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IN THIS ISSUE...

Joint TURBO EXPO–IJPGC Keynote Presentations Look to the Future

by Dilip Ballal and Lee Langston

Predicted to be "The Mother of All Keynote Sessions!" by IGTI Chair Bob Kielb prior to this year's co-located TURBO EXPO and IJPGC events in New Orleans, this much heralded session more than met expectations.

Randy Zwirn, President and CEO of Siemens Westinghouse Power Corporation, spoke first and predicted that gas turbines will generate 10 percent of the power in the U.S. in the next year. To meet this unprecedented demand, Siemens Westinghouse will increase production from 40 to 125 gas turbines per year. He called for more investment in production, e-trade to facilitate equipment transfer, service and analysis. He predicts a re-emergence of power equipment needs in Asia and Europe after the North American market slows; and suggests borrowing ideas from the nuclear industry to reduce power outages from days to hours or even minutes.

Wayne MacIntire, Senior Manager for Power Technology for International Paper presented the first power user's view. He stated that the rising cost of natural gas led his company to survey its $1 billion per year energy usage and cut consumption by 25 percent, in part by improving energy efficiency, such as by retrofitting vintage boilers.

Del Williamson, President of GE Power Systems Global Sales, provided a worldwide perspective on gas turbine power generation. Over the next five years, he predicted a 330 GW capacity growth in the Americas, 200 GW in the Pacific Region, and 170 GW in Europe. He stated that the major impact will be from deregulation, fuel prices, field availability of machines, the possible return of nuclear power, and transmission constraints. GE has increased its gas turbine production from 212 in 1999 to 281 next year. "We will supply California with enough LM2500 gas turbines to generate 450 MW," Williamson said. He further predicted the U.S. growth "bubble" in power plant orders would peak in 2001-2002.

Registration at TURBO EXPO 2001 in New Orleans

The next gas turbine user, Thomas Mason, Executive Vice President of Calpine Corp., said energy demand has driven the explosive growth of combined-cycle gas turbines. Calpine will soon be producing 7% of the entire U.S. electrical load. "We went from generating 16,000 MW to 37,000 MW last year, and have targeted producing 70,000 MW in the U.S. by 2005." Calpine has 27 plants under construction with 230 gas turbine units on order from OEMs. His company's main challenge is servicing that fleet while reducing costs for the company's ratepayers. To answer problems with parts supply and to re-engineer either failing or costly components, Calpine has hired its own gas turbine engineering staff and formed their own group, Power System Manufacturing.

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Dave Wisler, CHAIR, IGTI BOARD OF DIRECTORS

Positioning IGTI Strategically for the Next Decade

Looking back over the past several decades, one can get a justifiably warm feeling about IGTI success. After all, we had worked hard to earn the reputation as the premier gas turbine society in the world. This was accomplished through good leadership at all levels of IGTI, solid technical papers honed by an outstanding review process, and a host of dedicated and talented engineers and researchers from industry, academe and government. Life was good.

But change has been on the horizon for a while, and in some cases this change has already blossomed. I would like to address five areas that will require sound IGTI strategy during the next decade.

The first of these areas is the Technical Congress. Thanks to the hard work of many, the Technical Congress remains very strong, with income from this portion of TURBO EXPO (TE) in New Orleans for the first time being about equal to that of the Exhibition. Although we are still considered to be the premier gas turbine society in the world, we cannot rest on our past laurels. Alternative forums have always been available for our membership to present their technical work, but they have largely chosen IGTI. We must keep it that way. We must be even more adept in creating the kind of value in our events that causes the gas turbine community to continue to send their best engineers and researchers to participate in our activities. There is good return-on-investment for attending TURBO EXPO as participants listen to the latest research activities, network among international colleagues, and learn from the exhibitors.

The second area is troubling. The Exposition at TURBO EXPO has changed dramatically in the last seven years. It will come as no surprise to anyone when I note that of all the large Original Equipment Manufacturers (OEM's) only Alstom and P&W exhibited at TE'01 in New Orleans. For various business reasons, Honeywell (formerly Allied Signal), GE, Rolls Royce, Siemens/Westinghouse, and Solar all chose not to exhibit. Although our Atlanta staff did a good job of back-filling some of this loss by an aggressive marketing campaign to small companies, the impact of losing the large OEM's is significant. We need to find the means to reattract these companies.

Thirdly, a favorable but challenging change is upon us in the form of the relatively new Gas Turbine Users Symposium (GTUS). Users of gas turbine engines, be they owners, operators, engineers, technicians, or repair and maintenance personnel, form a vital segment of the industry. This year GTUS really spread its wings in New Orleans as it attracted a goodly number of end-users into IGTI activities. The inclusion of users into our fold will significantly enhance IGTI. These are the people who use and service the machines the OEM's design. The technical side of IGTI can learn much from GTUS. The challenge is to build bridges between the GTUS and the Technical Committees. This challenge should not be underestimated.

Dave Wisler
Chair
IGTI Board of Directors

> ***"Make no mistake about it, IGTI is financially sound and technically strong."***

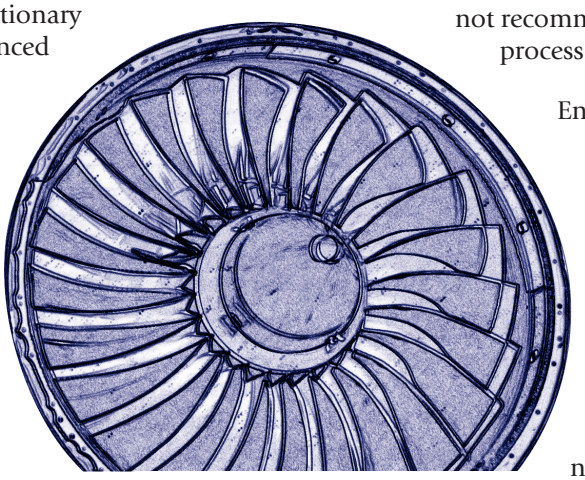
Now we come to a fourth and less-talked about aspect of IGTI activities - IGTI conferences other than TURBO EXPO. These efforts include COGEN, Asian Initiatives and South American ventures. Some of you will recall COGEN. It ran successfully for nine years but is no more, with the last event being held in Vienna in 1995. There were two Asian Conferences - Jakarta in 1996 and Singapore in 1997. There is currently a small South American initiative being discussed. With the business world going massively "global", IGTI must establish a sound strategic policy on global conferences outside of TE. This includes how best to partner with other societies at select conference venues. We must succeed in addressing this change or "others" will fill the void. And the "others" are working aggressively to do just that.

Lastly, we must pursue the new technology initiatives on the horizon, such as microturbines and distributed power initiatives. IGTI, through our Distributed Power Task Force, must be a strong player in this game. We must evaluate the issues and transition activities to the Technical Committees. Yet, important decisions must be made. Which of the Technical Committees will carry the microturbine banner? How should we lead these initiatives?

Make no mistake about it, IGTI is financially sound and technically strong. Although IGTI faces a number of challenges, your Board of Directors and the Atlanta staff are committed to making those decisions that keep it the premier gas turbine society in the world. We began addressing all of these issues and others in our strategic planning meeting held at GE Power Systems in Greenville, SC in August. All of us working together can keep us Number One. ☼

A report published by the **Frost & Sullivan** consultancy has claimed that the European market for small block-type thermal power plants (micro CHP systems) with capacities of up to 10kW is set to boom. Such facilities will succeed in becoming a recognized alternative to boilers between 2005 and 2007 and really make the breakthrough into the mainstream market. Small block-type thermal power plants with total capacity of some 3.5GW are forecast to be installed to 2010, raising annual sales from today's US$20 million to more than US$2 billion in2010, or from less than 2,000 units to around 500,000 units.

Pratt & Whitney Canada Corp. (P&WC) has successfully completed the first run of its revolutionary geared turbofan engine demonstrator, the Advanced Technology Fan Integrator (ATFI), designed for the regional airline and corporate jet markets. The ATFI demonstration program sets the stage for the new PW800 engine family of advanced geared turbofans in the 10,000-19,000-pound thrust range.



The US Navy's Unmanned Combat Air Vehicle - Naval (UCAV-N) is likely to be equipped with a variant of a commercially-developed turbofan engine, according to the Defense Advanced Research Projects Agency (DARPA). The UCAV-N may be fielded sometime after 2008. DARPA also expects the US Air Force's UCAV to use a commercial turbofan. Notional designs of UCAVs have suggested a 2,000 - 3,000 pound-thrust turbofan being used, presently making Williams-Rolls FJ44 and P&W Canada's developing PW600 turbofan applicable to the new design.

Pratt & Whitney and Mitsubishi Heavy Industries (MHI) Power Systems have agreed to explore development of a new generation of mid-size gas turbines to meet the growing demand for power internationally. No details beyond this statement have yet been released. Pratt & Whitney's Power Systems unit manufactures distributed power generation products ranging from 300 kW mini-turbines to the 60MW-capable FT8 "Twin Pac" turbine, making full use of its experience in aero-derivative technologies.

The US Department of Energy (DOE) is supporting a $13.4 million effort with private industry to extend the life and to improve the operations of advanced natural gas-fired gas turbine systems. Of the four projects selected in August by the DOE's National Energy Technology Laboratory (NETL), two will focus on protecting turbine components from being eroded by high internal heat. The other two projects will study ways to improve the stability and performance of turbines, also with a goal of lengthening their useful operating life. Solar and EPRI have have been awarded the erosion prevention contracts, while Siemens and EPRI have been awarded the performance contracts.

The International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) has reached agreement on a comprehensive set of recommendations to reduce aircraft noise and engine emissions. The CAEP recommended a new noise-certification standard aimed at reducing noise produced by new aircraft by an additional 10 decibels beyond current Stage 3 limits. The phasing-out of aircraft which would be non-compliant was not recommended, leaving that process to normal attrition.

