This document gathers information on the A-6 developed short courses. This overview is intended to make members and guests more familiar with these courses for suggesting classes to be proposed at future meetings, existing, or new seminars, to be developed. This information can be relayed within members teams and companies.
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Past delivery of Short Courses

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SAE INTERNATIONAL

A-6 Short Courses

Nov 2019

2
Our A-6 committee has been developing a number of technical training sessions, to be delivered at A-6 meetings, in parallel to the Monday working sessions. They are identified by a SAE number C1XXX. Some of these courses have also been requested to be delivered in house by companies.

Objective
The objective of these 4 hour “Short Courses” is to fulfill the needs of our members in terms of basic training and to bring new members to our committee.

Attendance
Some of these courses are intended for beginners, few require a previous experience on the subject, see “who should attend” in the course description. Average attendance has been around 15 persons.

Instructors
All instructors are A-6 members recognized as leading people in their discipline.

Registration and Fee
These courses require a specific registration and a fee of $325 to $425, depending on the date of registration:

More info
Contacts: A-6 Vice Chairman Dominique van den Bossche dvdb@free.fr or Dorothy Lloyd djlloyd@sae.org
OVERVIEW

This four-hour short course will present an overview of hydraulically powered flight control actuation systems used on fly-by-wire aircraft, covering both military and commercial applications. The scope this course covers the issues related to the mechanical design of actuators themselves, as well as their control electronics. Additionally, this course will provide participants an overview of the design considerations behind these flight control actuation systems.

Learning Objectives
By attending this seminar, you will be able to:
- Explain flight control actuation systems in military and commercial aircraft fly-by-wire systems
- Identify key design considerations of control actuators
- Identify the design considerations of actuator control electronics
- Evaluate overall design considerations of flight control actuation systems

Who Should Attend
This seminar is designed for engineers and other key personnel with little or no previous flight control actuation knowledge.

Prerequisites
None
C1132 - Design Considerations for Hydraulically Powered FBW Flight Control Actuation Systems

TOPICS / OUTLINE

Actuation System Architectures
- Centralized electronics
- Remote electronics
- Redundancy schemes (hydraulic and electronic)

Typical Requirements
- Operating modes
- Hinge moment (stall force)
- Stroke
- Rates
- Position accuracy
- Dynamic response and stability
- Static stiffness
- Dynamic stiffness
- Endurance
- Leakage
- Safety and Reliability
- Interfaces
- Envelope
- Weight
TOPICS / OUTLINE

Design Considerations
   Balanced versus unbalanced piston areas
   Piston sizing
   Stroke
   Servo valve parameters
   Flow passages
   Sensor selection
   Logic valves
   Seal selection
   Control loops, position and load sharing
   Loop gain
   Monitors
INSTRUCTOR: Thomas Greetham

Thomas Greetham has been employed at Moog Inc. for thirty-five years, mostly in the aircraft flight control arena. He has held various management and engineering positions, including key positions in the development of various aircraft actuation systems, including the B-2, Indian Air Force LCA, V-22, Challenger 300, EADS A400M and F-15 FBW. He is Vice-Chair of the SAE A-6B1 Hydraulic Servoactuation panel. He received both his B.S. and M.S. degrees in Mechanical Engineering from The Ohio State University.
OVERVIEW

This four hour short course provides an overview of hydraulic system design of typical business and commercial aircraft. Topics will include the principles, system architectures, power sources, and the main components and technologies of hydraulic systems including hydraulic power generation, filtration, fluid storage, distribution, sensing and control. The step by step process of designing a hydraulic system will also be reviewed. Additionally, future trends in hydraulic systems will be discussed.

Learning Objectives

By attending this seminar, you will be able to:

- Explain the operating principles and design process of an aircraft hydraulic system
- Identify system architectures attributes, including those that affect aircraft safety
- Identify power sources for hydraulic systems and how they operate
- Identify the various components of hydraulic systems
- Describe the hydraulic system design and certification process

Who Should Attend

This seminar is designed for engineers, program managers, executives, and other key personnel with little or no previous hydraulic system knowledge or experience.

Prerequisites

None
C1205 - Introduction to Aircraft Hydraulic System Design and Certification

TOPICS / OUTLINE

General Introduction to Aircraft Hydraulic Systems
Hydraulic System Terminology and Standards
A Brief History of Aircraft Hydraulic Systems
System Engineering - Principles and Practice
Requirements Quality
Hydraulic System Design and Certification
  Proposal Phase
  Preliminary Design Phase
  Detail Design Phase
  Aircraft Production Build and Test Phase
  Flight Test and Certification Phase
Hydraulic Interface with Utility Systems
Fluid Conveyance System Design
Introduction to Hydraulic Fluids
Market Trends and Future Technologies
INSTRUCTOR: Jon Jeffery

This course has been prepared by Jon Jeffery and may be delivered by someone else.

Jon has been involved with the design and certification of more than 15 military and commercial aircraft hydraulic systems during a 34 year career

- Parker (Hydraulic Systems Div): 1993 – 2015 (22 years)

Jon is currently working for Hummingbird Technologies, Inc., an engineering services firm, as President & CEO.

