

PROGRAMME FOR
HARMONISED AIR TRAFFIC
MANAGEMENT RESEARCH
IN EUROCONTROL



P H A R E

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PART 2 OF 2

ANNEXES

CENA PD/3 FINAL REPORT

Annex B: Controller Subjects and Training



EUROCONTROL

EUROCONTROL
96 rue de la Fusée
B-1130 BRUXELLES

Prepared by: C.Chabrol

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1. PURPOSE OF THE TRAINING

The aim of the training period was to provide the controllers with sufficient expertise, as far as time permitted, in order that they could attain a level of confidence and proficiency in the use of the PD/3 system, and thus allow them to participate fully in the PD/3 experiment. The training focused on providing the controllers with a full understanding of the system handling and philosophy.

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2. PREPARATION OF THE TRAINING

2.1 INTRODUCTION

A training working group was set up for the PD/3 trial so as to gather experience from the different PD/3 sites and to come to an agreement with a general training organisation. Among other tasks, Marian J. van Blanken from NLR was responsible as PD/3 Training Leader for co-ordinating information and producing the documents relative to the specific parts of the training.

It was agreed that the training program would be made for training in one week (the training time available at each PD/3 site).

The sequence training should tackled the following points :

- Computer Based Training (CBT) and presentations (i.e. kind of classroom instruction on concept) ;
- Ground Human Machine Interface (GHMI) rehearsal on real system ;
- working procedures baseline ;
- working procedures advanced ;
- skills speeding up and full system (including ISA/TLX instructions).

To support the training, the controllers were provided with a controller handbook designed by each site illustrating an resuming each lesson in the program.

2.2 OBJECTIVES

Prior to the trials, each controller team participated in a six days training phase. Few weeks before the training phase itself, the Training Team sent to the controllers a paper introduction of the PD/3 project comprising a presentation of the PD/3 concept and a familiarisation with the PD/3 system through the use of a Computer Based Training (CBT).

The Training Team, in consultation with the PD/3 Training Leader, established the following general objectives for the PD/3 training :

- Introduction of the PD/3 concept ;
- GHMI familiarisation ;
- Tools familiarisation ;
- Learning the procedures ;
- Integration of knowledge and skills.

2.3 TRAINING FACILITIES

The PD/3 training course was conducted in the experimental room which contained the full facility for the Departure, ETMA and En Route positions. For training purposes, and in order to be able to conduct the training in a flexible way, the controller working positions could be used in stand-alone mode (i.e. the six positions worked as independent units).

The other facilities that were available to the Training Team consisted of :

- an office for use of a classroom and debriefing room;
- a meeting room for use of general presentations.

The office and the meeting room were equipped with tables and chairs, and a projector, a screen and a board.

Specific training material, covering the overall concept, the simulated airspace, and the handling of the GHMI was provided (controller handbook and quick reference guides).

2.4 OFF SITE CONTROLLERS FAMILIARISATION

Before the controllers began their training on site, a Computer Based Training (CBT), an Handbook and a Pre-questionnaire were sent to them. These documents consisted of a presentation of the PD/3 project, concepts, experiment objectives and GHMI.

The Computer Based Training, with the Handbook, were sent to each controller two weeks before the on site training week. The purpose of this distance learning phase was to allow the controllers to familiarise with PHARE concept and GHMI.

The Handbook comprised the definition of the PD/3 background and concepts. It also presented the Working Procedures roles specific with the description of each controller's role, of the interactions between controllers, and of the sharing and transfer of responsibilities. Roles' differences between the two organisations were exposed.

This preparatory phase in the training did not fully fill its role. It proved to be not efficient to send the CBT to the controllers without a previous explanation. A prior phase of introduction would have been necessary to present the CBT to the controllers in order to explain its content, its purpose and the way to use it. Most of the controllers felt discouraged facing alone the application. Besides, some of them did not have the necessary equipment at their disposal to read the CBT. Likewise, they also reported that, without knowing the PD/3 system, the Handbook alone proved to be hard to read and seemed not to be sufficient to give a good and comprehensive representation of it.

2.5 TRAINING COURSE

The training course was conducted as a six-day training course, in advance of the measured trials. The first day consisted of a presentation of the PD/3 concept and experimental objectives, as well as an introduction to the simulated airspace. The second day was devoted to practical courses on the Baseline environment. The following days were devoted to practical courses on the Advanced environment. Day three and day four morning were sessions on the standalone system using exercises without pseudo-pilots. Day four afternoon and day five were sessions on the full linked system with the presence of pseudo-pilots. The feeder positions were also introduced as well as TLX (Task Load indeX) presentation. The last day consisted of a general revision, questionnaires and training run.