Engineers at the **USAF R&D** Propulsion Directorate have used a newly-developed traveling wave excitation that can test bladed disks of varying sizes and numbers of blades using either acoustic or magnetic excitation. According to the engineers, the traveling wave excitation system provides flexibility to test different bladed disks, as well as a non-contacting, high-frequency excitation system capable of engine order excitation, and expandable to high blade counts at a reasonable cost. If engineers can simulate the loading and response that a gas turbine component experiences while operating in a bench environment, the engineers can perform a significant amount of testing and validation inexpensively.

Air France is the launch customer for the GE/P&W Engine Alliance GP7200 on the Airbus A380-800, having ordered engines for 10 firm aircraft they are to start receiving in late 2006. The order, including option and spare engines, is valued at nearly $900 million. The 81,500 pound-thrust GP7200 is scheduled for joint FAA and European JAA certification in mid-2005. ☼

Gas Turbine News in Brief ... is compiled for Global Gas Turbine News by Carl E. Opdyke, Power Systems Aerospace Analyst, FORECAST INTERNATIONAL, 22 Commerce Road, Newtown, Connecticut 06470

A SUPPLIER PERSPECTIVE . . .

The Long Term Service Agreement . . . A Partnership for Profitability

by Giovanni Salerni, GE Nuovo Pignone

With increasing frequency, customers are delegating to equipment manufacturers (OEMs) the operation and/or maintenance of their plants (cogeneration plants, industrial plants, compressor stations, pipelines, re-injection stations, platforms, refineries, etc.) with the goal of maximizing profit and minimizing risk.

The several contracts awarded to OEMs are typical examples of this activity where customer and supplier work together to attain common objectives, sharing risks and rewards, working in a sort of partnership in order to benefit from the same common objectives ... power delivered, or gas transported or re-injected.

Increasingly fierce competition in a deregulated market is pressuring energy suppliers to lower operating costs while simultaneously keeping their plants at maximum efficiency. For this reason, suppliers often prefer to concentrate their efforts on their core business, delegating to specialized companies the maintenance and in some cases even the operation of their plants. In many cases the manufacturer of the plant is the best partner for this purpose, due to the specialized knowledge it has acquired during the design and construction of the plant itself. To offer customers all the services they may need, OEMs have organized themselves to be present in the market not only as manufacturers of machines and plants, but also as suppliers of related services such as those of operating the machines and providing for their maintenance. Global service activities include the so called Long Term Service Agreements (LTSAs) which usually last several years and offer the customer five main benefits:

1. the customer knows in advance how much maintenance will cost, eliminating uncertainty;
2. the cost of maintenance can be linked exclusively to the annual production level (kWh for power generation plants, cubic meters of gas handled for gas compression stations, etc.);
3. maximizing production is the common objective of both customer and manufacturer, and both are recompensed in proportion to the production level; consequently, the plant will be maintained at highest efficiency and constantly updated technologically, eliminating the risk of obsolescence ... often the OEM shares risks and rewards with the customer;
4. the customer's personnel are kept constantly informed of new technologies introduced into the plant and trained about the equipment and its operation and maintenance;
5. the customer is not obliged to keep and manage a spare parts warehouse with the locking up of capital this implies, and the supplier can benefit by sharing its warehouse and inventory with more than one customer.

Although most LTSAs cover the turbomachinery sector (gas and steam turbines, centrifugal compressors and generators) where maintenance operations require highly specialized personnel, there are also contracts for reciprocating machines which, although of more mature technology, may require the same level of sophistication for particular applications. LTSAs must be adapted to customer requirements, are a customized service for excellence, and are highly diversified. They range from the simple "time and material" approach to complex global service agreements with performance guarantees.

Independent Power Producers (IPPs), for example, usually are concerned only with generating and selling power. This necessitates plants as reliable and efficient as possible. Their personnel, however, may not have a thorough knowledge of production means ... of how their plants should be operated and maintained in order to maximize production and thus profit.

At the other extreme are companies operating in the oil and gas sector, which usually have their own organization for running and maintaining their plants and machines and tend to manage their facilities on their own. Nowadays, they are trying to concentrate just on the running (operation) of their assets, delegating the maintenance to the OEM. They require turbocompressors with high availability and controlled heat rate because it affects production and the cost at which they are able to transport their gas.

Because of the differing needs and circumstances of its customers, the OEM has developed a line of service packages which can be combined in different ways to offer each customer a contract tailored to meet real needs in the most economic way.

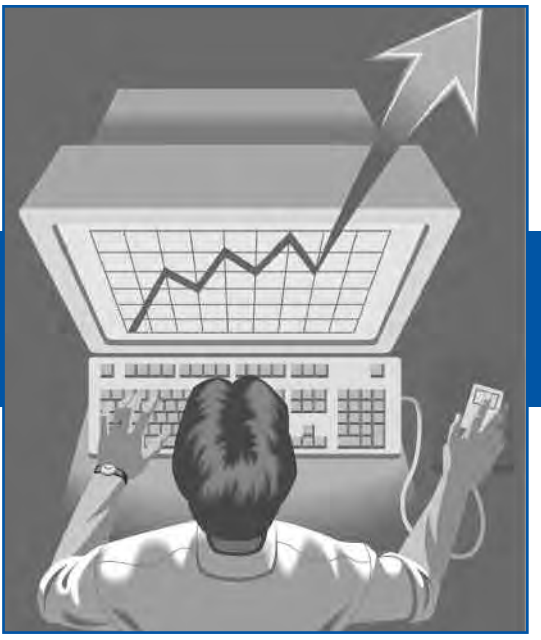
Everything necessary to attain customer objectives can be included in the contract or can be part of supplementary services to be paid separately by the customer: manpower, spare parts, tooling, logistics, repairs made during scheduled or emergency maintenance, technical assistance, etc.

To this can be added annual, periodic and predictive maintenance, tools, hoisting and transportation, training of customer personnel, improvements and modifications, supervision of maintenance, emergency calls, periodic inspection, technical support, supply of consumable/operational/capital spares, remote monitoring, diagnostics, headquarters support and more.

Usually an LTSA gives the customer a Guarantee of Performance such as availability, relia-

bility, maintenance costs, power output, heat rate, back-up lease engine, etc. for several years. The Guarantee of Performance often includes routine and emergency maintenance to guarantee the correct operation of the plant or compressor stations and to prevent any possible breakdown, failure and/or malfunction or defect which could impair or prevent regular operation.

In conclusion, LTSAs are a response to customer needs. Customers would like to operate together with the OEM, creating and strengthening a strong interconnection leading to a long lasting "partnership" thorough an LTSA, rather than establishing a mere customer/supplier relationship with low added value for both. ☼



A THIRD PARTY PERSPECTIVE . . .

Risk Assessment and Long Term Service Agreements

by Ron Natole, President, Natole Turbine Enterprises

Long Term Service Agreements (LTSAs) have become more common and more popular in recent years, particularly among power generators in an increasingly deregulated and competitive marketplace. Availability and efficiency are the twin goals that are seen to ensure profitability and LTSAs are often looked upon as the means to that end. It is important, however, that both the risks and the benefits of LTSAs be evaluated when making such an important decision. Benefits have been discussed elsewhere; let us look now to some of the risks. Bear in mind, however, that even this discussion is necessarily cursive, and a detailed cost/benefit analysis is recommended before any decision is reached.

WHAT IS INCLUDED and WHAT IS NOT

In the example discussed here, we will look at an 85 MW gas turbine generator. The term of the agreement is usually 10-15 years. LTSAs usually include maintenance and overhaul services, capital parts refurbishment, capital parts replacement, overhaul consumables, availability guarantees and output guarantees. What is not included, but what LTSAs usually require to go through them as the contracted provider, are operations expenses, routine and preventive maintenance and supplies, unplanned maintenance, extra work, and operating under conditions outside OEM recommendations. Some of these services may be negotiated or available as an added cost supplement to the LTSA, but others are not included in the agreement.

WHAT DOES IT COST?

Typical per unit costs are as follows:

Mobilization Fees	$50K to $100K
Fixed Fee	$6K to 15K per month
Unplanned Maintenance Option	$8K to 20K per month
Fired Hour Fee	$70K to 150K per Fired Hour
Availability Incentive	$25K to 200K per year
MW Performance Bonus	$80K to 400K per year

OEM parts costs are another important consideration. Hot gas path capital costs for an 80-100 MW machine (blades / buckets / vanes / nozzles) were $400K to $600K per set.

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Now they run from $800K to $900K per set. Hot gas path spares for a 150-200 MW machine will run from $1.5 to $2.5 million per set. And combustor parts are $50K to $150K per set for the older style, and $450K to $650K per set or more for the low NOx versions.

POTENTIAL PROBLEMS

LTSAs can give rise to some unexpected requirements because of their complexity and abundance of small print. Some of the things to be on the lookout for include:

- Requirement to use OEM services and parts even for unplanned, extra and "not covered" maintenance.
- Conversions, modifications and uprates may not be included in the costs or the parts and labor annual increase index.
- Unplanned maintenance costs may have incident and annual caps well below the potential risk.
- Unplanned and extra service and parts may not be covered and/or their prices not indexed.
- Outage extensions due to unplanned or extra incidents may not be covered in the availability guarantee.
- And the equipment must operate to OEM specs. That usually means no over-firing, no rapid starts, meeting fuel requirements, meeting water/steam requirements, meeting air requirements, and much more. Failure to comply with OEM specs may bring LTSA coverage into question.

RECENT EXPERIENCE

Producer acceptance of LTSAs has recently been a function of the type and use of the gas turbines owned. For more mature machines (prior to 1990), many power producers believe that the benefits offered by LTSAs are also available less expensively from the aftermarket. For the newer more advanced machines, those using the equipment for peaking are leaning toward Short Term Service Agreements of 3-5 years. For base load equipment of the newer technology, producers are more likely to go with LTSAs. The feeling is that without an LTSA there is almost no chance of getting the high technology parts needed to ensure availability because the aftermarket will not be producing them and LTSA agreements will place non-LTSA customers low on the priority list. As the demand for power generation equipment is met by the OEMs over the next few years, and their emphasis necessarily shifts to repair and maintenance, even these producers may have added options.

SUMMARY

Before signing on to any Long Term Service Agreement, it is important to remember that LTSAs do not give a firm price for all ten-plus years of the duration of the agreement; that "not covered" costs can be extremely high, particularly for parts; and that a detailed cost/benefit analysis is highly recommended. ☼

THE USER PERSPECTIVE . . .