He was Chairman for SAE A-6, the Aerospace Actuation, Control and Fluid Power Systems standards committee from 2009 - 2015.
OVERVIEW

This four-hour short course provides an introduction to contamination control principles in aircraft hydraulic systems. Topics covered include an introduction to the types of contamination in aircraft hydraulic systems, contaminant measurement, and reporting methods. In addition, the impact of contamination on hydraulic components is discussed in detail. Along with an introduction to filtration mechanisms, information on testing, rating, and specifying filters will be provided.

Learning Objectives
By attending this seminar, you will be able to:
- Associate the types of contaminant in aircraft hydraulic systems and the problems that uncontrolled contamination can cause
- Interpret a particle count or contamination level report
- Identify how filters work and are evaluated
- Explain filter ratings
- Formulate a basic specification for hydraulic filters

Who Should Attend
The course is intended for engineers with some basic knowledge of hydraulic systems, but with minimal experience with the impact of contamination and specifications of filtration products for controlling it.

Prerequisites
A basic knowledge of hydraulic systems will be beneficial.
C1206 - Filtration and Contamination Control for Aerospace Hydraulic Systems

TOPICS / OUTLINE

Contamination fundamentals
- What is particulate contamination and what are its sources
- How are contamination levels measured
- Reporting contamination levels in aerospace hydraulic systems
- Measuring and reporting water contamination

Contamination damage
- Types of wear that occur in hydraulic components: Abrasive; Erosive; Fatigue; Adhesive; Corrosive
- Critical clearances and wear in hydraulic components
- Benefits of controlling particulate contamination
- Benefits of controlling water contamination

Filtration fundamentals
- Types of filters
- Filter construction
- Mechanisms of filtration (how they work)
- Water removal principles

Filter efficiency testing and rating basics
- Nominal rating
- Absolute rating
- Gravimetric efficiency
- Filtration (Beta) ratio [Multi-pass test]
- Cyclic flow Multi-pass test (Stabilized cleanliness rating)

Other types of filter tests
- Writing a comprehensive filter specification
INSTRUCTOR : Puliyur Madhavan

Puliyur Madhavan is a Research/Engineering Fellow at Pall Aerospace, a division of Pall Corporation. His expertise is in filtration technology for Aerospace fluid systems such as hydraulic, lubrication, fuel, and air systems on-board aircraft and military land and sea vehicles.

He is a member of several technical standards development organizations including the SAE AE-5 Committee (Aerospace Fuel, Inerting and Lubrication Systems) and the SAE E-34 Committee (Aerospace Propulsion Lubricants), and he has worked on programs with the IATA Fuels Group. He has published numerous articles and technical papers related to contamination control in aerospace fluid systems, and he is also the author of a number of technical papers and SAE standards related to filter performance evaluation and filter debris monitoring.

Puliyur Madhavan received his doctorate in Chemistry from the State University of New York at Stony Brook in 1982. He did post doctoral research work at the Brookhaven National Laboratory and at the State University of New York at Stony Brook where he also held a joint position as lecturer in the Materials Sciences Department for several years. He joined Pall Corporation in 1987 and has held various technical and management roles in the company over the last 32 years.
OVERVIEW

This four-hour short course intends to present an overview of electrically powered flight control actuation systems, covering commercial applications. The scope covers issues related to the mechanical design of actuators themselves, with limited reference to their control electronics. Additionally, this course will provide participants an understanding of the design considerations behind these actuation systems.

Learning Objectives

By attending this seminar, you will be able to:

- Explain electromechanical actuation systems in aircraft flight control systems
- Identify key design considerations of electromechanical actuators
- Identify a few key design considerations of electric actuator control electronics
- Evaluate overall design considerations of electromechanical flight control actuation systems

Who Should Attend

This seminar is designed for engineers and other key personnel with little or no previous electromechanical flight control actuation knowledge.

Prerequisites

None.
TOPICS / OUTLINE

EMA Configurations
  Rotary
  Linear
  Redundancy schemes

Typical Requirements
  Operating modes
  Loads (applied, generated, and duty cycle)
  Stroke
  Rates
  Life
  Stiffness
  Other typical requirements from ARP5812

Actuator Components
  Motors
  Gears
  Ball Screws
  Roller Screws
  Stops
  Brakes
  No-backs
  Torque Limiters
TOPICS / OUTLINE

Sensors
Failure Mechanisms
Dampers
Controllers - a few leading considerations

Considerations
Jams
Efficiency
Back-drivability and load holding
Uncommanded motion
Sealing vs venting
Latency
Heat dissipation, temperature, and cooling
Materials, processes, and allowables
Test duration and acceleration
Space, envelope, form factor

Performance Analysis
Static
Dynamic
INSTRUCTOR : David Manzanares

David Manzanares is Vice President of Engineering for UMBRAGROUP, a provider of EM actuators and precision components.

Previously David was employed at Moog Inc. and predecessors for 20 years, mostly in the aircraft flight controls area where he held the position of Manager of Primary Flight Controls Actuation Engineering in the Aircraft Group’s Commercial Sector. During his career, Mr. Manzanares has led multiple engineering development activities for cockpit controls and electromechanical actuators including the design and development of the 787 spoiler EMA and horizontal stabilizer trim actuator.