In brief, the timetable for the six days training course was as follow:

Monday	To all controllers: Presentation of CENA. Presentation of PHARE. Presentation of the PD/3 concept (mean principles). Presentation of the PD/3 concept (Departure procedure) // Presentation of the PD/3 concept (ETMA and En route procedure). Presentation of the experimental environment and objectives. Visit of the buildings and simulation room. Introduction to the simulated airspace structure (I).
Tuesday	Oral Course on each sector : General presentation of the positions (HMI, telephones...). General presentation of the Baseline HMI (radar labels, Sector Inbound Lists, ...). Radar image module ¹ on the Baseline environment (SIL and Radar labels). Practical Course on each sector : Baseline tools module (Vertical Aid Window, Conflict Risk Display, Message In Window and Message Out Window).
Wednesday	Advanced Tools modules. To the concerned controllers only : Presentation of the specific ETMA and En Route advanced tools // Presentation of the specific Departure advanced tools (Departure Manager). Activity Predictor Display/DM module.
Thursday	APD/DM module. Presentation of the Trajectory Editor and Problem Solver/Trajectory Support Tool logic (I). TEPS module. Presentation of the TEPS/TST logic (II). TEPS module. Questions session.
Friday	TEPS module. Presentation of the feeder positions. Presentation of TLX. Questions session.
Monday	General revision. Introduction to the simulated airspace rules (II). Training Run. Questions session.

Overall presentation of PD/3 concepts

First day training was devoted to the introduction of PHARE / PD/3 concepts, the experimental environment and objectives, the explanation on the Baseline and Advanced organisations differences and the airspace structure and rules.

Explanation of the simulated airspace structure and rules

The controllers were taught the airspace to control, i.e. maps, control rules, specificity's, neighbouring sectors. They were provided with the following information :

- maps, Letter of Agreement (LoA), etc.,
- traffic samples,
- etc...

Practice sessions

These presentations were followed by oral and practical courses. The courses were divided into two parts :

- a theoretical course with the use of slides,
- immediately followed by practical application on the standalone or linked system of what had just been presented.

¹ Module = slides + exercises

Every morning, before each new training session, the trainers checked, thanks to a questionnaire, if the controllers still remembered and understood the previous lessons.

Quick reference guides were used such as :

- paper copy of the airspace structure (on position) ;
- frequencies (on position) ;
- radar label states and fields definition ;
- constraint points definition and figures ;
- working method for each role.

The standalone system

After the presentation of the mock up, directive exercises were proposed on the standalone system in order to learn the procedures and the sharing of the tasks. The standalone system is a simulation environment based on the PD/3 system. It allowed the participants to learn and practice the essential features of the PD/3 PHARE Advanced Tools (PATs) and GHMI self-paced. There was a standalone system for each controller working position (CWP). Each controller worked within a specific sector, having to learn two Controller Working Positions. No pseudo-pilots were needed until sessions on negotiation procedures began. One day of training was needed for the Baseline organisation whereas the rest of the training was dedicated to the Advanced organisation.

The linked system

The linked system was the full simulation environment as in the final demonstrations. The skill for using the PD/3 system was completed and speeded-up to a required level, including co-ordination and negotiation procedures. The fourth day training, the pseudo-pilots were present and trained before the training run on negotiation procedures.

Evaluation methods were presented to the controllers the day before the training run and put in practice at the end of the training run. Specific care was taken, especially for TLX, to the full understanding of the factors definition and the evaluation scale. A paper explanation of the ISA (Instantaneous Self Assessment) and TLX methods was supplied. A paper copy of the TLX category descriptions was available for the controllers to refer to as they completed the questionnaire.

3. PILOT PHASE

3.1 INTRODUCTION

The Pilot Phase took place from March 16th to March 27th at CENA Athis-Mons.

Preparatory documents were sent prior to the controllers :

- a letter of introduction ;
- a general introduction to PHARE and PD/3 ;
- a general description of the controller's role et tasks (extracted from the OSD, version 2.2, February 1997) ;
- notes relative to the conditions of the evaluation of the PD/3 experiment ;
- the Pilot Phase time table ;
- a pre-questionnaire aiming at gathering some information about the controllers, notably their experiment in the ATC and their potential acquaintance with the use of computers in general.

3.1.1 Instructional staff

The Training Team was composed by :

- 3 human factors experts ;
- 1 expert in airspace structure and rules ;
- 3 experts in different fields (concepts, HMI, tools) ;
- 2 controllers as coaches during the first week ;
- 2 instructors for the Pseudo-Pilots.

The assistance of experienced controllers and technical trainers having a thorough knowledge of the system allowed to satisfy the controllers' technical and operational questions and concerns.

