COOP-CT-2006-031253
PROTECC
PROTECTED CARDAN CHAIN IN INDUSTRIAL FLOOR CONVEYORS

CO-OPERATIVE RESEARCH PROJECT

Final review activity report

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All Partners

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Contents

Publishable executive summary 3
1. Project objectives and major achievements during entire project 5
2. Work package progress of the period 6
2.1 Work package A: Performance and design specification for the ProTECC system 6
2.2 Work package B: Development of ProTECC prototype 8
2.3 Work package C: System integration 10
2.4 Work package D: Field tests and system evaluation 11
3. Consortium management 15
4. Other issues 15
4.1 Contribution of the RTD performer to assist the SME in solving their problems 15
4.2 Balance of work / resources 16
Annex I: 19

Publishable executive summary

Powder coating is one of the most favourite technologies to apply coatings to metallic surfaces all around the world due to its fantastic benefits of having good adhesion, high weariness resistance; it can be recovered relatively easy and is therefore known as environmental friendly.
However, powder coating lines have been developed only for the use with chain overhead conveyors (COC) and floor skid conveyors (FSC), which are transporting the parts to be coated. But a significant big part of the industry applying coatings in their production can not use COC and FSC systems because of to heavy weight of the product (COC systems are becoming to expensive due necessary steel constructions) or abrasion (e.g. from overhead chains, bearings) which may fall on the freshly painted parts. FSC systems are used only for transporting large and heavy products (e.g. car bodies) as they are expensive and space demanding. Standard floor conveyors can not be used in powder cabins because the electrostatic loaded powder would get into the chain of the conveyor and would quickly damage the chain and consequently to entire conveyor.
This leaves many companies from mainly the automotive industry with the problem that they can not (or only with very complicate and expensive modifications to standard floor conveyors) use powder coatings for surface treatment and have to stick to less environmental liquid coatings.

The aim of the ProTECC project is to develop a novel chain floor conveyor system for powder application. CFC systems consist of a chain track with an integrated cardan chain running through the track. The chain in some cases also is equipped with pusher dogs into which the anchor of the carrier is hooked. The chain transports the loaded carrier throughout the entire production line.

The ProTECC system to be developed will be a totally new and special track system, which will be designed as following:

- Double skinned track to implement a wind curtain to stop any powder getting to the chain
- Application of an electrically charge to the out track to stop the powder sticking to the track and to allow for easy and quick cleaning

The prime industrial and economically objectives of the entire project are:

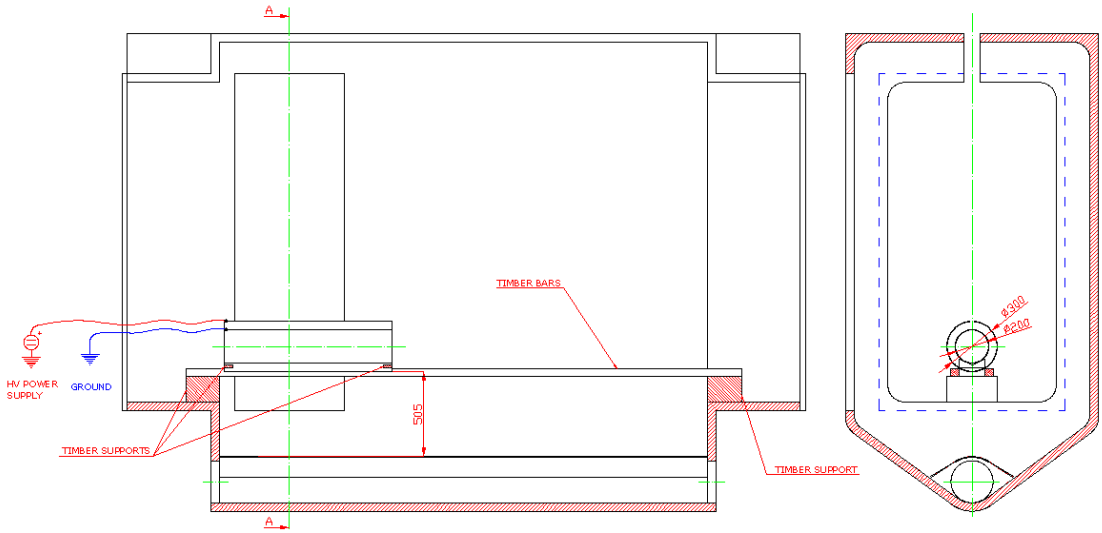
- Development of a novel technique that will enable the replacement of traditional liquid painting technology by a more environmental friendly one
- Up to 95% recovery of the powder overspray for reuse
- Increased productivity due to reduction of costs inherent to the replacement of liquid coating technology (e.g. less waste disposal cost)
- Quick (<15 min) change over between two different colours