LTSAs . . . On the River in New Orleans

by Terry Morgan, Terry Morgan and Associates, LLC

The Gas Turbine Users Symposium at ASME TURBO EXPO '01 in New Orleans hosted a well attended panel session on "Long Term Service Agreements - Current Performance and Future Trends". Long Term Service Agreements (LTSAs) were defined for the session as agreements offering differential access and/or pricing for services and supplies; preferential access agreements; agreements committing the parties to sole or restricted sourcing of services or supplies; or outsourcing agreements where long term mutual benefits are part of the contract.

Seven panelists represented both the oil and gas and large power generation segments of the LTSA marketplace. Panelists were Terry Morgan—Terry Morgan & Associates LLC (recently of ARCO Alaska, and Panel Chair); John Platt, Staff Advisor—BP America (Vice Chair); Armando Carrillo, Project Manager—Petroleos de Venezuela (PDVSA); Ed Sundheim, International Operations Manager—GPU Power; Daniel Barpal, Engineering Manager—Duke Energy North America; Kelly McGrath, VP Operations—El Paso Merchant Energy; and Doug Williamson, VP Gas Plant Operations—Calpine. Attendance was over 60 engineers, managers and other user representatives from around the world.

The panel discussed agreements typically offered by gas turbine OEMs and other major third party service providers in the power generation business. Other agreements common in the oil and gas business such as alliance and outsourcing were reviewed.

PRESENTATION

LTSA experience on the panel ranged from preferred supplier agreements to full outsourcing of major gas compression operation to power generation LTSAs for both new generation gas turbines, older GTs, and balance of plant agreements. Panelists commented in four areas: considerations for LTSAs; experience to date; improvement of current agreements; and the future of these agreements.

Reasons to Consider LTSAs. Panelists identified several reasons for considering the use of LTSAs. Among these were:

- Improved performance;
- Reduced operating expenses;
- Reduced project execution times where EPC services are part of the LTSA;
- Management concern that unplanned maintenance of new gas turbine plants is potentially much larger than past experience;
- Operator desire to share risk of new technology with OEM;
- Alignment of OEM incentives with operator business model; and
- Preferential access to supplies of high technology parts.

Experience To-Date. Panelists'experience to-date showed the following highlights:

- One operator reported a reduction of 25% in Operating Expenses (Opex) and 15% in Capital Expenses (Capex) in an agreement for outsourcing a major compression contract including Engineering, Procurement and Construction (EPC) work;
- Several operators reported that well written LTSAs did help align supplier and operator goals for costs and outage performance;
- Communication with the supplier at sites with LTSAs was good and frequent;
- The agreements create a desire to improve the working relationship on site;
- Standardized terms and conditions across operator sites was a major benefit; and
- For major outsourcing, agreement term should be longer than two major overhaul cycles to allow time to level results and gains/losses especially on large fleets.

Needed Improvements. LTSA agreements have several areas that the panelists feel need improvement:

- Selection of an OEM, or particularly a third party supplier, with the financial and technical resources to deliver desired results over all business cycles can be difficult;
- Supplier experience in actual delivery of contracted performance is seen as suspect in view of the projected power plant construction growth in the U.S.;
- Competition is needed—more third party suppliers with adequate financial and technical resources are required;
- Long term cost reduction needs more focus by suppliers;
- Better techniques are needed to respond to operating profile changes at a given location and renegotiate pricing accordingly;
- Concern exists that OEMs are using dedicated LTSA spares to support warranty needs, especially on advanced turbines—parts supply improvements are needed;
- OEMs and third party suppliers must demonstrate that contracted parts supply commitments, especially for advanced machines, can be met;
- Part design life is a serious issue and has not been "as advertised" nor "as assumed" in the execution of current LTSAs;
- Current LTSA forms do not lift any burden from operators and their insurers and do not control costs for risk management services;
- Repair technology development is seen as lagging demand for repair service; and
- Management support for long term use and modification of these agreements is less than desired.

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LTSAs . . . The User Perspective

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The Future of LTSAs. For the future, panelists predicted the following features and improvements would become part of LTSAs and major outsourcing agreements:

- Benchmarking of industry LTSA performance and better cooperation among operators in benchmarking efforts will become the norm;
- Contracts will be easier to modify and will more accurately reflect the real operating environment and business needs of both operator and supplier;
- Panelists expressed strong support for third party providers in the LTSA market while recognizing entry hurdles where advanced technologies controlled by the OEMs are used;
- Parts supply will expand - third party providers will be a market factor;
- Operators' contracting strategy will become more sophisticated as machines age and suppliers broaden—operators will drive the form of the contract; and
- Operators will selectively contract for elements of work or supply, as their business plan requires.

In those markets where insurance coverage is normally used to guarantee plant operations and allocate risk, panelists saw changes coming to control costs:

- Operators will become more forceful, especially with OEMs, in expecting the OEM to take some insurance risk for new technology offerings;
- OEM recommendations to run parts longer than experience dictates or originally contracted will result in negotiated risk sharing to cut insurance costs; and
- Operators will expect suppliers to assume some risk management burden—including property damage risks—there will be a new look at shared risks and rewards and proper allocation.

DISCUSSION

Attendees and panelists participated in a lively Question and Answer session. Some of the key topics covered were:

- An insurer observed that premiums and deductibles for LTSAs appeared to be going up as insurers see LTSAs as a higher cost service arrangement. Insurers are also concerned with suppliers' proposals to split benefits of proposed increases in time between overhaul with the operator. Such agreements can leave the insurer exposed to major coverage risk with no possible reward. This insurer observed that some insurance companies are canceling coverage in LTSA situations. Panelists agreed that it would be appropriate to share risks with the supplier. The panel was also concerned that risk management costs were not being properly shared with suppliers in current agreements.
- On the issue of extending run times in an LTSA or outsourced world, the panel and audience agreed that newer turbine technology has reduced intervals and that more supplier and parts competition is needed. Panelists are convinced that most of the risk in extending run times stays with the operator and it is a challenge to get the OEM to accept adequate risk sharing for extending run times.
- Ancillary or balance of plant equipment can be neglected in an LTSA. Oil and gas operators have had good success outsourcing this work separately from the LTSA by dealing directly with the ancillary equipment suppliers.
- The issue of rotable spares was discussed. Many felt most comfortable receiving their own rotable spares back from repair providers. Some major operators believe that OEM repairs transfer the risk of acceptable future life to OEM and are not demanding their parts back. One major user expressed confidence in OEMs to scrap parts if required but was doubtful other previous users would manage parts correctly.
- A lively discussion ensued about the use of Equivalent Operational Hours in LTSA contracts. All of the panelists pointed out differences in how this is handled by each OEM and in some cases site to site. All panelists cautioned that changes in site operating profile could heavily influence costs, parts availability, and supplier ability to respond to outages. A good review of costs versus hours per start was provided. There is a real cost issue between 20 hours/start and 30 hours/start where many plants in the U.S. are now operating.

In the power generation industry, most of the panelists felt that their LTSAs were working in accordance with their individual company situation and expectations. Difficulties were noted in parts access, OEM resources, third party provider access to the advanced turbine market, and with parts repair cycle time.

The oil and gas industry has used the alliance and outsourcing "cousins" of LTSAs for some time and is adept at using the agreements. Oil and gas agreements for turbine maintenance are more selective in scope and cover older, more mature equipment. Agreements for outsourcing of entire operations are becoming more common but are very unique and require flexibility and a clear view of the long-term goals. ☼

Aircraft GT Engine Life Management

The RCM Factor . . . Reliability Centered Maintenance

by Otha B. Davenport, Propulsion Product Group, Wright Patterson AFB
and Ralph E. Grimm, Universal Technology Corporation

A featured panel at TURBO EXPO '01 in New Orleans was entitled, "Advanced Aircraft Gas Turbine Engine Maintenance in the 21st Century." It was attended by more than 70 and provided for great information exchange and lively discussion. The panel included a good cross section of military and commercial users along with the developers and producers of gas turbine engines. Panel participants included Session Chair Otha Davenport representing the United States Air Force, Jason Chamberlain of Pratt & Whitney, David Garrison of Delta Air Lines, Dave Pauling of the United States Navy, Scott Crislip of General Electric, and Jim Uhl of United Airlines.

Each of the panelists presented information relative to the technical and management aspects of maintenance of aircraft gas turbine engines. One of the themes throughout the presentations was an emphasis on engine life management and specialized aspects of Reliability Centered Maintenance. Here we will explore some facets of these two subjects with an emphasis on Reliability Centered Maintenance as it applies to the United States Air Force.

ENGINE LIFE MANAGEMENT PLANNING

Life management has been around a long time beginning with the first turbojets that had frequent overhaul times and extending to modern sophisticated turbofans that power both commercial and military aircraft. We need to manage our fleets of engines from cradle to grave ... from the induction of a new engine into the fleet, through the maturing process, through long-term usage with recurring overhauls, and up through the aging engine stage prior to retirement. The United States Air Force Propulsion Product Group developed an "Engine Life Management Plan" to provide guidance for engineering and program management decisions. The plan incorporates information necessary for systems engineers, financial managers, and program managers to maintain and manage the fielded engine. Figure 1 provides a representation of the major components of this plan. This is a living document, updated frequently to embody the latest engineering and management information. It does not prevent surprises, but it helps provide program guidance and control. Top Air Force management has recognized the usefulness of the life management plan and has issued guidance through Air Force Instructions (AFIs). The team of engine developers, manufacturers, logistics specialists, engineers and program managers all contribute to the development of the plan. The execution of the plan is up to the program office with its cast of engineers, technical specialists, configuration managers, and logistics equipment specialists.