His present activities include establishing a product development capability in UMBRAGROUP’s Everett, WA facility, technical and project oversight for engineering development programs throughout the group, company and engineering strategy, capability and skill development, technology road mapping for the group products, and coordination of the group’s ~140 development and manufacturing engineers.

He received his B.S. degree in Mechanical and Aerospace Engineering from Cornell University and his M.S. degree in Mechanical Engineering from the University of Utah.
OVERVIEW

This half day seminar presents an overview of seals and sealing system design for military and commercial aircraft. It is aimed to provide engineers having some previous actuator and control valve design background with an understanding of the general hardware groove standards, standard parts for static applications and how seal designs and sealing systems can be best used in dynamic reciprocating and rotary applications. Information will be provided regarding seal material and fluid compatibility, friction drag, expected wear rates depending on operating conditions and duty cycle, hardware surface finish and topography. Also included will be information on seal installation procedures and potential pitfalls to avoid.

Learning Objectives
By attending this seminar, you will be able to:
Identify the standards relevant to seals and seal systems
Summarize key characteristics of dynamic reciprocating applications
Summarize key characteristics of rotary applications
Evaluate seal material characteristics and proper applications

Who Should Attend
This seminar is designed for engineers and other key personnel with some actuator and control valve design knowledge.

Prerequisites
Attendees should have some previous actuator and control valve design experience.
TOPICS / OUTLINE

First O-Ring Patent
    1932-Niels A. Christensen
Parker: Development of Range of Sizes
    Tables
AS568
    Range of sizes
    Cross sections
    Tolerances to Class 2- Tables
History and Application of Aerospace Gland Dimensional Standards for Seals and Scrapers
    MIL-P-5514 Revs A and B
    MIL-P-5514 Revs C, D, and E
    MIL-G-5514 Rev F
    AS4716, AS5857, MS33675, AS4088, AS4052
History of Backup Ring Standards
    MIL-R-8791, MS28774, MS27595, MS28782, MS28783
    AS8791, AS5781, AS5782, AS5860, AS5861
EPDM History and Applications
    NAS1613, NAS1611, NAS1612, AECMA specs
    prEN 6111, prEN 6075, prEN6076
Elastomer Materials and Applications
- In red oils
- In fuels
- In turbine oils
- Properties

Storage of Elastomers
- ARP5316

Plastic Materials and Applications
- AMS3678 and slash sheets
- Effects of fillers on PTFE materials

High Modulus Plastics
- PEEK
- PEKEKK
- Carbon fiber composites
- Properties and uses

Reciprocating Seals for AS4716 grooves

Piston Seals
- Bi-directional - to fit std. and non-std grooves - examples
- Uni-directional - to fit std. and non-std grooves - examples

Rod Seals
- Bi-directional - to fit std. and non-std grooves - examples
- Uni-Directional - to fit std. and non-std grooves - examples

Scrapers for MS33675, AS4088, and AS4052

Reciprocating Sealing Systems
- Tandem and tertiary sealing systems with scrapers
Face Seals
  Types for internal and external pressure
Seal Design Notes: An Appreciation
  Low temperature considerations
  High temperature considerations
  Friction calculations: C of F for PTFE compounds
  Friction calculations: Elastomers
  Consideration of elastomer shear strength
  Consideration of elastomer tensile strength
  Consideration of elastomer elongation percentage
  Thermal cycling: Reciprocating PTFE seal components
Rotary shaft seals
  Metal can types: Elastomeric lip(s)
  Metal can types: PTFE lip(s)
  Flanged spring energized seals: Thermal cycling
Hardware Surfaces, Coatings, and Roughness Finishes
  Dynamic
  Static
Installation Tools and Procedures
  For piston seals
  For rod seals
Hardware Design Tips: Avoiding Installation and Performance Catastrophes
Pump/Motor Function Applications
INSTRUCTOR: Alan Schofield

Alan Schofield is an active consultant for Greene, Tweed & Co., where he recently retired as Global Director of Engineering. With global responsibility for the engineering function of the organization's five business groups, as well as the Central Engineering function, Mr. Schofield was in charge of the management of all aspects of engineering design, product and material development covering applications engineering, R&D, validation, and in-service engineering support of all products. The Global Engineering function consisted of 118 engineers and support staff distributed over 10 sites in the USA, UK, France, Germany, Japan and Singapore.

Mr. Schofield was also Aerospace Engineering Manager prior to his appointment as Global Director. Prior to that he was with Coorstek as Director of Engineering Sales and Marketing, at Fluorocarbon Co. (now St. Gobain) as Seals Product Manager, at Shamban Intl. as Engineering Manager, and at W. S. Shamban & Co. (now Trelleborg) as Sales Engineer.