However, the main tasks for the first period of the project (month 1-12) were:

a) Specification of end-user requirements
This was mainly done by observing data from the German partner and end-user NW Oberflächenschutz GmbH. NWO is currently using an overhead handrail/chain combination for transportation of the product through the painting line. Furthermore BKM was contacting potential users of the ProTECC developments to gather information about existing coating lines.

b) Specification of the system
The ProTECC system was specified with respect to materials, way of charging the outer skin of the system, how to install and control the air curtain etc. Also the dimensions for the prototype were specified according to circumstances at NWO.

c) Investigation of interference
Already started during the first 5 month of the project was the analysis of interferences, which the ProTECC system installed to a powder coating cabinet, could have. The plan for building up a prototype according to the proposals decided to be developed within technical specification was started. The first drawings for prototype construction as well as the plan for first experiment series was started to be generated. The picture below shows the pre-prototype drawing, which was used to begin the development of the prototype and determine the interferences of the ProTECC system



In parallel a mathematically/electrically model was developed, explaining with a theoretically approach what was going to be expected during tests by means of MEF.

d) Mathematical model
A mathematically/electrically model was developed, simulation with a theoretically approach the effectiveness of the electrical charge being applied to the test equipment used for the investigations of interference.
In parallel the control system for applying the electrical load was specified according to the simulating results from the mathematical model. Main aspects of the control system are unique application of chosen voltage and the safety of humans.

e) Development of the ProTECC prototype
The prototype developed for the interference tests will not be the final version. However the final version including all technological innovations is still under design.

A successful ProTECC development will have several impact of different nature as:

- Improved competitiveness
  On one had fabricators of conveying systems will gain a new product that can be sold into the automotive industry for painting lines.

On the other hand end-user of the ProTECC system will benefit from the prime industrial and economically objectives as shown above.

- Environmental aspects
  The ProTECC system will enable many companies in the automotive industry to change from the use of liquid coatings to powder coating which are far more environmental friendly, due to the fact that the overspray can be collected for reuse.
- Quality of live, health, safety
  Concerning healthy working conditions and/or quality of live in general, the use of the ProTECC system will contribute in the way of reducing overspray waste, which won't exist any longer. Also the cleaning of powder cabins is far easier for the workforce where not already possible automatically.
- Increase of skill level
  Last but not least the ProTECC system will increase the skill level for the fabricators of the system as well as for the operator using and running it.

1. Project objectives and major achievements during entire project

Along the first 6 months of the project WPA and WPB were involved, two deliverables were generated and one milestone achieved. The objectives planned for the first semester of the project were fully reached.

Belonging to WPA, end-user requirements so as technical and design specifications for the ProTECC system were defined, involving NWO, BKM, MMS, JCB, CRIC and CENTIV. In addition after suggestions of potential solutions for the different ProTECC systems, some of them were chosen for further development in WPB. As result of WPA, deliverable 01 "Specification sheet of end-users' requirements" and deliverable 02 "Entire technical specification catalogue for ProTECC" were handed in as scheduled.

Regarding to WPB, the starting phase of the development of ProTECC system was initiated. The main task started to be performed within WPB was task B1 "Investigation of interference between ProTECC and powder spray booth". With the aim of developing the proposals decided in WPA, the drawings for building the first ProTECC prototype and the plan for the first experiment series were prepared. Partners involved within WPB during first semester of the project are JCB, BKM, UFS, NWO, CRIC and CENTIV.

During the month 6 to 12 of the project the full focus was on WPB. Two of the three planned deliverables were generated while the milestone was only achieved in a pre-prototype status. The objectives planned for the second semester of the project were not fully reached due to the fact that the tests for the investigation of interferences took longer than expected.

Regarding WPB, the starting phase of the development of ProTECC system was initiated. The main task started to be performed within WPB was task B1 "Investigation of interference between ProTECC and powder spray booth". With the aim of developing the proposals decided in WPA, the drawings for building the first ProTECC prototype and the plan for the first experiment series were prepared. All interference tests took place at the facilities of partner (end-user) NWO. Responsible for the design and the manufacturing have been partners UFS, JCB, Centiv and CRIC.

Another important part of WPB was the development of a mathematical/electrical model, which was used for simulating the effectiveness and efficiency of the electrical load, which was planned to be applied to the pre-prototype for interference tests.

The final aim of WPB was the development of the ProTECC track (prototype). Since the tests for investigation of interference took longer than expected this part of the work package B is still ongoing.

During the month 12 to 18 of the project the full focus was on WPC. All three deliverables of work package C were generated almost in time (D08 delayed by one month). The milestone of the period, however, was fully achieved with the same delay. The objectives planned for the third semester of the project were fully reached within the scheduled time and even a little faster; however, due to the delay from the first year, there was still a minor delay to the objectives of the third period. This delay will have no impact to the last quarter of the project, since some of the work of the last 6 month was already started in parallel, in order to meet the final line of the project.