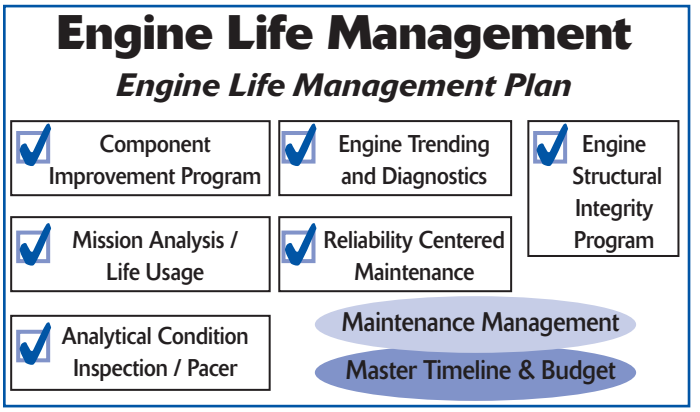

Figure 1

Reliability Centered Maintenance

Reliability Centered Maintenance (RCM) is a key element of the Engine Life Management Plan. The United States Air Force and the United States Navy are in the process of re-emphasizing RCM as a key maintenance management tool. RCM strives to maximize engine system reliability by repairing what is broken on an engine during unscheduled maintenance and what will likely fail before a desired time on wing interval. Figure 2 indicates the factors included in the RCM process.

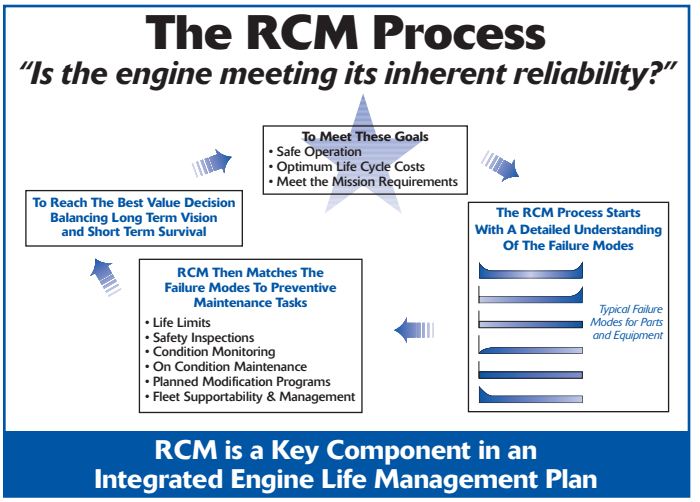

Figure 2

Background

Reliability Centered Maintenance has its roots in the aviation industry from the mid-1960s. RCM resulted from an

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effort to reduce the cost of then current airline maintenance policies as well as to meet existing safety concerns. Early engines (1940s) were often over-designed, which made them reliable and easy to repair. As complexity increased, the cost of maintenance escalated. Tests in the 1960s showed that scheduled overhauls of complex equipment had little or no effect on the inherent reliability of the equipment. This recognition lead to the need for new maintenance policies.

Reliability Centered Maintenance, and its derivative, RCM2, are the results. These concepts focus on preventative maintenance as a means to avoid, reduce or eliminate the consequence of failures. RCM2 is being applied at more than 500 industrial sites in 27 countries. USAF objectives in implementing RCM are to reduce engine related Cost Per Engine Flying Hour (CPEFH) while continuing to ensure that engines are safe and reliable.

RCM has been Air Force policy since the early 1980s. Recent review of Air Force reliability data indicates that many of the engine maintenance programs had migrated toward a pure on-condition maintenance (OCM) approach. OCM is characterized by performing a minimal repair task following removal and returning quickly to service. The cause for this migration was multifold and included issues such as increased operations tempo, manpower, and parts availability.

Reliability Centered Maintenance Today

The initial reintroduction to RCM within the Air Force was to apply the concepts to the TF39 engine for the C-5 aircraft. The program had been troubled by not having enough spares for fleet replacements. A group of Air Force experts were formed into a Propulsion Center of Excellence (PCoE) team to review and investigate the issues surrounding the TF39 engine. The team reviewed data at operational flight lines, and intermediate shop areas and overhaul depots, and visited commercial operators with large high-bypass engines. The team enlisted the support of the overhaul depot and the Air Mobility Command; and instituted a Reliability Centered Maintenance Program for the engine. Excellent results were achieved and available spares improved from a total of 28 in November 1997 to as high as 72 in October 1998. RCM is also the principal approach to maintenance on the contractor maintained F117 engine installed in the C-17 aircraft. This is the same approach used by the airlines for the F117 commercial-equivalent engine, the PW 2040.

Build standards and workscope planning are keys to Reliability Centered Maintenance improvements. In some cases, an engine coming in for overhaul may include modules with real useful life, but not for the engine that is to be rebuilt to the build standards. In this case a module with some life may be shuttled to another engine in order to align module time for the engine. We may then put an engine back into the field with a limited life as well as one with nearly full life, thus maximizing our utilization while minimizing our overall costs. In every case like this, a working group of engineers, maintainers, and logisticians is needed. They must be fully cognizant of the engine type being overhauled as well as the individual engine serial numbers.

Goals then shifted to our primary fighter engine fleets. A goal was established to conduct one-year-long demonstrations of RCM on our large F100-PW-220/E and F110-GE-100 fighter engine fleet. The goals included:

1) Determine how best to reapply RCM in the engine repair process in a distributed environment ... our intermediate shops and depots.

2) Develop a plan to manage any up-front workload or parts supportability issues associated with fleet-wide stand-up.

3) Re-educate our maintenance personnel in the RCM process.

4) Obtain Command buy-in to specific elements of an RCM-based build policy such as base-to-base swapping of stub time hardware.

Results from both the Luke AFB and Cannon AFB service testing demonstrations were positive. Shop Visit Rates (SVRs) showed an improvement of approximately 100%, resulting in longer times on wing and a corresponding reduction in the cost per engine flight hour. Figure 3 shows the results of the two demonstration tests. The defined build standards at the module and engine level provided the sought after improvements in reliability and flying hour cost. During this period, we learned some important lessons. These included quality of individual parts, the quality of the build, the importance of ingraining the RCM philosophy in our intermediate shops and depots, the need for engineering to play an active role in establishing the initial build standards, and the benefits of module or major assembly cycle matching.

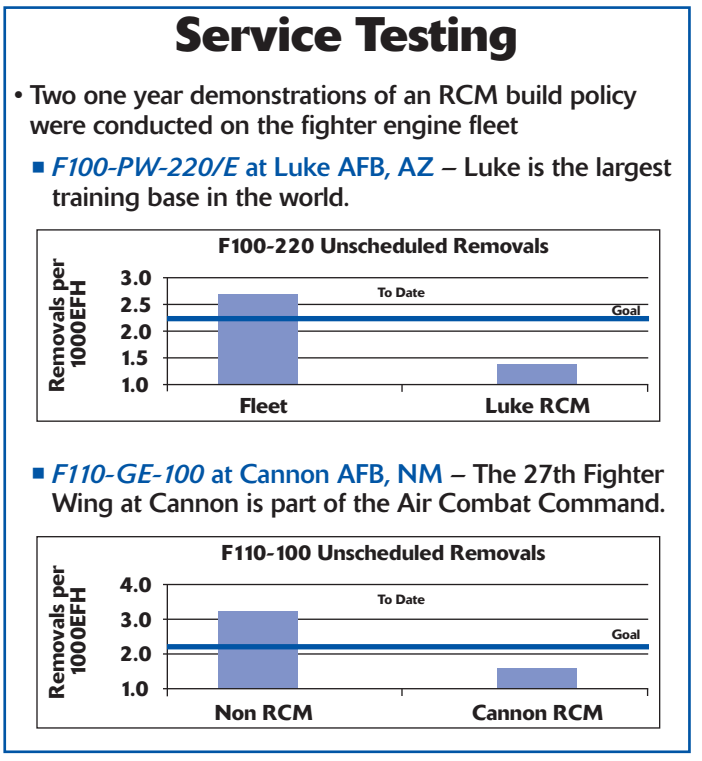


Figure 3

We are now focusing on fleet-wide implementation due to the successful RCM fighter engine demonstrations. This fleet consists of more than 4000 engines and represents more than $10 billion in inventory. The RCM team has recently put together an Air Force Propulsion RCM Steering Group to guide RCM actions and policies. The Steering Group includes representatives of the engine development activity, engine overhaul depot, and the users. The user involvement includes the airmen at the field and intermediate shop levels. The Steering Group is working to develop and refine processes and tools to effectively implement and sustain RCM. The Group will provide guidance on important issues such as the RCM Calculator, training, and RCM policies and procedures. The Group meets quarterly to ensure the implementation and sustainment of RCM within the operational fleet of gas turbine engines. The fleet wide implementation includes several new and novel ideas to enhance the process.

The Aeronautical Systems Center Propulsion Development System Office and the Air Force Institute of Technology (AFIT) combined efforts to bring RCM to the classroom. During January 2001, the initial offering of the "Reliability Centered Maintenance Analysis for In-Service Engines" course was held at Tinker AFB, Oklahoma. The goal of this course is to provide a fundamental understanding of the RCM process, an in depth look at RCM methods, and an overview of RCM implementation. This goal is to provide RCM instruction to individuals working at the depot repair level. A spin-off course tailored to Jet Engine Intermediate Maintenance (JEIM) shops has been developed for field maintenance personnel. This course will cover current Air Force RCM programs, look at how failure modes impact preventative maintenance practices, and discuss RCM analysis methods that can be used to track, predict, and improve the reliability of current engines in the fleet.

To standardize and simplify RCM implementation, the Air Force is developing a web based software tool called the RCM Calculator. This will introduce intermediate level maintenance personnel to the proper selection of modules in order to decrease hourly flying hour cost and increase time on wing. These calculations will initially use hard time alignment requirements (engine cycles, total operating time etc.), but will eventually be expanded to incorporate alignments based on Weibull analysis of failures, trending data from on aircraft diagnostics systems, and/or performance matching from in-flight or test cell data. They will also be useful for engineers who must maintain build policies that are consistent with RCM.

