

**Book's title**  
**“AIRPORT ENVIRONMENTAL IMPACT**  
**- Methodology of Atmosphere Protection”**

**CONTENTS**

**Chapter 1. INTRODUCTION**

- 1.1 Vision 2020 of Aviation Development
- 1.2 Airport Environmental Impact Case Studies
- 1.3 The EUROCONTROL Concept of Airport Environment Capacity
- 1.4 Aviation Fuel, its Combustion and Exhaust Gases
- 1.5 European Commission Thematic Strategy on Air Pollution

**Chapter 2. AIR TRANSPORT AND ITS PERSPECTIVES**

- 2.1 Environmental Aspects of Air Transport
- 2.2 General Purpose Aviation Segment
- 2.3 Air Transport Vision 2020 Perspectives
- 2.4 Air Transport Beyond 2020

**Chapter 3. AERO-ENGINE EXHAUST GASES**

- 3.1 Airplane propulsion systems
- 3.2 Aero engine exhaust pollutants
- 3.3 Exhaust pollutants reduction
- 3.4 Engine Enhancement Projects

**Chapter 4. AIRPORT EMISSIONS SIMULATION SOFTWARE - EDMS**

- 4.1 Hardware Requirements, Installation Modules and Features
- 4.2 Emissions Calculations
  - 4.2.1 Aircraft Activity
  - 4.2.2 Aircraft Support Equipment
  - 4.2.3 Auxiliary Power Units (APU)
  - 4.2.4 On-Road Vehicles
  - 4.2.5 On-Road Vehicles in Parking Lots
- 4.3 Inventory Data Output
- 4.4 Dispersion Calculations in EDMS Programme
  - 4.4.1 Inputs Required
  - 4.4.2 Weather Data
  - 4.4.3 Receptor Locations
  - 4.4.4 Dispersion Modelling and Calculation
  - 4.4.5 Point, Area, and Volume Sources
  - 4.4.6 Airport Pollution Sources
  - 4.4.7 Airport Graphical Display and Data Output

**Chapter 5. AIRPORT EMISSIONS SIMULATION SOFTWARE – ALAQS**

- 5.1 ALAQS Features, Objectives and Installation
- 5.2 Airport Emissions Methodology
  - 5.2.1 Movements Data
  - 5.2.2 Gate Emissions
  - 5.2.3 Taxiway Emissions
  - 5.2.4 Queue Emissions
  - 5.2.5 Runway Pre-processing and Emissions

**Chapter 6. AIRPORT EMISSIONS INVENTORY**

- 6.1 Aircraft pollution sources and reduction methods.

- 6.2 Flight phases
- 6.3 Emissions at Aircraft Stand
- 6.4 Emissions inventory of Frederic CHOPIN Warsaw Airport
  - 6.4.1 Aircraft Emissions
  - 6.4.2 GSE Emissions
  - 6.4.3 Road Vehicle Emissions
  - 6.4.4 Stationary Source Emissions

## **Chapter 7. EMISSIONS SIMULATION AND EXEMPLARY RESULTS**

- 7.1 Overview of Warsaw Frederic Chopin Airport
- 7.2 Aircraft Engines Emissions
  - 7.2.1 Models and Results
  - 7.2.2 Special considerations
- 7.3 Gate Emissions (APU, GPU, Engine Start and Ground Support Equipment - GSE)
- 7.4 Stationary Sources Emissions
- 7.5 Road Vehicle Emissions
- 7.6 Best practice recommendations

## **Chapter 8. POLLUTANTS DISPERSION**

- 8.1 Dispersion Computation
- 8.2 Measurement Techniques for Air Toxicants
  - 8.2.1 Passives sampling (diffusion tubes)
  - 8.2.2 Active sampling
  - 8.2.3 Automatic sampling
  - 8.2.4 Scope of Application of Measuring Methods
- 8.3 Near Field Dispersion
- 8.4 Condensation trails formation and effects
  - 8.4.1 Thermodynamics of Contrail Formation
  - 8.4.2 Persistent Contrails
  - 8.4.3 Climate Impact of Contrails, Mitigation Options and Conclusions
- 8.5 Volatile Organic Compounds Impact on Airport Air Quality

## **Chapter 9. ELECTROMAGNETIC POLLUTION**

- 9.1 The SIRENA project
- 9.2 The ADOC Proposal
- 9.3 The Electromagnetic Pollution at Warsaw Airport Expertise

## **Chapter 10. MONITORING OF AIRPORT NOISE**

- 10.1 Airport noise modelling state of the art
- 10.2 ENHANCE Project
- 10.3 Measurement system of noise monitoring at F. Chopin Warsaw Airport

## **Chapter 11. AIRPORT ENVIRONMENTAL IMPACT LEGISLATION AND STANDARDS**

- 11.1 Air Quality EU legislation
- 11.2 Aircraft noise legislations state of the art
- 11.3 Polish legislation relevant to airports environmental impact

## **Chapter 12.**

### **ENVIRONMENTAL and HEALTH EFFECTS, PROGNOSTICS and CONCLUSIONS**

- 12.1 Environmental Effects
- 12.2 Health Effects
- 12.3 Prognostics
- 12.4 Conclusions

### **Annexed CD contents**

- ❖ Day of flights over Europe
- ❖ Exemplary airport daily movements table
- ❖ EDMS manual
- ❖ ALAQS-AV application reference manual
- ❖ Air Quality European Union Directives