Regarding WPC, the assembly of the ProTECC system was initiated after all components were shipped and had arrived at the facilities of BKM. Some items as e.g. the air knifes needed purchasing and were slightly critical with the delivery time. However, the assembly of the entire system was done within scheduled time. A detailed description of the assembly activities is documented in deliverable D06.

Another important part of WPC was the completion of the control system. This involves the control of the power supply the cover of the ProTECC system including all required safety aspects, as well as the PLC as the interface between the ProTECC system and all other equipment of a powder coating line.

The final aim of WPC was the functional testing of the ProTECC prototype and the debugging of failures in the system. The functional tests were performed at BKM facilities and are described in detail in deliverable D08.

During the last 6 month the tasks of project work package D will put to action. For this a detailed plan for the tests at NWOs facilities will be developed. The main involved partners (NWO, BKM and JCB) will agree on necessary settings for the tests. Also part of the plan for testing will be a pre determined schedule for the test, (which NWO must agree on) showing the estimated down time of the production.

The soon a date for testing has been agreed on, the ProTECC prototype will be taken to NWO integration and field testing. All project partners will be invited for the tests with a two weeks notice.

After field testing on of the most important objectives of the project will be the test data evaluation period followed by an assessment of the ProTECC prototype. Any drawbacks of the system but as well any further potential for improvements will be discussed by all partners. An estimation of the projects success will be laid out.

BKM as the coordinator and the main interested partner in the results and the success of the project will than contact industries potentially interested in ProTECC, will develop and produce a project advertisement flyer and will organise public released in well known journals of the powder coating market.

2. Work package progress of the period

2.1 Work package A: Performance and design specification for the ProTECC system

This work package defined the necessary performance and the design of the ProTECC system according to the end-users' requirements.

2.1.1 Objectives and starting point of work at the beginning of the period

The objectives of WPA are the following:

- Produce specification of end user requirements
- Define technical operating parameters of system

- Establish control system requirements

2.1.2 Progress towards objectives

Work package tasks worked on comparing to the planned objectives are detailed in following points:

- Task A1 "Specification of end users requirements"

  Partners Centiv with the support of BKM, MMS and NWO brought together the requirements with regard to the use of the equipment, which includes topics like production capacity, size of products, required film thickness, number of different colours, changes of colour per shift, as well as, technical parameter as e.g. electrically load to powder, speed of flow in spray booth etc. A questionnaire was prepared for circulating around coating industrial companies in order to gather first hand information. D01 was generated as an outcome of this task.

- Task A2 "Technical specification"

  Within this task BKM, UFS and CENTIV defined the technical parameters of the system e.g. adaptation to chain floor conveyor, layout of ProTECC components, run parameters, etc. Crucially, all ideas concerning the innovative developments to protect the chain floor conveyor (e.g. air curtains, insulation material, electrically load to track etc.) were listed, specified and discussed. The technical specification sheet D02 was compiled containing a list of proposals decided to be further developed and tested within the research phase in WP B.

- Task A3 "Control system requirements"

  CRIC together with JCB and UFS specified the control and monitoring system, which controls the run parameter. This issue was only discussed since there was no system developed at that moment.

2.1.3 Deviations from the work programme and corrective actions

The only deviation comparing with the work program happened in task A3 as explained in last point. It was agreed among the responsible partners to complete the control specification along the project once the system to be used in ProTECC prototype is already tested. This information will be joined to the deliverable D02 as soon as possible.

2.1.4 List of deliverables

N°	Deliverable name	Wp N°	Date due	Actual/Forecast delivery date	Estimated indicative person-months	Used indicative person-months	Lead contractor
D01	Specification sheet of end users' requirements	A	01.12.06	08.01.07	4.5	4.3	CENTIV
D02	Entire technical specification catalogue for ProTECC	A	01.01.07	08.01.07	4	5.07	CENTIV

2.1.5 List of milestones

N°	Milestone name	Wp N°	Date due	Actual/Forecast delivery date	Lead contractor

M01	Established end-users' requirements and ProTECC system specification	A	01.01.06	08.01.07	CENTIV

2.2 Work package B: Development of ProTECC prototype

2.2.1 Objectives and starting point of work at the beginning of the period

The starting point of this work package was the end users and technical requirements coming from the successful accomplishment of WPA. The objectives for this second work package which will finish in the second semester of the project are the following:

- Investigation on possible interference between ProTECC track and a standard powder spray booth
- Development of a mathematical model
- Development of ProTECC track
- Develop integrated ProTECC sensor/control system

2.2.2 Progress towards objectives

Work package tasks worked on comparing to the planned objectives are detailed in following points:

- Task B1 "Investigation of interference"

CENTIV with the support of BKM and UFS was responsible for the development of the mechanical parts of a test unit (pre-prototype). One the other hand CRIC with support of JCB was in charge to develop the electrical supply system. Both parts were assembled at NWO's facilities to undertake investigations of interferences.
Since the first set of experiments (May ´07) did not give all required information, a second set of tests took place in July ´07.
The information from both tests and the results from task B2 were taken to start the development of the ProTECC track (task B3). However B3 is still under development.