> ***"In this case a module with some life may be shuttled to another engine in order to align module time for the engine. We may then put an engine back into the field with a limited life as well as one with nearly full life, thus maximizing our utilization while minimizing our overall costs."***

TECHNOLOGY

Technology plays an important role in the maintenance and use of gas turbine engines. Parts repair technology, component improvement programs, and engine upgrade programs must consider technology for fielded engines. We must also monitor and track trends in engine usage during operational service. We need to know how the fielded engines are being utilized in order to perform service inspections, maintenance and overhaul. The usage monitoring area is one where we believe technology may have a great impact in the next few years. Computer and information technology schemes will enhance the manner in which we gather, maintain and analyze data. The prognostic aspects of inspections can be greatly enhanced by new equipment in the hands of our trained mechanics. This is an area we need to exploit in order to extend the lives of our fielded aircraft engines. Our vision for the future is a system that monitors engine operation, provides data, tracks operational cycles, while providing the data to the user, field intermediate shop, depot maintainers, and engineers supporting the logistics systems.

SUMMARY

Sometimes it is necessary to redesign an engine or series of components and sometimes it is necessary only to review the processes involved in the maintenance scenario. The U. S. Air Force is in the process of revitalizing Reliability Centered Maintenance (RCM) in its engines. We started several years ago by looking at the reliability of the engine for the C-5 airlift aircraft. After an in-depth review of the maintenance processes, we came to the conclusion that we had to modify our fix-fly-fail-fix maintenance pattern and pay more attention to the maintenance program. We examined a considerable amount of data and discovered that each of our heavy maintenance overhauls produced engines with time on wing lives significantly lower than our expectations. We talked to our commercial counterparts, examined our data in detail, reviewed the engine build criteria, and conducted an RCM pilot test on aircraft at Luke and Cannon Air Force Bases. The results were convincing and we are now implementing Reliability Centered Maintenance for all USAF engines throughout the world. In doing this, we have increased our engine time on wing by two- or three-fold for some front line fighter aircraft, and as a result are avoiding costly unscheduled engine shop visits. Our flight line, intermediate level, and depot level personnel have seen the demonstrated results and have become advocates of RCM. The improvements have come about as a result of realizing that our maintenance processes and practices directly impact our operations. RCM is a great success story. ☼

ASME TURBO EXPO LAND, SEA & AIR 2001

Excellence and Innovation Mark ASME TURBO EXPO '01 in the "Big Easy"

by Dilip Ballal, Vice Chair, IGTI Board of Directors

Entrance to the co-located ASME power events ... TURBO EXPO '01 and IJPGC

New Orleans, Louisiana (the "Big Easy") hosted ASME TURBO EXPO 2001 last June 4-7. Over 3,650 people drawn from industry, academia and government attended this most important annual event of the international gas turbine community, ASME TURBO EXPO-Land, Sea, & Air. The exhibit featured over 325 booths of gas turbine products and services, the technical program comprised over 500 refereed papers, and the Gas Turbine Users Symposium (GTUS) attracted 100 more delegates than the last TURBO EXPO. Three key innovations marked TE '01:

1 Both IJPGC and SAM co-located with IGTI for the first time. John Parker, ASME President remarked on how excited he was to host all three society events at the same time in New Orleans. "It bodes well for the power industry to see the same kind of synergy here that it will need for the 21st Century," Parker noted.

2 Hanni von Ohain, wife of Dr. Hans von Ohain, and Ian Whittle, son of Sir Frank Whittle, the two co-inventors of aircraft gas turbine engine, performed the historic ribbon-cutting to open the exhibit on Monday 4 June. The Air Force Research Laboratory (AFRL) sponsored a special display honoring the accomplishments of Dr. Hans von Ohain and Sir Frank Whittle at the entryway to the Exposition.

3 Top Federal Agencies ... the Department of Energy, NASA, and the U.S. Air Force ... participated in celebrating our congress and exhibit theme, "New Horizons for Global Power." Event activities were sponsored by world class companies such as Alstom, Bently Neveda, Entergy, GE Power Systems, Parker Hannifin, and Reliant Energy to name a few.

Thanks to the efforts of the Local Liaison Committee, chaired by Matt Greek of Reliant Energy, the TURBO EXPO-IJPGC-SAM co-located events made an excellent start with a sumptuous Welcome Reception on Sunday evening in the Riverside Hilton Grand Salon sponsored by Entergy Wholesale Operations, GE Power Systems, and Reliant Energy. The New Orleans-style hospitality and music brought many power professionals and users together for a great evening of comraderie. Conference Chairs, Dilip Ballal (IGTI) and Brian King (IJPGC) welcomed the delegates and presented plaques of appreciation to the sponsors.

Keynote Session Highlights

The joint TURBO EXPO-IJPGC Keynote Session featured some of the most distinguished speakers ever gathered for this event. Randy Zwirn of Siemens-Westinghouse Power Corporation, Wayne MacIntire of International Paper, Del Williamson of GE Global Sales, and Thomas Mason of Calpine gave thought provoking and insightful presentations in the "Manufacturer-User Dialogue." Rita Bajura of DOE followed with her thoughts on the current and future state of the power industry. (See separate article on page 1.)

Geoff Roberts, President & CEO of Entergy Wholesale Operations and Executive Conference Chair of TE'01, introduces keynote speakers in New Orleans

Technical Congress, Users Symposium, and Exposition Highlights

A total of 520 papers assembled into 115 technical sessions were presented over the four-days of the event. All these papers are available on a CD. New this year, papers in 50 sessions were grouped in 8 Power Generation Tracks. Below is just a sampling of the hot topics discussed:

Technical Congress

1 Mike Dunn presented an excellent IGTI Scholar Award Lecture entitled, "Convective Heat Transfer and Aerodynamics in Axial Flow Turbines." This prestigious IGTI Award includes a $7,500 prize.

2 Monitoring, diagnostics, component repair, and controls attracted high interest as pressure grows toward cost effective, reliable, and available power generation. Advance technologies for burning coal and other fuels were discussed to maintain the same high performance and efficiency of power-generating turbine plants using natural gas.

3 Growing interest in insurability, financing, regulations, and cost effective operation of the combined and simple cycle GT power plants.

4 A Distributed Power Generation Task Force was established (Chair: Norm Holcomb) at TE '01. There was a strong interest in turbine developments for integration with a fuel cell at less than 20 MW output rating especially in Italy, Germany, and other European countries from microturbine manufacturers, Rolls Royce, Honeywell, Capstone, and Bowman.

One of the more than 500 presentations of developing gas turbine technology at TURBO EXPO

5 A turbo fuel cell concept based on a 5 kW personal turbine and a solid oxide fuel cell was presented. If practical, this will reduce the size of turbo fuel cells significantly below the current Siemens-Westinghouse unit of 220 kW. Low cost of electricity values and high efficiencies (circa 60%) were projected for a 20 MW-class solid oxide fuel cell (SOFC)/ATS gas turbine power system that uses the Siemens Westinghouse tubular SOFC and the Solar Turbines Mercury 50.

6 A theoretical study of an SOFC/GT hybrid power system was reviewed that predicts improved system efficiency (by nearly three percentage points) if a humid air turbine (HAT) is incorporated in the system cycle. Finally, User/Utility/DOE representatives discussed DG applications and concluded that there was an urgent need to understand integration issues (both contractual & technical) between the grid and the user applications and also, interconnection technology was required consistent with a variety of DG applications and across a number of grid systems.

7 A distinguished panel chaired by Otha Davenport of the U.S. Air Force discussed aircraft GT maintenance, overhaul, repair, and reliability of both commercial and military jet engines. (See separate technical article.)

8 International experts led by Erik Prisell, Chief Engineer of Aero Propulsion Systems in the Defense Materiel Administration, Stockholm, Sweden discussed lessons learned from past gas turbine developments and emerging future trends for this versatile power plant.

Users Symposium

TURBO EXPO 2001 saw the birth of a Gas Turbine Users Symposium Advisory Group. The group exists to support, educate, and assist working gas turbine users in finding practical, technically sound solutions to their current operations, maintenance and business problems and to build networks to share common problems and solutions. Contact Harold Simmons, Chair Oscar Backus, or Vice Chair Terry Morgan.

1 Operators, manufacturers, and service providers debated emissions, performance testing, condition monitoring, compressor fouling, inlet fogging, LTSA's, project financing, hot section durability, repair strategies, coatings, improving reliability, and system modifications.

2 Tutorial sessions focused on GT user career advancement was a feature at the GTUS; subjects included maintenance optimization, refurbishment, failure diagnosis, emissions, gas turbine application, combined cycle systems, and hot section materials. Lew Broadbent, a senior consultant, provided perspective in the design, application, selection, inspection, testing, installation, start-up and maintenance of rotating equipment.

3 The Education Committee presented tutorials entitled, "Industrial/Utility Gas Turbine Applications, Maintenance and Refurbishment," and "Introduction to Gas Turbines and Applications." These courses addressed the needs of the end user with respect to applications, operation, turbine repair, and cost of ownership. A course in "Preliminary Design of Gas Turbine Engines" was equally well received.

Getting ready for the Exposition

IGTI Board Chair Bob Kielb (left) presenting 2001 IGTI Scholar Award to Michael Dunn

Max Bentele, ASME R. Tom Sawyer Award winner

1999 ASME Gas Turbine Award winners (l. to rt.) Steele, Cowell, Smith and Cannon

ASME Dedicated Service Award winner Walter F. "Walt" O'Brien

IGTI AWARD WINNERS

The following persons are the IGTI Award Winners honored at the Joint IGTI/IJPGC Awards Banquet held in New Orleans at TURBO EXPO '01. Congratulations one and all!

2001 ASME R. Tom Sawyer Award:
Max Bentele ... Heinkel, Curtis Wright, Avco Lycoming (retired)

1999 ASME Gas Turbine Award:
Luke H. Cowell ... Solar Turbines Inc.
Robert C. Steele ... Ramgen Power Systems
Steven M. Cannon ... CFD Research Corp.
Clifford E. Smith ... CFD Research Corp.