The holder of three U.S. patents involving seal design and application, Mr. Schofield presently serves on the Steering Council for the SAE-A6 Fluid Power, Actuation and Control Technology Committee. Additionally, he also represented Airbus on the SAE-A6C2 Seals Panel, serving as Panel Chair for eight years and Secretary for six years. He has also served as a member of the SAE-AMS Committee P (Polymers) for twenty-three years and the AMS Committee CE (Elastomers) for fourteen years. During his participation in SAE committees, Mr. Schofield has acted as sponsor for twenty-two document reviews and sponsor for the publication of six new documents. Mr. Schofield received his B.S. in Mechanical Engineering in the UK.
OVERVIEW

This four-hour short course intends to present an overview of electrohydraulic flow control servovalves commonly used in flight control and utility actuators. The scope of this course covers the history and design of servovalves, as well as their most common performance characteristics. This course will provide participants an understanding of the application of electrohydraulic servovalves in hydraulically powered actuators and preparation of the servovalve procurement specification.

Learning Objectives

By attending this seminar, you will be able to:

- Recognize differences between various types of electrohydraulic servovalves.
- Understand terminology specific to electrohydraulic servovalves.
- Identify key performance characteristics.
- Evaluate effects of the servovalve characteristics on performance of a control actuator.
- Prepare design specification for electrohydraulic servovalve.

Prerequisites

This seminar is designed for engineers and other key personnel involved in the design and specification of hydraulically powered flight and utility control actuation systems including fluid power, electrical, and systems engineering disciplines and those involved with aircraft certification. In addition, this seminar will benefit other key personnel desiring an understanding of power distribution through electrically powered valves and aircraft actuation systems.
Overview of Electrohydraulic Servovalves
   History of development of servovalves
   Control function (flow vs. pressure control)
   Architecture (single vs. two-stage)

Servovalve Specific Terminology
   Electrical characteristics
   Steady-state performance characteristics
   Dynamic performance characteristics

Specification Considerations
   Typical Requirements
   Effects of tolerances
   Test methods and equipment
   Quality assurance considerations
Mr. Simkin has been involved with the design and development of electrohydraulic servovalves since 1988. Born in Ukraine, he received his M.S. degree in Mechanical Engineering from National Technical University in Kharkiv, Ukraine. Since 1998, Mr. Simkin has been employed at Abex and Parker Aerospace working in electrohydraulic servovalves design. He has held various engineering positions, including key positions in the development of the servovalves for Airbus A330/340 and A380, Boeing 717, 777 and 747-8, EMB 170/190 and 505, DHC8-400, ARJ-21, MRJ and more. He has participated in the SAE A-6 committee meetings starting in 1998 and is currently the Secretary of the A-6B1 Hydraulic Servo Actuation panel. Mr. Simkin has sponsored the latest revision of the SAE ARP490-Electrohydraulic Servovalves.
OVERVIEW

This four hour short course will provide an overview of design considerations for electrohydrostatic actuation for transport and business aircraft applications. The instructor will present the critical topics of electrohydrostatic actuation (EHA) from a systems development perspective (V-Approach). Beginning with aircraft system requirements, the instructors will then guide participants through EHA subsystem requirements, component design, component verification test, aircraft integration, and use. Also included will be a short history of the evolution of EHA technology, and an overview of the advantages and system tradeoffs for selection of electrohydrostatic actuation on aircraft.

Learning Objectives
By attending this seminar you will be able to: Describe the evolution of EHA for aircraft flight controls Evaluate the unique advantages/disadvantages of EHA in flight control applications Establish an awareness of high level aircraft system and requirements for EHA Explain basic design considerations for EHA Identify unique test and verification methodologies for EHA Describe important considerations for aircraft integration Evaluate key lessons learned about EHA development and aircraft usage

Who Should Attend
This seminar is intended for engineers and other key personnel involved in the design and specification of hydraulically powered flight and utility control actuation systems including fluid power, electrical, and systems engineering disciplines and those involved with aircraft certification. In addition, this seminar will benefit other key personnel desiring an understanding of aircraft electrohydrostatic actuation systems.
General topics covered in this seminar include:

- Introduction and History of EHA for Flight Control Applications
- Aircraft System Requirements and System Safety
- Types of Electrohydrostatic Actuation
- System Architectures
- Specification Unique Requirements
- EHA Performance Attributes
- Duty Cycle and Thermal Management
- EHA Components
- EHA Design Considerations
- EHA Verification Testing and Qualification
- EHA System and Aircraft Integration
- Lessons Learned
- Future Trends
- SAE International and ISO Specific Documents
Dominique van den Bossche is retired from Airbus since Jan 1st 2009, and is now an independent consultant, mainly for European and US Flight Control Actuation companies / organizations.

He was formerly appointed as Head of Department, in charge of the Primary Flight Control Actuation & Hydraulics Department in the Airbus Engineering organization. He was covering R&T, design, development, validation and in-service engineering support of the Primary Flight Control Actuation, Hydraulic Generation and Hydraulic Distribution equipment, for all Airbus models from A300B to A380, A400M and A350, with a team of 115 engineers located in Toulouse France, Hamburg and Bremen Germany.

He received a Master’s Degree in Aeronautics in 1971, after a 3 year training at the French “Ecole Nationale Supérieure d’Ingénieurs de Constructions Aéronautiques”.

He has been teaching Flight Control Actuation Systems at the Institut Universitaire de Technologie (IUT), Blagnac, France, to students preparing an Aeronautical Maintenance degree and formerly at the Ecole Nationale de l’Aviation Civile (ENAC), in Toulouse, France, and giving lectures at the Institut National des Sciences Appliquées in Toulouse, Technische Universität Hamburg, Beihang University Beijing and Politecnico di Torino. He his giving training courses at SAE International and at many aerospace companies/organizations.