- Task B2 "Mathematical model"

CRIC was performing the mathematical/electrical model of the loaded cover by means of FEM, in order to get a functional anti adhesion of any powder particles on the electrically loaded cover of the ProTECC system. Also, this model will be useful to study in detail the electrical field surrounding the cover as well as the interaction of said electrical field with the grounded booth. The final outcome of this task is a theoretical simulation of the effects using an electrically loaded cover in a powder spray cabin.

- Task B3 "Development of ProTECC track"

BKM with the support of UFS and CENTIV are leading the development of the chain floor conveyor. This includes the adaptation of the electrically cover of the system, the design and the manufacturing of the wind curtain, the introduction of mechanical seals, and last but not least the manufacturing of a cardan chain, which will be used inside the track. These issues have been started to be managed at the same time as the task B1, "investigation of the interference", preparing the plan for the first experiment series and the drawings of the prototype. However, this task is still in the phase of design. It is planned to have the design completed in October and all parts manufactured within November.

- Task B4 "Development of sensor/control system"

CRIC with the support of JCB are the partners in charge for the development of the control software and sensor system, which is required to sense and monitor the load of the electrical cover, to monitor that no unwanted sparks can be created by the system, and also to control the correct airflow for the creation of the wind curtain. For the time being control systems of both power suppliers used for the experiments were developed, however the final sensor system is not completed yet and it will be ready as soon as the completion of task B3 when the ProTECC track will be completed. A computer simulation of the system, which can simulate all possible emergency situations of the system, will be developed, to progress the optimisation of the sensor/control system. The sensor/control system is planned to be designed in November and manufactured in December.

2.2.3 Deviations from the work programme and corrective actions

As mentioned there is a little delay of about 1-2 month concerning the development of the ProTECC cover. The reason for the delay comes from the performance of two experiment series which takes more time that

2.2.4 List of deliverables

N°	Deliverable name	Wp N°	Date due	Actual/ Forecast delivery date	Estimated indicative person-months	Used indicative person-months	Lead contractor
D03	Risk information sheet about possible interference between ProTECC and powder spray booth	B	01.10.07	14.09.07	7	7.78	CENTIV
D04	Mathematical model of electrical track loading	B	01.07.07	18.07.07	4	4.26	CRIC
D05	ProTECC components developed	B	01.10.07	30.11.07	13	13.95	CENTIV
D14.1	First progress report	E	01.04.07	19.09.07	0.1	0.1	BKM
D14.2	Second progress report	E	01.10.07	1.10.07	0.1	0.1	BKM

2.2.5 List of milestones

N°	Milestone name	Wp N°	Date due	Actual/Forecast delivery date	Lead contractor
M02	Operational prototype manufactured	B	01.10.07	30.11.07	CENTIV

2.3 Work package C: System integration

2.3.1 Objectives and starting point of work at the beginning of the period

The starting point of this work package was the end users and technical requirements coming from the successful accomplishment of WPA. From the specification the investigation of interference and the development work started and was completed with some delay only in the third period of the project.
The objectives for this third work package were the

- Assembly of the ProTECC system
- Functional testing
- Assessment and optimisation

2.3.2 Progress towards objectives

Work package tasks worked on comparing to the planned objectives are detailed in following points:

- Task C1 "Assembly of ProTECC system"

  CRIC as the leader of this task was responsible that all developed components were sent to the facilities of BKM within the foreseen time. All partners that were responsible for shipment and/or purchasing of any items (CENTIV: PLC and air knifes; MMS: brackets for later installation; CRIC/JCB: 'black-box'; UFS: isolation material; BKM: cover, track, chain) did send their equipment of assembling to BKM. The process of assembling is described in detail in deliverable D06 and was successfully completed on the 7th of March 2008.

- Task C2 "Functional testing"

  The functional testing was done in two steps. CRIC was performing some prior tests to the assembly in their own electrical department. These tests were only concerning the power supply/control unit (black box) and required some special measuring equipment. The second step of functional testing performed at BKM included aspects as e.g. electrical supply, air curtain tests, efficiency of insulation etc.
  At the end of the third project period these functional tests were still ongoing. However, functions tested till the end of the third semester were all having good results.
  The complete functional testing is described in deliverables D07 (control unit) and D08 (entire ProTECC system).

- Task C3 "Assessment and optimisation"

  During assembly and functional testing of the ProTECC system CRIC and JCB for the 'black box' and BKM and Centiv for the remaining equipment were modifying and optimising the ProTECC components when required. However, it was found that only minor modification were necessary to achieve full function of the system. These modifications (position of drillings, broken cable etc.) were, when applicable, also changed in the design for the equipment.