3.1.2 Controller subjects

9 controllers from France, Romania and USA (2 Departure, 2 ETMA, 2 En-Route, 3 feeders) attended this general rehearsal of the PD/3 experiment.

The controllers who attended the Pilot Phase were qualified and fully aware of what was going on in ATM field.

The controllers selected all had experience in the mouse input device for months (for one controller) or years. They all used a personal computer at home or at least at work. Three controllers had some knowledge about the data-link concept.

3.1.3 Equipment / Material

During the Pilot Phase, the Training Team had at their disposal :

- formal presentations ;
- standalone system ;
- full linked system.

The Computer Based Training was not yet available at this time.

3.2 PROGRESS

3.2.1 The system

Regarding the equipment, the use of the standalone system proved to be efficient and practical. It was a light system, easy to operate and quite faithful to the linked system at an HMI level.

With the full linked system, we benefited from a flexible platform notably allowing hot restart of quite every part. There was the ability to downsize the platform if needed. The warm up proved to be stable and reliable.

3.2.2 The training course

The sequence of theoretical / practical courses proved to be quite efficient. The directive sessions focusing on specific part of the tools were successfully led. The controllers were guided on a smooth progression towards the system.

3.3 FINDINGS OF PILOT PHASE

Regarding the theoretical and technical presentations of concepts and tools, it appeared necessary to emphasise on practical differences between current CWP, tools and method compared to the PD3 system.

The Training Team agreed that there was too much theory at a too detailed level during the first 2 days and decided to limit the theoretical level during the formal presentations (trajectory type, trajectory editing, constraint coding...) and only to focus on what was essential. It was found important to particularly insist on some major topics :

- label action through menu Vs TEPS ;
- validate function of the TST Vs register function ;
- how to edit a vertical profile, meaning behind vertical constraint ;
- how to solve conflicts ;
- Time constraint Vs Speed instruction ;
- explanation on why the decision was taken not to use speed neither rate of Climb/Descent but 4D constraint in time level and space ;
- Release function Vs Transfer function ;
- system limitation and how to cope with ;
- practice on editing procedure 2, how datalink and co-ordination actually work together.

The controllers suggested they could have received a more detailed presentation on :

- Formalised Clearance function Vs negotiation ;
- how Frequency Change work at an HMI level ;
- airspace, rules, LoA, behaviour of adjacent sectors.

The Training Team also decided to organise the training in order to switch quite soon to practice (second day) and then if questions raised, to organise small courses on purpose.

Regarding the practical courses, it was found that each lesson should have a precise goal so that the controllers could know whether they caught the essential point. Small

briefings should be organised each time it would be necessary. A dedicated room should be available for that.

One particular finding was that the standalone session had to be carefully led. The controllers must have a precise task to accomplish. The instructors should not let them too much possibility to look around and escape from the purpose of the lesson. They also should explain carefully the differences between the standalone and the full linked systems. Finally, they should avoid putting the controllers in a situation of control.

Regarding the adjacent sectors (feeders), the Training Team found that their role had to be defined more precisely with the help of script of nominal behaviour and script of actions which could be performed.

The role of Pseudo-Pilot had to be defined more precisely. The Pseudo-Pilots also needed to have an introduction to the general goal of the PD3 experiment. They actually are pilots and can provide an interesting feedback. As they were to intervene (Pilot Request), it was necessary to fully inform them about the rules of the experiments and the role they had to play in it.

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4. MAIN TRAINING AND TRIALS PHASES

4.1 INTRODUCTION

A full five day course was run plus one day for refresher training and two training runs.

Each controller was provided with their own training course support (loose-leaf binder). It was completed at the start of each course. The training support contained the following presentations and courses :

- PD/3 operational concepts ;
- space model ;
- PD/3 sectorisation ;
- trajectory management ;
- Baseline environment ;
- Advanced tools.

4.1.1 Instructional staff

The Training Team was composed by :

- 3 human factors experts ;
- 1 expert in airspace structure and rules ;
- 3 experts in different fields (concepts, HMI, tools) ;
- 2 controllers as coaches during the first week ;
- 2 instructors for the Pseudo-Pilots.

There was one instructor (human factors expert) per controller working position. For the Departure position, one instructor for two controllers. For the ETMA position, one instructor for three controllers. For the En Route position, one instructor for four controllers. Given the previously established requirement (during the Pilot Phase) of one instructor at least for two controllers, it was found necessary to assist the instructors of ETMA and En Route positions by some Technical Team members from CENA Toulouse.