2001 IGTI Scholar Award:
Michael Dunn ... Ohio State University Gas Turbine Laboratory

2001 IGTI Aircraft Engine Technology Award:
John Adamczyk ... NASA Glenn Research Center

1999 John P. Davis Award:
Christopher Freeman ... Rolls-Royce plc
Arthur L. Rowe ... Rolls-Royce plc

ASME Dedicated Service Award:
Walter F. O'Brien ... Virginia Institute of Technology

Between sessions ... heading toward the Exposition

Emotional presentation of IGTI Turbine Wheel Pin to widow and children of Jim Peters in posthumous recognition of his service as Chair of the Combustion & Fuels Committee. Pictured are (l. to rt.) Anna, Teresa Peters, Sam and IGTI Chair Bob Kielb

Keynoter Thomas R. Mason of Calpine

Exposition Opening Ceremony featuring (l. to rt.) Dilip Ballal, IGTI Chair of Conferences; ASME President John R. Parker; Ian Whittle, son of the late Sir Frank Whittle; Hanni von Ohain, widow of Hans von Ohain; ASME Executive Director David L. Belden; and Brian King, Chair of the IJPGC Sponsors Committee. John R. "Jack" Lloyd, ASME Senior Vice President, Council on Engineering is at the podium

Keynoter Randy Zwirn of Siemens Westinghouse

Technical Committee Chairs completing one and two years of service are recognized at the Appreciation Luncheon

Keynoter Del Williamson of GE Power Systems Global Sales

Exhibitor at work

Judy Osborn, IGTI, presenting the latest techno-toy, a hand held computer, to Thursday prize drawing winner Jerzy "George" Michniewicz of Siemens Westinghouse, Canada

ASME TURBO EXPO LAND, SEA & AIR 2001

TURBO EXPO '01

... Continued from page 13

Viewing the Exposition

Exposition

Of special interest in the exhibit hall this year was an unusual display of a 320-plus hp, 266 mph gas turbine powered motorcycle produced by Marine Turbine Technologies, LLC. Ted McIntyre, inventor of this Y2K (Rolls Royce Allison) turbine powered street bike was available to answer questions. The exhibit also attracted Top Federal Agencies—Department of Energy, NASA, and Air Force in celebration of our congress and exhibit theme, "New Horizons for Global Power." There were GT parts and repair companies, project evaluation and financing companies, and GT Research & Development organizations. Such diversity added a special flavor to the broad based display many of the world's leading suppliers of gas turbines and associated equipment.

Other Special Events

IGTI award winners were honored at the Joint IGTI/IJPGC Awards Banquet on Monday, June 4 at the New Orleans Hilton Riverside Hotel. Our heartiest congratulations go to all the award recipients.

Finally, it remains for me to thank the numerous people and organizations whose support made the ASME TURBO EXPO 2001 an outstanding event marked by excellence and innovation. Our sincere thanks go to:

- You, the conference attendees, our exhibitors, and our sponsors;
- Our distinguished keynoters, Executive Conference Chair Geoff Roberts, and invited dignitaries Hanni von Ohain and Ian Whittle, who made the 2001 ASME TURBO EXPO a truly special event;
- All Local Liaison Committee members (Matt Greek, Chair);
- Our stalwart and hard working Technical Committee point contacts, vanguard chairs, and session organizers;
- All members of IGTI Board of Directors, and the IGTI staff in Atlanta led by Ann McClure; and
- The leadership team members: Technical Program Chair, Abbie Layne; GTUS Chair, Harold Simmons; Review Chair, Ron Natole; and Chair of the Distributed Power Generation Task Force, Norman Holcomb ... all of you worked extremely hard to produce a TE '01 marked by excellence and innovation! Thank you all.

We hope that each and every one of you who attended TE '01 found it to be valuable for information gathering, problem solving and network building. Those who missed it lost out on a rewarding experience forever. Don't lose out next year! Plan now to attend the 2002 ASME TURBO EXPO in Amsterdam, The Netherlands. The dates are June 3-6. Mark your calendar. ☼

A portion of the more than 1,000 industry professionals assembled to hear the keynote presentations at TE'01 in New Orleans

Keynote

... Continued from front page

The final speaker, Rita Bajura of the DOE's National Energy Technology Laboratory, gave the government's perspective on "New Horizons for Global Power." Bajura credited the strong collaboration between government, industry, and universities with improving gas turbine efficiencies to 60 percent (e.g., GE 480 MW H machine and Siemens Westinghouse 501 G machine), and yet emitting fewer than 10 ppm of nitrogen oxide, by using lean premix combustors. She noted that distributed power generation systems employing microturbines will bring energy to populations in developing countries where no power infrastructure exists. Bajura also projected that where such an infrastructure does exist, the larger role of distributed power, with the use of microturbines and gas turbine/fuel cell hybrids, will result in a new type of grid. ☼

INTRODUCING

New Members of the IGTI Board of Directors

Abbie is responsible for planning and budgeting all the U.S. Department of Energy's Office of Fossil Energy turbines and engines programs, and for coordinating advanced engine and distributed energy resource programs with state energy offices and the DOE Office of Energy Efficiency and Renewable Energy. During her 17 years with NETL, Abbie has been a project manager in advanced turbine systems and product manager of NETL's Advanced Turbine Systems program; a petroleum engineer in natural gas systems analysis; a technical analyst of natural gas extraction processes, market assessments, product planning, and business development; and a combustion engineer involved in designing, testing, and analyzing advanced combustor designs for coal-fired power generation. She has also been employed by Island Creek Coal Company as a mine degasification engineer and West Virginia University College of Engineering as an instructor.

Abbie is the author of over 100 publications on power generation, natural gas extraction, fracture mechanics and geomechanics, and has won two best paper awards from the American Association of Petroleum Geologists and IGTI. She is a member of ASME and SPE, and served as Technical Congress Program Chair for TURBO EXPO '01 in New Orleans.

INCOMING MEMBER

ABBIE W. LAYNE - "Abbie"
Product Manager, Advanced Turbines and Engines
Strategic Center for Natural Gas
National Energy Technology Laboratory
U. S. Department of Energy
Morgantown, West Virginia USA
Attended: West Virginia University
Term: 2001 - 2007

Roger joined Bently Nevada Corporation in 1966 and has held various Engineering and Executive positions prior to assuming the present post in 1986. He is a member of The American Society of Mechanical Engineers (ASME), the American Petroleum Institute (API), and the Instrument Society of America (ISA), and has published numerous technical papers and articles on the application of vibration monitoring systems to turbomachinery. Roger served as Gas Turbine Users Symposium Program Chair for TURBO EXPO '99 in Indianapolis, Indiana.

MEMBER-AT-LARGE

ROGER G. HARKER - "Roger"
President and Chief Operating Officer
Bently Nevada Corporation
Minden, Nevada USA
Attended: University of California at Berkeley
Term: 2001 - 2003

Introducing

SELECTED NEW IGTI COMMITTEE CHAIRS

FOR THE 2001-2003 TERM

Reza held various design and senior research positions in industry, specifically at Textron Lycoming and later at Calspan Advanced Technology Center. In 1995, he joined the faculty of Ohio State University (OSU) with joint appointment in the Aerospace Engineering Department and the Mechanical Engineering Department. He jointly founded and was Associate Director of the OSU Gas Turbine Laboratory. In October of 1999, he joined the Swiss Federal Institute of Technology in Zurich where he is currently a full Professor and the Chair of Aerothermodynamics in the Mechanical Engineering Department. Reza Abhari's research interests are on the experimental and computational study of fluid dynamics, heat transfer and aeromechanical response of aircraft engines and power generation plants. One of his major contributions to the technical field has to been to demonstrate the impact of unsteady rotor-stator flow interaction on turbine cooling.

Reza enjoys traveling with his family and exploring different parts of the world. He also has been very interested in the stock market in the past decade, but since the spring of 2000 has taken up gardening instead!

COMMITTEE: Turbomachinery

Reza S. Abhari - "Reza" (Karen)
Professor, Chair of Aerothermodynamics
Institute of Energy Technology, Dept. of
Mechanical and Process Engineering
Swiss Federal Institute of Technology
(ETH Zurich) Zurich, Switzerland
Attended: Oxford University
Massachusetts Institute of Technology
Term: 2001 - 2003

Karen, Reza with the girls in Monterey, California.

Rakesh embarked on his research career in the field of turbomachinery, particularly in the area of centrifugal compressors, in the mid-seventies. While pursuing his Ph.D., he conducted research in understanding near-wall turbulence structure in a blade end-wall corner region and designed and developed a research quality low turbulence level wind tunnel facility on a research project sponsored by NASA. His current responsibilities include mechanical design of pipeline compression facilities and consulting in the areas of rotating machines.

He possesses experience in wide ranging aspects of turbomachinery including field performance testing, performance retention analysis of new gas turbines, failure analysis, sizing and selection of rotating equipment for oil & gas, offshore and petro-chemical industries and international consulting. Rakesh taught thermal sciences to undergraduate and graduate students including customized courses to practicing engineers. He has published a number of technical papers, is an Associate Fellow of AIAA and a member of ASME and SAE.

Rakesh enjoys photography, hiking, swimming, gardening and other activities. His desire to explore and learn new things in life recently led him to learn martial arts, where he is four ranks away from his first-degree black belt.

Visiting Linderhauf Palace, Germany after TE 2000.

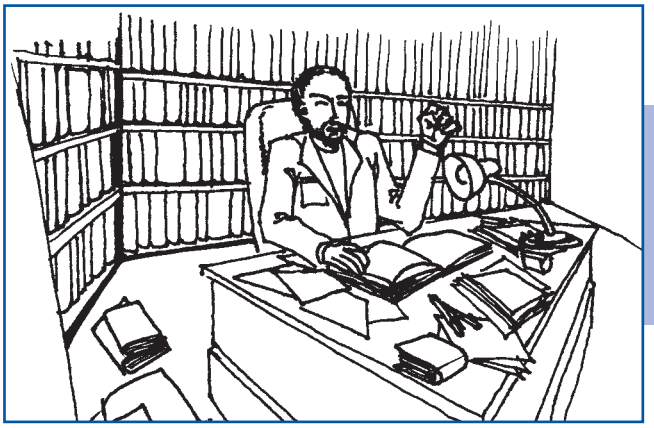
COMMITTEE: Oil & Gas Applications

Rakesh K. Bhargava
Project Engineer
Universal Ensco, Inc.
Houston, Texas USA
Attended: IIT, Madras, India
City University of New York
Term: 2001 - 2003

TECHNICAL COMMITTEE CHAIRS

Cyrus' 21 years of industry experience include gas turbine and compressor design, troubleshooting and engine development. He has worked in the areas of power augmentation, aerothermal analysis, compressor fouling, blading problems and vibration analysis. Cyrus has been a consultant to utilities and operating plants in the areas of operating problems and failure analysis. Prior to joining Mee Industries, he worked as a Turbomachinery Specialist at Bechtel Corporation and as Head of Research and Engineering at Boyce Engineering International, Inc. Cyrus is a registered Professional Engineer in the state of Texas, a Fellow of ASME, and has several publications in gas turbine engineering.