  Since the functional testing was not completed before the end of month 18 the assessment and optimisation will also continue. The complete assessment table will be available in deliverable D08.

2.3.3 Deviations from the work programme and corrective actions

Due to the delay from the first project year, also the assembly and consequently the functional tests were delayed. This, however, will have no impact on the last quarter (onsite testing) of the project, since some of that work was started in parallel to remaining tasks from WP3.

2.3.4 List of deliverables

N°	Deliverable name	WP N°	Date due	Actual/ Forecast delivery date	Estimated indicative person-months	Used indicative person-months	Lead contractor
D06	ProTECC system assembled	C	31.12.07	07.03.08	6	6.80	CRIC
D07	Control protocol report	C	29.02.07	04.02.08	4	4.33	CRIC
D08	Functional ProTECC prototype	C	31.03.08	23.05.08	8	8.25	BKM
D14.3	Third progress report	E	01.04.08	23.05.08	0.1	0.1	BKM

2.3.5 List of milestones

N°	Milestone name	Wp N°	Date due	Actual/Forecast delivery date	Lead contractor
M03	Nonconformities and system anomalies identified and rectified	C	01.04.03	23.05.07	CENTIV

2.4 Work package D: Field tests and system evaluation

2.4.1 Objectives and starting point of work at the beginning of the period

The starting point of this work package was the completion of the prototype functional testing and the optimisation. As it was found during functional testing, one electronic part in the 'black box' of the power supply unit failed and needed replacement. The modification was done by CRIC and JCB before the date of field tests. The objectives of the last work package D where than:

- Definition of field test procedures
- Implement field test of ProTECC system
- Evaluate field test results

2.4.2 Progress towards objectives

Work package tasks worked on comparing to the planned objectives are detailed in following points:

- Task D1 "Definition of field test procedures"

  The aim of this task was to define the testing procedures in order to guarantee smooth running of the tests and to minimise the downtime of NWOs production. Therefore the definition was built up from two parts:

  a. Test procedure: A table was developed showing the different settings of the system components and their combinations. It was agreed on to run and test at least four different scenarios.
  b. Time schedule: A 'working on minutes' time table was developed for the duration of testing. The time table started with the arrival, some cold checks, the installation

and ended with the de-installation of the system, highlighting the downtime for NWOs production.

The specification of the field test procedures are shown in deliverable D09.

- Task D2 "Implementation of field-tests at end-users site

The implementation of the field tests took place at the projects end-user site of NWO. The tests were performed following the test procedure from task D1:

- ✓ Partners arrived with the ProTECC equipment at NWOs facilities in the morning unloading the prototype and getting it preinstalled next to the cabin for some cold checks.
- ✓ Then the prototype was taking into the cabin (see pictures in Annex 1, figure 1) and necessary settings were made prior to the first test.
- ✓ Test by test was performed according to the planned test procedure. Another test of interest was added to the planned procedure to investigate any influence between the openings of the prototype and the powder accessing the cover. (Annex 1, figure 2).
- ✓ After completion of all tests the prototype was taken out of the powder cabin again and rearranged for shipment back to the facilities of BKM.

- Task D3 "Test data evaluation"

Test data evaluation started straight after completion of the field tests in order to fix the impressions gained and observation made during the testing. This was important since hardly any results could be measured in terms of number or figures. However, many pictures and a video from the onsite testing will reflect on the observations made.

During evaluation discussions between BKM, CRIC, UFS, NWO and Centiv the following has been issued:

- ✓ Successful and promising results
- ✓ Unsuccessful results
- ✓ Potential for future improvements

It was decided that before the end of the project a new drawing including the potential improvements will be made by BKM and Centiv and that minor modification as e.g. a brush assembly would be integrated into the prototype for showing the idea to potential customers.

It was also decided that BKM will prepare a advertisement flyer in English and German language for promoting the equipment at the end and after the end of the project.

2.4.3 Deviations from the work programme and corrective actions

Due to the delay from the first project year, also the assembly and consequently the functional tests were delayed. Also the planning for the onsite testing was still delayed while the onsite testing and hence the data evaluation took place as planned. However, the consortium would have appreciated some additional time at the end of the project for testing the improvement considered for the future.