He holds 4 patents involving flight control actuation equipment design and application.

He has been presented an award by the French Academy of Technology in 2007 for his achievements on electrohydrostatic actuation technology.
Jérôme Socheleau currently serves as the Head of Systems Group at Collins Aerospace in France. He has been working for more than 20 years in Aircraft Primary Flight Controls domain; he was in charge of the development of several primary flight control actuation systems for new aircraft involving the state of the art "Fly By Wire" technology on A340-500/600 and the introduction of first EHAs on A380. Additionally, Mr. Socheleau led the design of several advanced primary flight control actuator prototypes in the field of Research and Technology projects, these include hybrid Electrically Assisted Hydraulic Actuator (EAHA), which enables hydraulic and electric power summing in a single actuator hydraulic power ram, and also the TRL6 demonstration of several ElectroMechanical Actuator (EMA) for Primary Flight Control Actuation. He is currently responsible of Systems activities development for Collins Aerospace in France, his teams are involved in R&T activities including Power Drive Electronics and Flight Control electronics as well as EMA, they are additionally in charge of products development for new platforms such as Embraer KC-390 and Irkut MC-21. At last, Mr. Socheleau is the current vice chairperson for the SAE A6B2 Electrohydrostatic Actuation Panel aimed at providing guidelines and recommended practices for EHA design and use. He received a Master's Degree in Aeronautics at the French Engineering School “École Nationale Supérieure de Mécanique et d'Aérotechnique” in Poitiers.
OVERVIEW

This four hour course provides an overview of hydraulic tubing installations, principles, and design criteria. Although the primary focus is airplanes, the requirements and principles covered are valid for use in other types of flight vehicles and industries.

Learning Objectives
By attending this seminar, you will be able to:

- Select materials and connections appropriate for the desired usage
- Develop routing strategies that minimize the impact of costs, weight, maintenance, and structure
- Provide installations that ensure manufacturability, reliability and safety
- Reference standards, recommended practices, and information reports to support the design decision

Who Should Attend
Personnel involved in the design and selection of fluid transport routing, installation, and material selection for hydraulically powered aircraft systems including design and fluid power engineers, system engineers, and those involved with certification.
C1305 - Hydraulic Installation Design: Materials, Rules, and Routings

TOPICS / OUTLINE

Overview of aircraft fluid installations
History
Environments that impact installation designs
Fluid Transport Design
Materials selection (past and present)
Couplings and end fittings (common and special use)
Application for non-hydraulic uses
   Fluid Transport Routing
Lessons learned
Tube restraint systems
Specials designs (drains, vents, and reservoirs)
Timothy Neff has been involved with the design and maintenance of aircraft hydraulic systems for over 35 years. After his ten years as an active duty U.S. Army pilot and Aircraft Maintenance Officer, he held engineering positions with Beach, Cessna, Gulfstream, Northup-Grumman, and his current employer Spirit AeroSystems. He is the Panel Chairman of A-6A4 Uility Control Systems and Panel Vice Chairman of A-6C4 Tubing. Mr. Neff sponsored the latest revision of the SAE Aerospace Recommended Practice ARP994 “Recommended Practice for the Design of Tubing Installations for Aerospace Fluid Power Systems”.
OVERVIEW

This 4 hour short course offers an overview of aircraft hydraulic pumps focusing on their application in hydraulic systems, design and performance characteristics, and integration issues. These topics will examine the various pump technologies available for aircraft system applications, their design, performance and operational characteristics and limitations, and discuss the challenges and lessons learned in the integration of pumps in hydraulic systems.

Learning Objectives
By attending this seminar, you will be able to:
- Identify the various pump and pump control technologies used in common hydraulic systems
- Evaluate the design characteristics and limitations inherent in applying the various technologies of pumps in their application in hydraulic systems
- Evaluate the critical aspects of integration of pumps in hydraulic systems, such as controlling air entrainment, heat removal, and back-up strategies
- Evaluate the interfaces between pumps, hydraulic systems and other aircraft systems

Who Should Attend
This seminar is designed for engineers, executives, and other key personnel with some experience in hydraulic pump design or system integration. The former will benefit in understanding the application and integration of pumps, while the latter will benefit in understanding the complexities and limitations of current pump designs.
TOPICS / OUTLINE

General
Hydraulic systems overview
Brief history of aircraft hydraulics
Hydraulic pump technologies overview

Application of Hydraulic Pumps
Engine Driven Pumps
Electric Driven Pumps
Others, such as Air Driven and Hydraulic Driven Pumps (PTU"s)

Design of Hydraulic Pumps
Pumping Technologies
Fixed / Variable displacement
Axial piston inline
Bent axis
Critical Design Factors
PV factors
Dynamic characteristics
Inlet conditions
Control of pumps
Flow / Pressure / Torque performance characteristics
Integration Challenges and Lessons Learned
  Starting Issues
    Engine driven pump torque control
    Electric motor pump inrush current
  Air ingestion control
  Fluid conditioning
  Heat rejection / Case drain flow
  Pressure ripple control

