPM.

Section 2.3.2 (CCUA) Unit Accessories**Objective**

Four new accessory systems will be designed: the gas fuel heating system, the cooling-air cooling system, the clearance control system, and the gas turbine steam cooling system. Design of the heat exchanger and piping for the hot fuel will take into consideration the need to avoid coking. Deposit formation will be investigated. The effectiveness of coke barrier coatings, which have been under development for liquid-fueled systems, will be evaluated in long-term tests. Designs of remaining accessories will be conventional.

Technical Progress**Fuel Heating System**

With the overall system configuration determined in the prior reporting period, the engineering design team began development of the individual components of the fuel heating system. This involved preliminary discussions with component suppliers. Since the fuel heating system is a new system, no historical reliability data are available. During the current reporting period, plans were laid out for a Failure Mode Effects Analysis (FMEA) reliability study for the fuel heating system, which will be carried out through the remainder of 1996 and into 1997. These plans include input from CRD and Stanford University. The engineering design team also received training in preparation for creating the flow schematic and electrical schematic to the Process and Instrumentation Diagram (P&ID) format (the current industry standard vs. the internal GE standard used on all previous machines) that will be completed in the remainder of 1996.

Cooling-Air Cooling (CAC) System

During the prior reporting period, several design configurations developed for the cooling-air cooling system were eliminated and a single configuration was selected. During the current reporting period, this configuration was further developed to define the number and type of components required to meet the design requirements expected for this system. Preliminary discussions were then held with component suppliers in support of component development. Since the cooling-air cooling system is a new system, no historical reliability data are available. During the current reporting period, plans were laid out for an FMEA reliability study for the cooling-air cooling system that will be carried out through the remainder of 1996 and into 1997. These plans include input from CRD and Stanford University. The engineering design team also received training in preparation for creating the flow schematic and electrical schematic to the P&ID format (the current industry standard vs. the internal GE standard used on all previous machines) that will be completed in the remainder of 1996.

Clearance Control System

During the current reporting period, the functional requirements that the clearance control system must satisfy have been further defined by the gas turbine engineering design team and will continue to be defined during the next period. The clearance control system was developed in conjunction with the development of the functional requirements of the turbine section of the gas turbine. In addition, the functional scope of the clearance control system was expanded to include servicing the compressor section of the gas turbine, which will alter the design and number of components required by the clearance control system. The functional requirements for the compressor section of the gas turbine will be defined in the remainder of 1996. Since the clearance control system is a new system, no historical reliability data are available. During the current reporting period, plans were laid out for an FMEA reliability study for the clearance control system that will be carried out through the remainder of 1996 and into 1997. These plans include input from CRD and Stanford University. The engineering design team also received training in preparation for creating the flow schematic and electrical schematic to the P&ID format (the current industry standard vs. the internal GE standard used on all previous machines) that will be completed in the remainder of 1996.

Steam Cooling System

The steam cooling system represents an entirely new turbine technology for cooling the hot gas path parts of the gas turbine. The reliability of this system is critical to the operation of the gas turbine. Therefore, during the current period, plans were laid out for an FMEA reliability study for the steam cooling system that will be carried out through the remainder of 1996 and into 1997. These plans include input from CRD and Stanford University. Further development of the steam cooling system components took place during the current reporting period, focusing on the steam filter skid. The engineering design team also received training in preparation for creating the flow schematic and electrical schematic to the P&ID format (the current industry standard vs. internal GE standard used on all previous machines) that will be completed in the remainder of 1996.

Exhaust Diffuser

Although the requirements for the advanced machine exhaust system dictate that it be similar to the F machine exhaust system, several structural problems experienced on the F machine exhaust system required that an entirely new design be developed. An exhaust system task force was assembled during the current reporting period. The charter for the task force was: to assess the structural problems experienced with the F machine exhaust system; develop a long-term fix for the failed field units; develop an entirely new exhaust system design for future F machines, and apply this knowledge to the development of the advanced machine exhaust system. During the current reporting period, a field fix for existing F machines and a new design for future F machines were developed (not as part of this ATS program). As feedback on the performance of the F machine fix is received from the field during the next reporting period, development of the advanced machine exhaust system will begin during the remainder of 1996.