2.4.4 List of deliverables

N°	Deliverable name	WP N°	Date due	Actual/ Forecast delivery date	Estimated indicative person-months	Used indicative person-months	Lead contractor
D09	Specification sheet for onsite tests	D	30.04.08	27.06.08	3	3	NWO
D10	Onsite test report	D	31.07.08	11.07.08	9	4.5	CRIC
D11	Final assessment report including data from field tests	D	30.09.08	05.09.08	6	10.5	BKM
D14.4	Fourth progress report	E	30.09.08	13.10.08	0.1	0.1	BKM

2.4.5 List of milestones

N°	Milestone name	Wp N°	Date due	Actual/Forecast delivery date	Lead contractor
M04	Field tested and operating ProTECC prototype	D	30.09.08	30.09.08	BKM

Scheduling of tasks (original plan) – Month 1 to 12

Calendar semester		1st Semester						2nd Semester					
Project month		1	2	3	4	5	6	7	8	9	10	11	12
WPA	Performance and design specification for PROTECC system												
A1	Specification of end-user requirements												
A2	Technical specification												
A3	Control system requirements												
WPB	Development of ProTECC system												
B1	Investigation of interference												
B2	Mathematical model												
B3	Development of ProTECC track												
B4	Development of sensor/control system												

Scheduling of tasks (original plan) – Month 12 to 24

Calendar semester		1st Semester						2nd Semester					
Project month		13	14	15	16	17	18	19	20	21	22	23	24
WPC	Development of ProTECC system												
C1	Assembly of the ProTECC system												
C2	Functional testing												

C3	Assessment and optimisation												
WPD	Field tests and system evaluation												
D1	Definition of field test procedures												
D2	Implementation of field tests												
D3	Test data evaluation												

Scheduling of tasks (update) – Month 1 to 12

Calendar semester		1st Semester						2nd Semester					
Project month		1	2	3	4	5	6	7	8	9	10	11	12
WPA	Performance and design specification for PROTECC system												
A1	Specification of end-user requirements												
A2	Technical specification												
A3	Control system requirements												
WPB	Development of ProTECC system												
B1	Investigation of interference												
B2	Mathematical model												
B3	Development of ProTECC track												
B4	Development of sensor/control system												

Scheduling of tasks (original plan) – Month 12 to 24

Calendar semester		1st Semester						2nd Semester					
Project month		13	14	15	16	17	18	19	20	21	22	23	24
WPC	Development of ProTECC system												
C1	Assembly of the ProTECC system												
C2	Functional testing												
C3	Assessment and optimisation												
WPD	Field tests and system evaluation												
D1	Definition of field test procedures												
D2	Implementation of field tests												
D3	Test data evaluation												

3. Consortium management

The project coordination was performed by the Bremer KettenMontage on a regular basis. The friendly and productive atmosphere within the consortium led to a successful work in different tasks of the project, in particular the close cooperation between the partners working in the same topic. However, the information flow in between the partners was ensured by use of usual media systems.
Beside the normal use of email and Fax a webpage has been installed in the first month of the project (www.protecc.eu), which also is in use for information transfer concerning technical progress as well as management aspects.

A specification meeting was held in Barcelona at the beginning of the project in November 2006, where the objectives of the project, the end-user requirements as well as the technical specification were discussed. Furthermore a detailed plan of action for the first six month was laid down in order to avoid any delays at the beginning of the research work.

To strengthen the personal contact and to guarantee the transfer of project data and knowledge, two other meetings were held at the site of the partner Centiv. These meetings took place in Bremen alongside the first and second series of tests concerning interferences between the ProTECC system and the powder coating cabin of NWO.

In month 12 of the project the mid-term meeting was held at CRIC in Barcelona, where the attending partners were informed about the work performed during the first year of the project. Also the activities of the following 5 month were discussed and finally the up coming management aspects were explained.

During the process of assembling and functional testing only partners BKM and Centiv were coming together for the practical work, while all other partners according to their expertise where contacted for contribution and help by standard communication technologies.

The field testing was planned and organised for the 26th of June 2008. BKM, Centiv, CRIC and NWO performed the tests following the scheduled procedures. After field testing a meeting was held for a first review for test data evaluation.

The last meeting of the project – the final meeting – was held in Bremen, Germany at the facilities of Centiv. The attending partners were informed about the work done in the second year of the projects and the results of field testing. Also all required management aspect for the completion of the project were discussed.

4. Other issues

4.1 Contribution of the RTD performer to assist the SME in solving their problems

The fourth period of the project was characterised by the performance of the tasks regarding WPD. The RTD's of the project CRIC and Centiv, who were the main responsible partners for the development of the ProTECC prototype, were also performing high quality work during the time of field testing, test data evaluation and assessment of the prototype. CRIC and Centiv were supporting mainly BKM and NWO in this period, since the shipment of the prototype started at BKM while the field test took place at NWO.
The table below gives a summarised overview about the work of the RTD performer done for the SME. Detailed information can be found in the deliverables.