Overview of Industry Specifications and Other Reference Material
Mr. Stricker has worked since 1983 in the aerospace industry, working on hydraulic systems and components for Vickers, which was later acquired by Eaton Corporation. During the first twenty years, he was engaged in the engineering design and development of hydraulic pumps, motors and integrated systems for commercial, military fixed and rotor wing aircraft, as well as ground defense vehicles. During the last fifteen years, Mr. Stricker has been involved in the Sales and Marketing side of the business, providing technical sales and marketing support and financial modeling for commercial and military aircraft hydraulic systems. Beginning during the spring of 2014, he will be "semi-retired", working on selected engineering projects. Mr. Stricker is currently Vice Chairman of the Power Sources Panel of SAE Committee A6, Aerospace Actuation, Control and Fluid Power Systems. He has authored two recent SAE documents, AIR5872 Aerospace Hydraulic Pump Controls and ARP4940 Application Guide for Aerospace Hydraulic Motors. Mr. Stricker holds a B.S. Mechanical Engineering from McGill University, a M.S. Mechanical Engineering from the University of British Columbia, and an M.B.A. from Millsaps College. He has been a registered Professional Engineer in the State of Mississippi since 1980.
OVERVIEW

This 4 hour short course provides an overview of Power Electronics (PE) in use in modern transport aircraft. This course includes the context, principles, design drivers, and the main PE components of various flight applications, including those for harsh environments. This course is designed to deliver and demystify the basic theories and best practices of mechanical, electronics, thermal management, safety, reliability and maintainability disciplines. In addition, future trends in Power Electronics will be discussed.

Learning Objectives

By attending this seminar, you will be able to:
- Explain and evaluate the use of the power electronics in various aircraft systems
- Identify and explain the various PE architectures
- Identify the main requirements and technical drivers to develop PE units
- Identify the various components of PE equipment
- Evaluate lessons learned from existing PE products flying in various commercial aircraft

Who Should Attend

This seminar is designed for engineers, in particular "mechanical" engineers, executives, and other key personnel with little or no previous electronics knowledge or experience. The information presented in this course will also benefit individuals from the production and support disciplines, including airlines and maintenance repair organizations.
C1420 - Power Electronics for Mechanical Engineers

TOPICS / OUTLINE

Design Theory
  Fundamentals of Power Electronics
  Typical motor control architecture
Component Functions and Technologies
  Active components
  IGBT, MOSFET
  Passive components
Harsh Environments
  Aircraft context
  Main design drivers for PE equipment
  Some examples of applications
Other Environmental Constraints
  EMI, Lightning
  Thermal management
  Aircraft quality electrical network
Best Practices
  Multidisciplinary approach
  Lessons learned examples
  Best practices for PE
Future Trends
INSTRUCTOR : Michel Todeschi

Mr. Todeschi holds the Senior Expert position in Electrical Actuation and Power Electronics within the Airbus Group.

He started as a development engineer for the A330/A340 program and research programs. In 2001, He was appointed to the A380 program as Task Leader where he led the team in charge of the development of the A380 Primary Flight Control Actuation. In particular, he was responsible for the introduction into service of Electrohydrostatic Actuators (EHAs) and associated Power Electronics Modules in Commercial Aircraft applications.

In 2008 he became Head of the Electromechanical Actuation and THSA group in charge of the management of R&T, design, development, validation and in-service engineering support of the Electromechanical Actuation and THSA s for all Airbus models from A320 to A380, A400M and A350.

Mr. Todeschi contributes to the SAE-A6 committee as chairman of the Commercial Panel and member of the Flight Control Systems, EMA and EHA Panels.

He received his M.S. in Electronic Engineering from ENSEEIHT, Toulouse France.
**OVERVIEW**

This 4 hour short course will provide an overview of the hydraulic components used on aircraft. There will be a brief overview of hydraulics, aircraft hydraulic systems, and aircraft flight controls. You will learn the function of each component used within the hydraulic system, and then look in depth at each component's design.

**Learning Objectives**

By attending this seminar, you will be able to:
- Explain how a hydraulic system is used in an aircraft
- Identify the various components used in a hydraulic system
- Explain the functions of hydraulic components
- Identify the design styles of hydraulic components
- Explain the strengths and weaknesses of hydraulic components
TOPICS / OUTLINE

General
   A History of Hydraulics
   Hydraulics in Aircraft Systems

The Aerospace Hydraulic System
   Principles
   System Architecture
   Hydraulic Actuation
   Hydraulic Issues (Contamination, Air, Cavitation)

Hydraulic Power Sources
   Pumps, Accumulators, RAT
   Theory of Operation
   Designs
TOPICS / OUTLINE

   - Filtration
   - Restrictors
   - Check Valves
   - Relief Valves
   - One Way Restrictors
   - Pressure Regulating Valves
   - Thermal Relief Valves
   - Selector Valves
   - Solenoid Valves
   - Shuttle Valves