Work Planned for Next Reporting Period

For the accessory systems being designed for the advanced gas turbine, the following work is planned during the next reporting period.

New System Development

During the next reporting period, the conceptual design phase of the four new accessory systems (the gas fuel heating system, the cooling-air cooling system, the steam cooling system, and the clearance control system) will end and the preliminary design phase will begin. The engineering design team for the four new systems will become involved in this phase of the program starting with the development of the Process and Instrumentation Diagram. At this point, each step of the preliminary design phase and final design phase for the unit accessories is scheduled in the GEPG TIMES automated scheduling system.

The P&ID created will include both a flow diagram and an electrical diagram for each of the four new systems. Initially, preliminary diagrams for both the flow and electrical diagrams are scheduled to be developed and released. Upon release of these documents, a design review is scheduled for review of the preliminary P&ID by all necessary members of the advanced machine design team. The engineering design team for each of the four new systems will then include any changes resulting from the design review into the final P&ID, which is scheduled for development at the end of the third quarter, with the final design review and final release of the P&ID scheduled for completion in the fourth quarter.

Coordination of the FMEA study with the development of the four new systems will be conducted so that the results of the study will be received in time to be included into the system design prior to the completion of the final design phase of each of these new systems. GEPG will continue its work on the FMEA study in conjunction with CRD and Stanford University.

Exhaust System

The conceptual design of the advanced machine exhaust system will continue in the next reporting period with the intent of defining a single design concept so that the preliminary design of the hardware can begin during the remainder of 1996. An exhaust system task force created in the current reporting period has up to now focused its attention on the F machine exhaust problems, intending to apply the lessons learned during the development of a new F machine exhaust system to the development of the advanced machine exhaust system.

Section 2.3.3 (CCCL) Controls**Objectives**

An integrated plant control system will be developed and designed that will be suitable for the advanced gas turbine combined cycle power plant. Specifications of control equipment requirements will be prepared. Control and protection strategies will be developed for gas turbine steam cooling and integration with the steam turbine and HRSG. Control system dynamic behavior will be studied by dynamic simulations. Specifications of control algorithms will be prepared for implementation in the control system program.

Technical Progress

Documentation of the control system models has been completed. These models are being used in a continuing study of the dynamics of the combined cycle, the combined cycle components, and the control system. Initial definition of the control system algorithms was completed.

Work Planned for Next Reporting Period

Certain control loop dynamics will be studied to determine limits of operation and controllability. The graphics philosophy document will be completed.

Section 2.3.4 (CCRA) Reliability, Availability, and Maintainability (RAM) Analysis**Objective**

An evaluation of the reliability, availability, and maintainability (RAM) of the 7H and 9H equipment will be performed. The basis for the work will be the EPRI High Reliability Controls and Accessories Study. The RAM analysis will include: the flange-to-flange gas turbine, heat recovery steam generator, steam turbine, controls and accessories, electrical generator, and balance of plant equipment. A failure modes and effects analysis (FMEA) will be included.

Technical Progress

There was no activity associated with this task under the ATS Phase 3 Cooperative Agreement during the current reporting period.

Work Planned for Next Reporting Period

Although this task was not scheduled to begin until January of 1997, some elements of the task may start in the next reporting period so that preliminary results can influence the gas turbine and system design earlier.

Section 2.4 (MF) Manufacturing Equipment and Tooling**Objective**

The materials, equipment, tooling, and processes required to produce the 7H and 9H turbines will be identified. Manufacturing schedules will be established to support ATS pre-commercial demonstration goals. Manufacturing procurement schedules and cost will be defined.

Technical Progress

Forging drawings for the turbine wheels were completed that will allow completion of the forging dies. A mock-up of the exhaust portion of the 9H machine was completed that will allow completion of the steam box, piping designs, and instrumentation schemes for the prototype 9H and 7H machines. An order was placed for a mock-up of the CDC/inner shell area of the machine that will aid in final design of the many mid-section components in the combustion/first-stage nozzle area of the machines. An order was placed for an

advanced robot for the TBC coater in Greenville. A manufacturing schedule and investment/tooling budget for the 7H machine have been established.