Cyrus enjoys reading and is an avid book collector. His fascination with the history of turbomachinery has taken him to several museums and archives and has resulted in a series of ASME papers on the early history of gas turbine engines. He and his wife Chinnu spend much of their time with their twins Ari and Anissa who just entered their teens!



Cyrus as reader, writer, collector and history buff.

COMMITTEE: Industrial & Cogeneration

Cyrus B. Meher-Homji - (Chinnu)
Chief Engineer, Mee Industries, Inc.
Gas Turbine Division
Sugar Land, Texas USA
Attended: Shivaji University
Texas A&M University
University of Houston
Term: 2001 - 2003

As Founder and President of the Hands-On Science Center, Tullahoma, TN, Grant speaks at the ground breaking ceremony

After work on graduate degrees, Grant entered the U.S. Army as project manager in the SAM-D (later Patriot) missile project office. Upon leaving the Army he taught at the University of Tennessee and worked on jet noise research. Grant has worked at AEDC since 1977 where he performed tests and evaluation of performance, operability, stability and stall recoverability on the F100, F110, F414 and F119 engines. He resolved discrepancies between ground flight test results of combustors light of characteristics, and led numerous programs leading to improved test capability and efficiency. Presently Grant coordinates and focuses AEDC technology programs on improvements in test capability and reduction in test costs. He also lectures in short courses at the University of Tennessee.

Grant and Janet revel in playing with their new, first grandson. Grant also enjoys singing in small groups, both in Church and out. He has participated in Community Playhouse productions of *The King and I, My Fair Lady, Camelot, Oklahoma, Music Man, and Mame*; and plays the guitar for added enjoyment.

COMMITTEE: Aircraft Engine

Grant T. Patterson - (Janet)
Engineering Specialist, Sverdrup Technology, Inc.
AEDC Group, Aeropropulsion Department
Arnold AFB, Tennessee USA
Attended: University of Tennessee
Term: 2001 - 2003

Grant as Indian Joe in a recent children's Musical.

TECHNICAL COMMITTEE CHAIRS

After earning his Ph.D. in 1983, Pericles worked for Caledonian Airmotive in gas turbine overhaul while pursuing his MBA part-time. Fluent in English, Spanish, Greek, French and Portuguese, he was appointed Lecturer at Cranfield University in 1986, then to Senior Lecturer and Professor. He currently serves as Head of the Gas Turbine Engineering Group and leads a large, internationally renowned research team in gas turbine performance. Pericles is deputy director of Rolls-Royce UTC, and a consultant to Rolls-Royce and the Hellenic Air Force. The director of six regular and many special short courses, Pericles if a Fellow of the Royal Aeronautical Society and a member of ASME.

For hobbies, Pericles enjoys bridge, chess and traveling.

Having a good time at the Bazaar! Pericles on the right with his wife, Pamela, second from the left.

COMMITTEE: Cycle Innovations

Pericles Pilidis - (Pamela)
Professor of Gas Turbine Performance Engineering
Cranfield University
Cranfield, UK
Attended: Glasgow University
Term: 2001 - 2003

Sep has been with Alstom Power (ABB) since 1984 where his primary focus has been on gas turbine power plants and technology. With over 40 years experience in power generation, Sep provides insight into new business opportunities in the industry for Alstom. Sep supported the first workshop, when the DOE ATS program was initiated and participated in two of its phases. He continues to provide support through the Gas Turbine Association, where he serves on their Board. Sep has presented several papers at IGTI congresses and served as technical program chair for COGEN TURBO POWER '91 in Budapest. He is currently program coordinator for IGTI's South American initiatives.

Sep enjoys travel and is fascinated with the cultures and customs of different countries. He likes to play tennis and takes his racquet when he travels. Sep is also a member of the PRIVATEERS, a people-to-people program started in the Eisenhower years to form worldwide friendships through sport.

COMMITTEE: Electric Power

Septimus van der Linden - "Sep" (Liesbeth)
VP New Technologies - Business Development
Turbine Generator Division
Alstom Power, Inc.
Midlothian, Virginia USA
Term: 2001 - 2003

Have stick will travel ... at 1998 World Cup in Holland. Sep's group of field hockey players have enjoyed matches in Venezuela, the Caribbean, Bermuda, Australia, Malaysia, Africa, Fiji, England, The Netherlands and France and has hosted many visiting teams to the USA. Sep plays golf also, but don't be surprised to find his hockey stick in the bag ... it seems to be very useful when under trees or bushes.

TECHNICAL COMMITTEE CHAIRS

After receiving his graduate degree from Caltech, Cliff worked at Pratt & Whitney, Florida for thirteen years (1973-1986) in the Combustor Component Group, performing applied research studies on advanced combustors and augmentors. In 1987, Cliff joined CFD Research Corporation, a small R&D company specializing in CFD software and engineering projects. His specialty areas include low emission fuel injector design and the development of unsteady combustion LES software to model and control combustion instability. Cliff has co-authored over 25 technical papers, and holds two patents on fuel injectors. Cliff received the 1999 ASME Gas Turbine Award as co-author of the most outstanding technical paper in gas turbines.

Cliff has been married to his wife Thelma for 26 years, and they have three children: Andy (21), Kristy (18), and Ryan (17). Cliff has coached baseball for 22 years, ranging from tee ball to high school baseball, and thinks 10 year olds are the most fun to coach (they actually listen). His other passion is golf, having played at some of the top golf courses in the world, including Pebble Beach and St. Andrews Old Course.

Cliff hitting a 300 yard tee shot (he wishes) on the 18th hole at the St. Andrews Old Course in Scotland. He actually shot a 90, and almost parred the road hole.

COMMITTEE: Combustion & Fuels

Clifford E. Smith - "Cliff" (Thelma)
Vice President/Combustion Engineering
CFD Research Corporation
Huntsville, Alabama USA
Attended: Virginia Tech
California Institute of Technology
Term: 2001 - 2003

As Manager of Environmental Programs at Solar Turbines, Leslie is responsible for the interpretation of global air emissions regulations and their effect on Solar's markets and products. Her position also supports customers with air emissions data and air permitting strategies. Prior to joining Solar, Leslie was Manager of Consulting Services for Trinity Consultants where she assisted industrial clients with air permitting and regulatory compliance. Her specialties include PSD and non-attainment permitting.

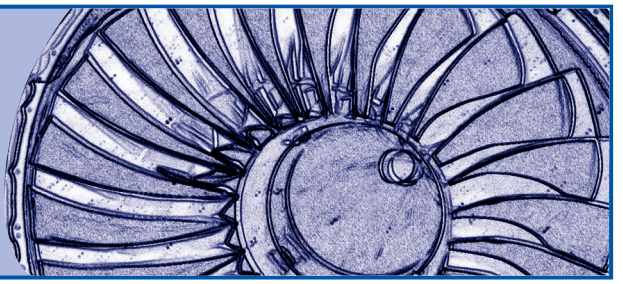
Leslie enjoys time away from work with her husband Charlie and their two children, Ryan and Connor. San Diego offers great outdoor activities and the family enjoys hiking, biking, going to the beach, swimming, camping and going for walks. Vacations are usually spent with the grandparents in St. Louis and Kansas City, although they recently took an RV vacation to Yosemite National Park.

Leslie, Ryan and Connor at the Zoo.

COMMITTEE: Environmental & Regulatory Affairs

Leslie Witherspoon - (Charlie)
Manager, Environmental Programs
Power Generation Marketing Division
Solar Turbines Incorporated
San Diego, California USA
Attended: University of Missouri - Rolla
University of Kansas
Term: 2001 - 2003

JOURNAL OF ENGINEERING FOR GAS TURBINES AND POWER



Lee S. Langston

Important News ...from Lee S. Langston, Editor

Greetings. It is my challenge, pleasure and honor to be the new editor (July 1, 2001 - June 30, 2006) of the Transactions of the ASME, Journal of Engineering for Gas Turbines and Power. Retiring Technical Editor Hal Nelson is advising me as I get started. I thank him and Ted Okiishi, editor of our companion publication, Journal of Turbomachinery, for their help and continued support. I look forward to working with and being advised by the Journal's experienced team of Associate Editors, and the leadership of the Technical Committees.

The Journal of Engineering for Gas Turbines and Power publishes reviewed technical papers on topics related to energy and power conversion. These topics include cycle thermodynamics, hydrocarbon and nuclear power generation, gas turbine technology, internal combustion engines, fuel cell systems, aircraft and aerospace propulsion and combined cycle and combined heat and power systems. Within ASME, the Journal serves IGTI and a number of ASME Divisions which include Internal Combustion Engines, Fuels & Combustion Technologies, Nuclear Engineering, Advanced Energy Systems, and Power.

Robert Day, author of a well-known text on technical writing*, observes that editors have an impossible job, because of the attitude of authors toward them. Day sums up his slightly satirical view with an assertion from an unnamed author: "I expect the editor to accept all my papers, accept them as they are submitted, and publish them promptly. I also expect him to scrutinize all other papers with the utmost care, especially those of my competitors." Day then adds another author's comments on an editor's place in the scheme of things: "Editors are, in my opinion, a low form of life - inferior to the viruses and only slightly above academic deans." (Having been a one-time dean, this author's opinion delights me, for as a new editor, my station in life has been elevated from that in the past.)

In all fairness, let me offer some support for an editor's opinion of authors with a quote from Samuel Johnson. In carrying out editorial duties for a London publication in the 1700's Johnson wrote to an author: "Your manuscript is both good and original, but the part that is good is not original and the part that is original is not good."