4.1.2 Controller subjects

The two Main Phase trials for PD/3 were carried out over 2 periods of 3 weeks with 9 controllers participating in each period. A total number of 18 controllers were made available by the following organisations:

Country	Organisation	Number of participants
France	ADP Roissy	2
France	ADP Orly	2
France	CRNA/E	1
France	CRNA/SO	2
France	CRNA/SE	4
France	CRNA/N	3
USA	FAA	1
Germany	DFS	1
Romania	ROMATSA	2

The controllers who attended the Main Phases were qualified and fully aware of what was going on in ATM field.

The majority of the controllers selected had experience in the mouse input device for years. One controller only had one month experience and three other ones never used a mouse. The experienced controllers all used a personal computer at home or at work. Two of them, though experienced, did not use Personal Computer neither at home nor at work. One controller already had some knowledge about the datalink concept.

4.1.3 Equipment / Material

During the Main Phases, the Training Team had at their disposal :

- Computer Based Training ;
- formal presentations ;
- standalone system ;
- full linked system.

4.2 PROGRESS

4.2.1 The system

The standalone and the full linked system were used as in the Pilot Phase training (see Chapter 3.2.1).

4.2.2 The training course

The execution of all the courses proceeded according to the plans. As the Baseline environment was not ready on time for the first Main Phase, the order of the courses was simply inverted, starting with the Advanced Organisation system. For the second Main Phase, the order was respected. The training on the Baseline environment proved to be better in the second Main Phase, because the Training Team had time to

train on the Baseline system whereas for the first Main Phase, they practically discovered it with the controllers.

Following the findings of the Pilot Phase, the next recommendations were applied :

- The training was structured in order to switch to practice as soon as the second day. A dedicated room was available for the small briefings that were organised on purpose when questions raised on specific subjects.
- Regarding the practical courses, a precise goal was defined for each lesson so that the controllers could know whether they caught the essential point.
- The standalone session was carefully led. The controllers had a precise task to accomplish and the instructors took care of not letting them escaping from the purpose of the lesson.
- Regarding the adjacent sectors (feeders), the role of the controllers was precisely defined with the help of script of nominal behaviour and script of actions which could be performed.
- The Pseudo-Pilot had an introduction to the general goal of the PD3 experiment. Their role was also more precisely defined so that they were able to provide an interesting feedback.

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5. RESULTS OF TRAINING

5.1 INTRODUCTION

The training ensured that the controllers were able to work with the PD/3 system and had a good level of understanding of the concepts involved in PD/3.

The following sections detail the results of the training. These fall into two categories, those observations of the Training Team made during the courses and those from the questionnaire.

5.2 TRAINING TEAM OBSERVATIONS

Thanks to the organisation and intensity of the training, the Training Team succeeded in meeting the objectives of the course. The controllers were generally extremely interested in the new concept, the new HMI and the technical aspects of the system. They achieved a good level of skill and appropriation of the concepts and the tools.

5.3 QUESTIONNAIRE

Some questions regarding the training course were asked in the frame of a common questionnaire filled up by the controllers at the end of the PD/3 experiment. These questions, aiming at gathering the controllers' opinion of the course, concerned their feeling about the training on :

- airspace and route structure ;
- HMI tools and functions ;
- controllers' role ;
- feeder position ;
- use of ISA ;
- TLX questionnaire.

The controllers had the general feeling they were provided with enough training on the sharing of tasks as well as on the HMI tools and functions. They would have liked to have further training on the airspace and route structure.

Among the tools and functions they had to learn, the controllers encountered some difficulties with the use of the TEPS and the management of the TST. They generally complained they worked too late on the real system compared with the time they spent on the standalone system. Regarding the complexity of the co-ordination / negotiation process, they would have like to be trained sooner on the full linked system in order to well understand the logic of the exchanges and their operational implications.

The training on the feeder position was felt easy and sufficient. The controllers often took advantage of the time they had notably to continue to train with the functions of edition (TEPS).

The training on TLX was felt as sufficient. Nevertheless, TLX questionnaire raised some questions about the definition of some terms (factors). Notably, the difference between "effort expended" and "physical demand" and "mental demand" was not clear. Along the trial, some controllers had to ask the trainers for the recall of some definitions they had difficulty to remember or understand.

The analysis of the results is fully described in Annex D.

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6. CONCLUSIONS AND RECOMMENDATIONS

The CENA PD/3 training programme succeeded in meeting the training objectives. It was found necessary to have instructors who are capable to answer in a competent manner all operational and technical questions and concerns of the controllers.

Recommendations:

- As much as possible, for an efficient training during the practical courses, a very limited set of controllers for one instructor. Two controllers maximum per instructor. Ideally, one instructor for one controller.
- More training for some controllers to get used to the specific TMA airspace and rules.
- Additional lessons in Personal Computer handling (use of the mouse, menus, clicking ...) for the controllers who are not familiar with it.
- Courses providing a combination of operational and technical expertise.