Future Trends
   - Power Sources (EHA, EBHA)
Jeffrey C. Dickey is Executive Vice President - Hydraulics for The Lee Company, a manufacturer of high precision miniature hydraulics components used in the aerospace, medical, and industrial industries. He is responsible for seven business units, overseeing both engineering and manufacturing. Mr. Dickey has been designing hydraulic components since 1986, starting as a project engineer and working his way up to his current position. He has designed and developed an array of proprietary hydraulic component designs for plugs, restrictors, check valves, pressure relief valves, flow regulating valves, pressure regulating valves, pilot operated valves, shuttle valves, bypass valves, solenoid valves, etc. His designs have helped solve issues within hydraulic systems for aerospace, medical implants, military vehicles, missiles, satellites, submarines, down-hole oil tools, formula 1 race cars, etc. He has Patents on a High-Pressure Pin Plug (Patent 4867333) and Expansion Sealing Device (Patent 5121947). He is an active member of the SAE - A6 Fluid Power, Actuation and Control Technology Committee. He is currently the Panel Chairman of the A6C5 Components Panel, and Co-Author of SAE Paper 912134 "Total Flexibility in Cartridge Valve Porting Through Innovative Sealing Technology". Mr. Dickey received his B.S. in Mechanical Engineering from the University of Connecticut.
C1507 - Role of DER-AR and Airworthiness Certification Process

OVERVIEW

This four hour short course will provide an overview of the airworthiness certification process and the role of the FAA Designated Engineering Representative (DER) and Authorized Representative (AR) with insight into the type design, minor/ major Changes, FAA conformity process, and test witnessing. It also provides familiarity with FAA forms.

Learning Objectives
By attending this seminar, you will be able to:
- Identify the Airworthiness Certification Process
- Explain Type Design
- Describe Certification and Qualification plans
- Describe FAA Conformity and Test witness
- Explain the Role of FAA Engineering Designees (DER / AR)
- Identify Minor and Major Change classification
- Identify and explain FAA & EASA forms

Who Should Attend
This seminar is designed for Design and Systems Engineers, company DER(s) and DER candidates, Certification Engineers, Quality Engineers, Engineering Managers and Leads and other staff involved with requirements management.
C1507 - Role of DER-AR and Airworthiness Certification Process

TOPICS / OUTLINE

Acronyms

FAA History and Mission

FAA Designated Engineers (DERs)
  Why DERs?
  FAA Designees
  Players & Roles
  What is DER?
  DER Qualification Requirements
  Types of DERs
  DER Designations
  What Does a DER do?
  DER Responsibilities
  DER Activities
  DER Liabilities
C1507 - Role of DER-AR and Airworthiness Certification Process

TOPICS / OUTLINE

Type Design Airworthiness Certification
   (Video)
   Certification Roadmap
   Cert Roles
   Typical Certification Cycle
   Type Design
   Certification Plan
   Qualification Plan

FAA Conformity/Conformity Process

DER Data Approval/FAA Forms
   “Request for conformity” / 8120-10
   “Statement of conformity” / 8130-9/ Deviations
   Conformity Record 8100-1
   “Airworthiness Approval” Tag / 8130-3
   “Statement of compliance with airworthiness standards” 8110-3 (DER)& 8100-9 (AR)

Major and Minor Changes
Magdy Kandil is a retired Technical Fellow from UTC Aerospace systems with 34 years of experience in the design, research, development, qualification and airworthiness certification of mechanical, hydraulic, electrical power generation, and emergency power for aerospace commercial and military systems. He is currently an Engineering Consultant with Ingenium Technologies and formerly a Consultant DER, UTC company DER and a Boeing Supplier AR with FAA delegations to cover order 8110.37 EChart C1, Chart C2, Chart E, Chart B for CFR14, Part 25, Part 21, Part 33 including Flight Controls, PMA identicality and Major repairs with Proven experience in developing qualification and certification plans, FAA conformity and test witnessing. He pioneered the development of high power density hydraulics for electrical power and actuation systems, 8000 psi servo controlled variable displacement hydraulic motors and starter drive generator for UTAS/ Hamilton Sundstrand 737 AEWC IDG, A380 and F-22 programs. Mr. Kandil is recognized by his peers as an expert and mentor in Hydraulics, Sealing Technology, Mechanical Design, and Airworthiness Certification with specialty in high pressure axial piston pumps/motors, control valves, static and dynamic seals with solid experience in failure analysis and C/A, evaluating supplier capabilities, technical adequacy assessment and controlled builds for supplier engineered components. He was the vice chair of SAE A6C-2 Seals committee and contributed to the creation of new industry standards, update and revision of numerous SAE publications including SAE AIR744C, development of AS6235, and co-authored SAE technical paper 901794 on the “Design, Development and Demonstration of High Pressure, Over-Center Variable Displacement Hydraulic Motor”. He was voted as best presenter by SAE A-6 for his tech presentation “Types of Wear & Galling Process in Hydraulic Pumps”. Mr. Kandil is a 1975 graduate of the University of Alexandria, Egypt with a BS in mechanical engineering. He holds six US patents, two pending patents and numerous patent disclosures under review.
OVERVIEW

The purpose of this four hour short course is to provide information to understand how is established the basic architecture of a Flight Control Actuation System of a transport airplane, i.e. understanding the rationale for the distribution of the control surfaces, power sources, actuators and computers.