The work of and interplay between authors and editors has sustained the Journal of Engineering for Gas Turbines and Power for over one hundred twenty years. The Journal began as the collection of papers on energy conversion technology in the first volume of the Transactions of the ASME, in 1880. Over the years the number of published papers increased each year, so that in 1959, the Transactions was subdivided into five separate quarterly journals, one of which was called Journal of Engineering for Power (Volume 81, Series A, Number 1), later to have "Gas Turbines" added to the Journal title in 1983.

From its beginning in 1880 the Journal had an ASME staff editorial department. That changed in 1983 when the Journal got its first volunteer/member editor. Since then, the Journal has had the following editors:

Arthur Wennerstrom	1983 - 1988
George Serovy	1988 - 1993
Howard Julien	1993 - 1998
Harold Nelson	1998 - 2001

As one would expect, the general areas of energy conversion technology dealt with by Journal papers has changed since 1880. Papers before 1900 dealt mostly with steam power (e.g. "Steam-Engine Efficiencies: The Ideal Engine Compared with the Real Engine", R.H. Thurston, Trans. ASME, 1891, Vol. XII, pp.729-739. The author was ASME's first president). Technical papers on internal combustion aircraft engines first started to appear after 1915. At the present time, about 75% of the Journal's papers deal with gas turbine technology.

In Table 1 I have listed a short history of energy conversion devices. One can see a reason for the present dominance of gas turbine papers in the Journal; the gas turbine is by far the "youngest" of the energy converters listed in the table. Thus activity in gas turbine technology would be expected to be more intense than that of the more mature converters (such as steam engines).

In the past decade, a revolution of sorts has been happening with energy converters listed in the table. Steam and gas turbines have been brought together to form combined cycle plants with the highest of thermal efficiencies ever (~60%). Their high efficiency and low cost are two of the underlying reasons for the deregulation of electric power generation worldwide. Thermal efficiencies and the cost of both Otto and Diesel engines are being greatly improved. ASME papers are being published, showing how fuel cell and gas turbine systems can be combined to get 70% thermal efficiencies and greater.

James Boswell, Editor Samuel Johnson's biographer (Life of Johnson, 1791) interviewed early British industrialist Matthew Boulton, cofounder of Boulton and Watt Company, manufacturer of the James Watt steam engine. Boulton's words to Boswell were: "I sell here, Sir, what all the world desires to have - POWER." As with many other companies, Boulton and Watt no longer exists, but the world's need for power - and power technology - continues to grow.

The next five years look very exciting for power technology and for the Journal, now in its 121st year. As the new editor, I invite you to contribute as a writer, researcher, reviewer, session organizer or reader, to the Journal of Engineering for Gas Turbines and Power. ☼

**How to Write & Publish a Scientific Paper*, 3rd Ed., Robert A. Day, Oryx Press, 1988

Table 1

ENERGY CONVERTERS
Date of First Working Device

Steam Engine	1769
Fuel Cell	1839
Otto Engine	1876
Steam Turbine	1884
Diesel Engine	1897
Gas Turbine	1939

ASME TURBO EXPO '02 LEADERSHIP TEAM

The following volunteers will be leading the more than 1,000 individuals contributing their time and efforts to organize and bring to completion what promises to be a highly successful TURBO EXPO '02 in Amsterdam next June 3-6. Our special thanks go to them, to our hard working volunteers at all levels, and to the companies who support their efforts.

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RAI Conference Centre Amsterdam, The Netherlands

June 3-6, 2002
Exposition ... June 3-5

LETTER TO THE EDITOR...

... FROM MARIO DeCORSO VICE-PRESIDENT, POWER TECH ASSOCIATES, INC.

Dear Mr. Lindsay:

The article on "Humming" by Stuart A. Greenwood in the Global Gas Turbine News (2001 Issue #1, pp. 12-15) describes very well the fundamental difficulties of DLE (also called DLN) combustor design. Reading it prompted me to take a walk down memory lane.

I have observed the battle to get emissions ever lower on gas turbines starting with the time when the EPA NOx number for the nation was 75PPM. Now regulators are calling for NOx numbers like 2PPM.

OEMs are designing DLE combustors with very low NOx numbers. Some plant installers are utilizing exhaust cleanup such as SCR and CO catalytic systems to reach the level demanded by regulators and the market.

• What is the "Right" way to do the job?

1) Let the engine do the job.
2) Have the engine and exhaust cleanup share the load.

Thinking about this, I recalled how the auto industry settled this question for auto engines. I became aware of the auto story when I worked on developing catalytic combustors at Westinghouse in the 1970s. The argument then had many of the aspects of today's argument on GTs and may be instructive.

• How did the auto engine industry settle this question?

There is not space here to describe the auto engine debate in detail, but there were arguments about technical feasibility, cost, type of fuel, life, operating hazards, reliability and fuel efficiency.

The tipping point came when GM took out a full page ad to announce use of a catalytic reactor on their engines. From that time to the present, auto emission control evolved such that the exhaust reactor design and the engine design work together, and interact to get the best result.

• How will the Gas Turbine industry settle his questions?

You may be able to place a "You Are Here" arrow for gas turbines in the auto emission debate chronology. The arguments are just heating up about how much of the emission control design belongs on the engine vs. the exhaust cleanup system.

- How low can we make the engine design, consistently?
- The role of exhaust cleanup in gas turbine plants
- Parameters of technical feasibility, cost, type of fuel, life, operating hazards, reliability and fuel efficiency.

The "You Are Here" arrow is at the place where the gas turbine builders hold that the right way is to design the engine itself for low emissions. Meanwhile, exhaust cleanup system manufacturers are designing reactors for exhaust cleanup. The most effective approach is likely to be combining both technologies. ☼

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The History of Aircraft Gas Turbine Engine Development in the United States ...
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About the Author.

James St. Peter is a Technical Historian contracted by the Air Force to research and write this historical look into the development of aircraft gas turbine engines in the United States. He was ideally suited for this landmark project because of his in-depth knowledge of jet engines and previous research experience.

St. Peter was selected by the Air Force Wright Laboratory, Aero Propulsion & Power Directorate, at Wright-Patterson Air Force Base in Dayton, Ohio. The effort was co-sponsored and financially supported by the Army, Navy, Air Force, NASA, and the ASME International Gas Turbine Institute.

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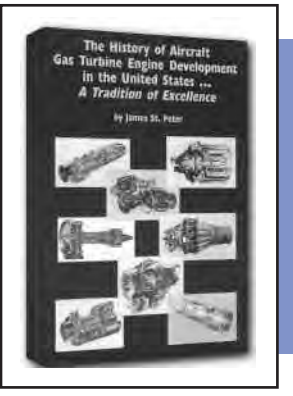

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This home Study Course is a 162 page non-mathematical approach to understanding the fundamental nature of gas turbine engines and the processes which affect their performance. The Course is ideally suited to technicians and management personnel. It will also prove to be of value to those engineers starting their careers in the fields of gas turbine engine and auxiliary equipment operation, maintenance or service, specification, sales and manufacture.

Introduced in 1985, more than 4,000 orders for "Basic Gas Turbine Engine Technology" have been received from industry personnel throughout the world. Here is a sample of comments from some of those completing the course:

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Course Content

The Course is organized into ten chapters. Following each chapter when you are ready, you will take a test on that material. Take your time in answering the questions and feel free to double check by referring to the text material. When you are satisfied, send the completed tests to the International Gas Turbine Institute in Atlanta for scoring. Your corrected answer sheets will be returned for your information and review. When you have finished the the entire Course, you will receive a Certificate of Completion.

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This Home Study Course introduces you to the fundamental principles for thermodynamic analysis and design of gas turbine components and systems, with insight into design practice. Selected gas turbine hardware is illustrated and described in the accompanying videotape. A companion personal computer program facilitates investigation of the effects of chosen design parameters on performance. This Course is intended for graduate engineers with a knowledge of thermodynamics and an interest in design analysis and performance prediction of gas turbines and components.

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IGTI ORGANIZES LUNCHEON SEMINARS AT THE WORLD ENERGY CONGRESS IN BUENOS AIRES

by Dave Lindsay, IGTI

Under the leadership of Septimus van der Linden, IGTI's Program Chair for South American Conferences, the Institute has developed a gas turbine seminar program for two luncheon meetings to be held in conjunction with the World Energy Congress in Buenos Aires October 21-25. The program will consist of an hour of presentations on both days (Tuesday and Wednesday, Oct. 23 & 24) with time for questions.

IGTI will also be participating in the Exposition with several ASME departments. The World Energy Congress is expected to draw more than 5,000 delegates including Ministers and regulators, CEOs and industry leaders, senior academic researchers and consultants, representatives from approximately 50 international organizations and financial agencies, and press from all over the world. The luncheon seminar program will introduce many of these influential energy industry leaders to IGTI as their source of gas turbine information and generate contacts for IGTI among government policy makers and gas turbine buyers and users throughout the world.

The luncheon seminar program is as follows:

THEME: THE GAS TURBINE AS PRIME MOVER OF CHOICE IN MODERN POWER PLANTS

Tuesday Luncheon, October 23:
Sponsored by Duke Energy

The Benefits of Gas Turbine Power Plants – Latest Developments
Presentation by: Victor Der, U.S. Department of Energy

Performance of Mature "F" and Advanced Technologies 2000 Gas Turbines
ASME Paper 2001–GT–394 presented at TURBO EXPO 2001 by:
Axel von Rappard, Consultant – Gas Turbine Engineering, and
Salvatore DellaVilla, President – Strategic Power Systems, Inc.
Presentation by: Septimus van der Linden – ALSTOM Power, Inc.

Wednesday Luncheon, October 24:
Sponsored by Bechtel Corporation

Overview of Gas Turbine Maintenance and Repair Technology – Trends and New Developments
Presentation by: Ron Natole – President, Natole Turbine Enterprises, Inc. and
Board Member of ASME International Gas Turbine Institute

Gas Turbine Project Development Economics
Presentation by: Frederik Bok – ALSTOM Power, Inc. (Member, Institute of the Americas)

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