

## Seminar Description

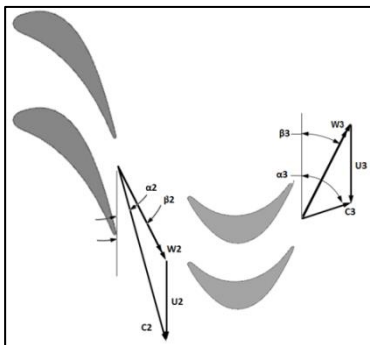
The turbine design seminar has been structured to build technical comprehension in steps, beginning with a basic review of aero/thermo fundamentals and advancing through more in-depth turbine design material. Three different seminar options are available, varying from 2 to 4 days in duration. Course material has been collected from 40 years of turbine design practice and assembled into a valuable resource of presentation material. Worked problems and quizzes are also used to reinforce essential material. This seminar can provide attendees with answers to their general turbine aero/thermo design and analysis questions as well as an opportunity to discuss specific technical concerns.

### Days 1 & 2 – details on page 2

The first two days of this seminar provide a solid introduction into turbine design and analysis methods for relatively new engineers to the field. The presentation material also serves as a good technical refresher for the more experienced turbine engineer.

This part of the seminar will enable you to:

- Evaluate and prioritize the key factors affecting a turbine's performance level
- Work through the basic relations involved in properly sizing a flow path for good efficiency
- Decide important blade manufacturing tolerances
- Consider key stress & vibration failure criteria
- Step through the complete process of stage sizing, performance analysis & detailed blade design
- Scale designs for other operating conditions or for different frame sizes.
- Examine blade profile design methods and follow a step-by-step software demo of blade construction



### Days 3 & 4 – details on page 2

Days three and four days offer more in-depth material on important special topics with hands-on software demos:

- Special considerations for multi-stage turbines, including exhaust diffuser and hood design, thrust calculations, testing and instrumentation. (Day 3)
- Sizing strategies as illustrated by a software demo for multi-stage turbines (Day 3)
- Comparison of design techniques for three stage types: Curtis, High-Pressure, Low-Pressure (Day 3)
- Analysis of supersonic nozzles and blades (Day 3)
- Transfer of axial turbine skills to radial turbines and learn how to design component details (Day 4)
- Two refresher sessions to focus on review of key material presented in the seminar (Day 4)

### Presenter

John Perera is a specialist in turbine design and analysis and has been consulting as PerAero Turbine Designs since 2007. His experience began at Elliott Company where he progressed in engineering R&D responsibilities to become the technical lead for aero development of steam turbines, turbochargers and hot gas expanders. John continued broadening his experience as the Associate Director of Turbine Aerodynamics at Concepts NREC where he added expertise in flow path design of turbopumps and hydraulic turbines. He also provided turbine design seminars and software training worldwide for university students and turbomachinery engineers. Since 2007, PerAero Turbine Designs has consulted for more than twenty turbomachinery companies on:



- Turbine aero/thermo design and analysis for new power generation products
- Rates & repair assistance for existing equipment
- Development or modification of in-house software
- Custom software, training seminars and webinars

## Day 1

### 1) Turbine Applications & Construction Features

- Turbine Applications & Cycles
- Steam Turbine Constructions
- Aero & Mechanical Components

### 2) Fundamentals of the Expansion Process

- Fluid Properties / Mollier Chart
- Available Energy versus Used Energy
- Velocity Triangles & Energy Conversion
- Choked Flow

### 3) Basic Considerations in Stage Design

- Stage Loading & Velocity Ratio
- Impulse versus Reaction
- Nozzle and Blade Losses
- Stage Parasitic Losses

### 4) Flow Path Sizing & Scaling Methods

- Specific Speed / Specific Diameter
- Flow Factor / Loading Coefficient
- Radius Ratio / Aspect Ratio
- Scaling Methods

## Day 3

### 9) Multi-Stage Turbines

- Stage Carryover Energy
- Part Load Operation & Performance Mapping
- Diffusers & Exhaust Hoods
- Axial Thrust Calculations
- Instrumentation & Testing

### 10) Multi-Stage Sizing Demo

- Worked Sizing Problem with Software Demo (**Aeolus Configurator**)
- Performance Analysis Demo (**Aeolus Meanline**)

### 11) Specific Stage Designs: Curtis, HP & LP

- Curtis Stage Characteristics & Components
- HP Stage Advanced Designs
- LP Stage – Vortexing, Erosion, Advanced Designs

### 12) Supersonic Stage Designs

- Expanding Nozzles
- Supersonic Blades
  - Unique Incidence/Limit Loading/Annulus Choking

## Day 2

### 5) Blade Mechanical Design & Manufacturing

- Blade Stress & Vibration Basics
- Failure Criteria & Evaluation Diagrams
- Manufacturing Considerations & Tolerances

### 6) Nozzle & Blade Loss Analysis

- Profile Loss Component
- Secondary & Leakage Loss Components
- Deviation Angle

### 7) Turbine Design Cycle Steps

- Important Considerations
- Overview of Design Cycle Steps
- Preliminary Design – Meanline (1D) Analysis
- Detailed Design – Throughflow (2D) Analysis
- Blade Profile Geometry
- Application Curves

### 8) Blade Profile Design & 3D Stacking

- Profile Design Goals
- Radial Equilibrium & Advanced Stacking Methods
- Profile Construction Demo/Evaluating Loadings

## Day 4

### 13) Introduction to Radial Turbine Design

- Component Descriptions
- Comparisons with Mixed Flow & Axial Turbines
- Sizing & Design Goals
- Preliminary Design Software Demo

### 14) Detail Design of Radial Turbine Components

- Loss Calculations, Volute Design
- Nozzle Design with Software Demo
- Impeller & Diffuser Design with Demo

### 15) Refresher – Part 1

- Review of key turbine design considerations given in Sessions 2, 3, 6 & 8

### 16) Refresher – Part 2

- Review of key turbine design considerations given in Sessions 4, 5, 10, 13 & 14

### Seminar Options and Costs

All attendees can receive a free evaluation copy of the Aeolus design and analysis system that is used in seminar to demonstrate basic principles and design strategies.

### In-House Seminars at Your Company

The Turbine Design Seminar is offered as a convenient and cost effective in-house training course at your company site.

- 2-Day Seminar: \$5,500 to \$6,800 depending on location
- 3-Day Seminar: \$6,400 to \$8,100 depending on location
- 4-Day Seminar: \$7,700 to \$9,600 depending on location

These costs are all inclusive and include three copies of both the reference book\* and all presentation material (over 500 informative slides for the 4-day seminar). Additional copies of the presentation material are available for \$100, \$125, or \$150 each (2, 3, or 4 day). Extra copies of the book are \$120 each.

\*Reference Textbook:

Turbine Aerodynamics: Axial-Flow and Radial-Inflow Turbine Design and Analysis by R. H. Aungier

### Registration Details

- Each seminar day runs from 8:30am to 4:30pm and is divided into 4 sessions with time allocated for Q&A, worked problems, quizzes & lunch
- 25% pre-payment must be received prior to the scheduled seminar start date. A \$500 discount is provided for full payments received 2 weeks prior to start. Balance of registration fee will be due 30 days after completion.
- Cancellations receive a full refund for notices received 2 weeks prior to seminar start date. After this deadline, the 25% pre-payment fee will be retained for application to a future PerAero seminar or consulting service.
- Contact John Perera at 802-249-1235 or [jperera@peraero.com](mailto:jperera@peraero.com) to schedule an in-house seminar