Work Planned for Next Report Period

During the next quarter, the turbine wheel forging dies will be completed, the CDC/inner shell mock-up will be delivered, and the upgraded robot for the TBC coater will be delivered to Greenville.

Section 2.5 (IG) Integrated Gasification and Biomass Fuel**Objective**

An assessment of the ATS will be performed as part of an efficient and environmentally compatible integrated gasification combined cycle (IGCC) power generation system. Modifications to the gas turbine to accommodate the high mass flow resulting from the low heating value fuel gas and nitrogen injection for low NO_x emissions will be identified. Analyses will be performed to optimize the integration of the steam cycle with one oxygen-blown entrained flow gasifier and gas cleanup system and integration of the gas turbine with the air separation unit. IGCC system performance will be analyzed for one coal composition at ISO ambient air conditions.

Technical Progress

There was no activity associated with this task under the ATS Phase 3 Cooperative Agreement during the current reporting period.

Work Planned for Next Report Period

There is no planned activity for this period.

Section 2.6 (DE) Pre-Commercial Demonstration**Objective**

A commercial proposal will be prepared and submitted to the host utility.

Technical Progress

Commercial activity remains high. Excess of generating capacity in the domestic market continues to delay project approvals; however, commercial discussions (equity shares, price, shipment requirements, insurance premiums, performance levels, construction financing, and service agreements) with potential host utilities and power marketers continue to intensify.

Work Planned for Next Report Period

GE will continue to support the potential host utilities' technical and commercial evaluations.

Both the third Utility Advisory Board (UAB) Controls "Sub-Group" meeting and the fourth UAB meeting to update UAB members on the status of Advanced Machine performance, operability, maintainability, reliability, availability, plant arrangements, and installed cost are being scheduled for September 1996.

Section 2.7 (PM) Program Management

Objective

Within GEPG Engineering, an ATS Program Office will be established and a Program Manager and a Contract Administrator will be assigned. The Program Manager will direct the overall activities of the Program Office, and will have responsibility for reporting to DOE and ensuring that the program goals are achieved. The Program Office is responsible for communicating contract requirements, authorizing applied labor and expenses for material and services, scheduling, monitoring, and reporting cost and technical performance. Additional responsibilities include coordinating ATS activities with CRD and GEAE. The assigned Contract Administrator will support the Program Manager in all administrative matters. All materials and equipment acquisitions will be closely monitored by the Program Office with support from the Finance and Sourcing organizations.

Actual scope, schedule, and budget will be tracked against plan. An integrated program plan will be maintained, including a detailed Work Breakdown Structure, that accurately describes the planned work, reflecting all changes in work scope or schedule. The integrated program plan includes the implementation and coordination of all program support procedures and initiatives such as Target Costing, Key Quality, and Design for Manufacturing.

Reports will be prepared to serve both DOE and GE needs for oversight and monitoring, including quarterly reports, annual reports, and topical reports. A final report will be prepared at the completion of the cooperative agreement. Reports specified in the Cooperative Agreements Financial Assistance Reporting Requirements Checklist will be supplied. Technical papers will be submitted for presentation to professional society meetings. Open communications will be maintained with DOE and the Industry Advisory Board.

Based on work in Phase 3, a Continuation Application will be prepared and submitted to DOE incorporating the details for the proposed Pre-commercial Demonstration including the host utility site selection, permitting, environmental factors, fuel characteristics, utilization plans, and plant arrangement constraints.

Technical Progress

A Program Review was held on April 18, 1996, in Schenectady, NY, at the facilities of GE Power Systems and GE Corporate Research and Development. The review covered all current design activities associated with the ATS Program as well as a tour of the laboratory facilities at Corporate Research and Development being utilized in the Enabling Technologies support activities for the design effort. A follow-up video conference was held on June 21, 1996, between DOE/METC and GE, where an updated version of the

Program Review was presented for the benefit of those DOE personnel who had been unable to attend the April 18 review meeting.

Monthly and quarterly program reporting has been submitted to DOE, as required, and preliminary discussions have been held regarding reconfiguration of the 7H utility demonstration (Phase 4).

Work Planned for Next Reporting Period

Following a request from DOE/METC, a preliminary BUDGETARY estimate of costs for a program replan for Phase 4 will be prepared and submitted.

Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.