Learning Objectives

By attending this seminar, you will be able to:

- Understand the Flight Control Actuation System main requirements
- Identify technical alternatives covering various aspects of Flight Control Actuation System architecture
- Identify the impact of some installation constraints on Control Actuation System architecture
- Describe various examples of Flight Control Actuation System architectures

Who Should Attend

This seminar is designed for engineers, executives, and other key personnel with little or no previous flight control knowledge or experience.
TOPICS / OUTLINE

Actuation System Architecture Driving Requirements
- Certification
- Particular Risk
- MMEL requirements
- Margin on failure probabilities
- Arbitrary failure conditions to be covered
- Dissimilarity

Actuation System Architecture Design Considerations
- How many control surfaces
- Balanced vs unbalanced surfaces
- Mechanical vs powered system
- How many power sources
- Electric vs hydraulic power sources
- How many actuators per surface
- Active/active vs active/stand-by & double activation
- EMA vs EHA
- EBHA vs EHA
How many computers
Centralized vs distributed electronics
COM/MON vs triplex voting
Dissimilarity (electronics, power sources, back-up system)
Back-up system

Pilot Controls
Side stick vs control column
Active vs passive side stick

Considerations On System Installation
UERF and System Routing
Bird strike and segregation
Electric actuator thermal management
Fire prevention
Lightning Strike
Actuator installation configurations

Actuation system architecture examples
System architecture analysis principle
Architecture examples
INSTRUCTOR: Dominique van den Bossche

Dominique van den Bossche is retired from Airbus since Jan 1st 2009, and is now an independent consultant, mainly for European and US Flight Control Actuation companies / organizations.

He was formerly appointed as Head of Department, in charge of the Primary Flight Control Actuation & Hydraulics Department in the Airbus Engineering organization. He was covering R&T, design, development, validation and in-service engineering support of the Primary Flight Control Actuation, Hydraulic Generation and Hydraulic Distribution equipment, for all Airbus models from A300B to A380, A400M and A350, with a team of 115 engineers located in Toulouse France, Hamburg and Bremen Germany.

He received a Master’s Degree in Aeronautics in 1971, after a 3 year training at the French “Ecole Nationale Supérieure d’ Ingénieurs de Constructions Aéronautiques”.

He has been teaching Flight Control Actuation Systems at the Institut Universitaire de Technologie (IUT), Blagnac, France, to students preparing an Aeronautical Maintenance degree and formerly at the Ecole Nationale de l’Aviation Civile (ENAC), in Toulouse, France, and giving lectures at the Institut National des Sciences Appliquées in Toulouse, Technische Universität Hamburg, Beihang University Beijing and Politecnico di Torino. He has giving training courses at SAE International and at many aerospace companies/organizations.

He holds 4 patents involving flight control actuation equipment design and application.

He has been presented an award by the French Academy of Technology in 2007 for his achievements on electrohydrostatic actuation technology.
OVERVIEW

This four-hour short course provides an introduction to fluids for aerospace hydraulic systems. Topics covered include an introduction to basics fluid properties, rheology, tribology, and fluid product development. In addition, the history and performance of different classes of fluids are discussed in detail, and specific failure modes such as erosion and sludge formation will be described. Along with an introduction to fluid degradation, information on used oil analysis test methods and interpretation will be provided.

Learning Objectives
By attending this seminar, you will be able to:
- Describe the general properties and components of a fluid
- Interpret a fluid specification or report
- Identify key performance advantages and disadvantages for different fluid types
- Explain fluid degradation processes

Prerequisites
A basic knowledge of hydraulic systems will be beneficial. Some elementary knowledge of chemistry and chemical structures will also be helpful, but is not required.
TOPICS / OUTLINE

Fundamentals of fluid lubricants
- Basic physical properties
- Functions of a lubricant
- General lubricant compositions
- Basic lubricant rheology and tribology

Aviation hydraulic fluids
- Fluid development process
- General qualification procedures
- Types of aviation lubricants

Hydrocarbon hydraulic fluids
- History and applications
- Key specifications and products
- Performance advantages and disadvantages
- Failure modes
TOPICS / OUTLINE

Phosphate ester hydraulic fluids
   History and applications
   Key specifications and products
   Performance advantages and disadvantages
   Failure modes, including erosion

Silicon-based hydraulic fluids
   History and applications
   Key products
   Performance advantages and disadvantages
   Failure modes

Oil degradation and used oil analysis
   Chemical kinetics of degradation
   Key used oil tests and their significance
Dr. David Racke is a research associate at ExxonMobil Research & Engineering, Lubricants Technology. He currently leads the development group for aviation and industrial lubricants, and is the lead chemist for aviation hydraulic fluid development and testing. He is an active participant on several technical committees for aviation hydraulics, including SAE International and the International Standards Organization (ISO).

Dr. Racke received a BS in Chemistry from Hillsdale College, and a PhD in Analytical Chemistry from the University of Arizona.
### Past delivery of Short Courses

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As a Summary

• Short Courses are one of our tools for disseminating knowledge

• They are a great opportunity to become familiar with many aspects of our activity

• They may be particularly useful to young engineers

• Think about it, discuss it within your Panels

• Relay information within your teams and your companies

… and register on time!