### **ABBREVIATIONS AND ACRONYMS**

### **BIBLIOGRAPHY**

#### **This manual I dedicate to:**

- **Professor Ewelina KANTOWICZ, Director of Inter-faculty Study Programme in Environmental Protection of the UW - Warsaw University,**
- **Professor Jan MISIAK, Rector of the WSEiZ - University of Ecology and Management in Warsaw.**

### **Summary**

This book is concerned with aviation sustainable development. First three chapters comprise “state of the art” in relevant topic of air transport and aero-engine exhaust gases. Next two are dedicated to the most popular programmes for calculation aircraft pollutant emissions and their dispersion: American EDMS – Emissions and Dispersion Modelling System and European ALAQS-AV – Airport Local Air Quality System-ArcView. Only short introduction is presented in the book – full software manuals, with other files interesting for environment subjects students of UW - [http://www.msos.uw.edu.pl/new\\_msos/index.html](http://www.msos.uw.edu.pl/new_msos/index.html) and WSEiZ - <http://www.wseiz.pl/index.php> , are available at annexed CD.

EDMS calculations are flight cycle based, while ALAQS approach is aircraft movements based. The second programme was used to assess air contamination by Warsaw F. Chopin Airport activity in 2004, which is described in Chapters 6 and 7. Planned exhaust gases dispersion computation is subject of next Chapter. Other nuisances resulting from airport activity like noise and electromagnetic radiation are shortly referred in suite, with current legislation, prognostics and conclusions to end up with. The scope of this book does not encompass route flight induced pollution except for condensation trails – because of the broad interest they excite and their contribution to the climate change.

The author’s aim was to make available, mainly for Polish students of this domain, concise results of recent research in air traffic environmental issues, with authors’ kind agreement in every case I asked them for such dissemination permission.

The knowledge presented here comes mainly from the Scientific Networks AERONET II and AERONET III titled “Aircraft Emissions and Reduction Technologies”. Polish Institute of Aviation, in 2004 was accepted as a partner to this EU Coordinating Action – we would like to express our cordial thanks to many West-North European scientists for encouragement.

#### **Author’s profile**

Marian JEŹ began his scientific career in 1964 in Flight Tests Department of Warsaw Institute of Aviation where he was involved with modifications to the first Polish jet engine, used in the ISKRA military trainer. In 1969/1970 he served in the Polish Delegation to International Commission for Supervision and Control in Viet-Nam. Between 1972 and 1978 he coordinated the strength part of nation-wide research programme dedicated to diesel and gas turbines engines.

In 1976 he presented his Ph.D. in engine suspension and in 1999 completed D.T.Sc. in mechanics.



Between 1981 and 1985 he lectured “Machines Thermiques” in Kinshasa, now the Democratic Republic of Congo. In 2000 Marian JEŻ was nominated for as professor at the Warsaw Aviation Institute. Since 2002 he is the Polish aeronautics expert on the EC AEROSPACE Programming Committee. He also serves as the Polish partner of two European scientific networks: AERONET and Air Transport Net.

His scientific achievements were reported in 61 publications and two books: “Moteurs Thermiques” (Internal Combustion Engines) in French and “Dynamika Silnika Tłokowego” (Piston Engine Dynamics) in Polish.

### **PREFACE**

Flying is an atavistic human dream, stemming from observing birds. Other animal species began flying much earlier: insects about 400 mln years ago and pterosaurs about 200 mln years ago. Those three flying animal groups, together with bats mastering flying in darkness, count for 2/3 of all animal species, which now inhabit the Earth.

Homo sapiens employ tools – balloons from XVIII century, later gliders, then airplanes and helicopters. Globalisation of markets, tourism and personal relations are strong driving forces for future growth of aviation. These are also factors which support a peaceful development between countries. In 2004 European Union airlines transported about  $10^9$  passengers. Aviation branch of EU economy employs over 3 million workforce.

Aviation is the means of transport with highest growth rates on national as well as on international level - until 2050 even moderate scenarios show a four to six-fold increase of air transport. In Poland, the latest annual rate of air transport increase is 30 % (2<sup>nd</sup> place after China). The role and importance of big European agglomerations depend on their air transport utilities. They stimulate development of the agglomeration and region in multiple aspects and are important for its relation with the rest of the world. The industry currently invests some 14% of its annual turnover in Research and Technology Development, which is the key to innovation and improved performance. In the last 40 years, fuel consumption was diminished by 40 % and noise - by 20 dB.

In spite of technical progress, aviation emissions, both at ground level and at atmosphere during flight time will grow in the future. Air transport uses 5÷6 % of available liquid fuels, but generates environmental impact twice as big and constitutes dominating source of nuisances in the regions of several hundred intensively used European airports.

Commercial airliner is depositing hundreds of noxious exhaust per second right to high troposphere during cruise. During hundreds of take-offs and landings, which took place each day at major airports (about 500 at Warsaw F. Chopin, 1600 at Paris Ch. de Gaulle) spoiled air of jet streams contaminates surroundings with NO<sub>x</sub>, CO, etc. Although noise is more easily discernible, it is air quality which is most lethal around airport.

An example of application of European ALAQS Programme in 2005 was assessment of Warsaw Airport environmental impact, executed by Polish Institute of Aviation in cooperation with “Polish Airports” Enterprise, sponsored by EUROCONTROL - organisation responsible for the “seamless sky” over Europe.

Continued and substantial government funding is necessary to deliver the technological improvements which will be required in the future to cope up with incoming challenges.