	Centiv	CRIC
Task D1: Definition of field test procedures		

• BKM • NWO • UFS • MMS	- Development of the field test procedures in terms of mechanical settings - Development of a schedule for the overall testing period	- Development of the field test procedures in terms of electrical settings
Task D2: Implementation of field tests at end-users site		
• BKM • UFS • NWO • JCB	- Shipment of prototype from BKM to NWO and back - Installation and testing of mechanical ProTECC prototype - Reinstallation after testing	- Installation and testing of electrical ProTECC prototype - Reinstallation after testing
Task D3: Test data evaluation		
All SME	- Working out suggestions for prototype improvements on the mechanical side - Integration of brush assembly - CAD drawing of potential improvements	- Working out suggestions for prototype improvements on the electrical side

4.2 Balance of work / resources

The following tables will give a summarised overview about the balance of work and resources done by each partner:

Partner	Work carried out	Resources made available
BKM	Collecting information from external end-user potentially interested in the ProTECC system	*Personnel*: Engineer, Technician *Material*: Cardan chain + transfer, timber brackets, 2 times outer cover, conveyor track, pneumatically equipment, brush assembly *Subcontracting:* Audit certificate
	Support in the design of the pre-prototype	
	Fabrication and assembly of pre-prototype	
	Support in design of the mechanical parts of the pre-prototype (second series of tests)	
	Manufacture of the mechanical parts of the pre-(second series of tests)	
	Design and fabrication of the brackets for the pre-prototype (second series of tests)	
	Performance of two series of test at NWO's facilities	
	Organisation of assembly at their facilities	
	Support during functional testing	
	Support during onsite testing	
	Contribution to prototype optimisation	
	Development of ProTECC advertisement flyer	
	Management of project	
UFS	Assistance during specification of technical requirements	*Personnel*: Engineer, Technician *Material*: Teflon isolator for pre-prototype, test equipment for air curtain *Subcontracting:* Audit certificate
	Support during design and fabrication of pre-prototype	
	Support during design of the air curtain	
	Support during integration and functional tests of the air curtain	
	Contribution for potential to mechanical improvements of the prototype	

	Supporting project flyer development	
MMS	Support during definition of end-user and technical requirements	*Personnel*: Engineer *Subcontracting:* Audit certificate
	Advise concerning the installation of the pre-prototype of interference tests	
	Advise and support for adapting the installation equipment to the ProTECC system at NWOs facilities	
	Installation advise prior to prototype integration at NWOs facilities	
NWO	Definition of end-user requirements	*Personnel*: Engineer *Material*: Powder for all test series, screws, washer etc. during onsite adaptation *Subcontracting:* Audit certificate
	Support during the design of the of the pre-prototype to be used in their powder cabin	
	Performance of two series of test at NWO's facilities	
	Support during functional testing with main interest on safety aspects	
	Development of onsite tests procedures and for the timing of the tests	
	Host for filed tests	
JCB	Support during technical specification	*Personnel*: Engineer, Technician *Subcontracting:* Audit certificate
	Assistance for the development of the electrical / mathematical model	
	Fabrication of electrical equipment for the pre-prototype	
	Design and fabrication of the power supply for the pre-prototype for the second series of tests	
	Fabrication and shipment of power supply for prototype	
	Support during functional tests of power supply	
	Support during onsite testing	
	Contribution to electrical optimisations	
Centiv	Specification of end-user requirements	*Personnel*: Scientific staff, Technician *Subcontracting*: Professional ProTECC webpage *Material:* Air curtains
	Specification of the technology concerning the mechanical part	
	Design of pre-prototype (first and second series of tests)	
	Support during fabrication of pre-prototype (first and second series of tests)	
	Performance of two series of test at NWO's facilities	
	Mechanical assembly of prototype and follow up of required modifications	
	Execution of functional test at BKM and support during assessment reporting	
	Supporting the development of test procedures	
	Prototype shipment and execution of field tests	
	Assessment of test data and redesign of mechanical parts of the prototype	
	Dissemination activities through updating ProTECC webpage	
CRIC	Specification of the technology concerning the electrical part	*Personnel*: Scientific staff *Material*: Transformer, Power supply/control unit
	Development of electrical/mathematical model	

	Support during fabrication of electrical supply unit for pre-prototype	
	Performance of two series of test at NWO's facilities	
	Support during assembly of prototype	
	Functional tests of power supply/control unit at their electrically department	
	Support during field testing	
	Support during test data evaluation	

Annex I:

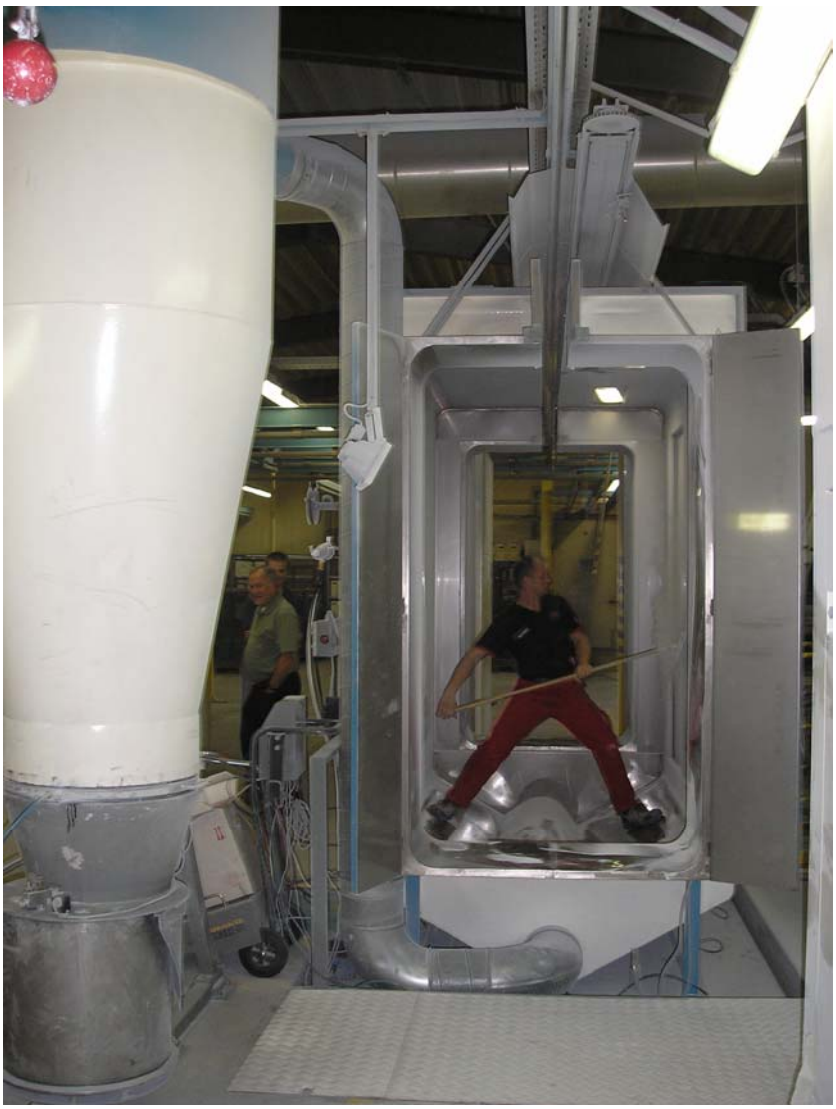


Fig. 1: Automatic spray cabin at NWO

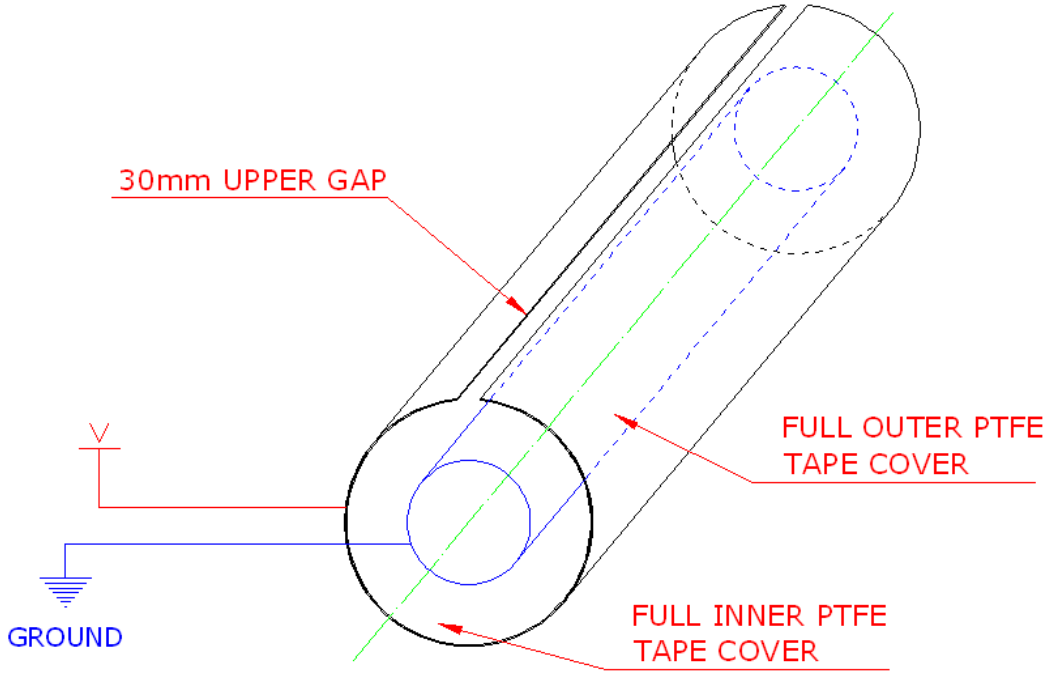


Fig. 2: Pre prototype3D CAD drawing

Fig. 3: Pre-prototype built ready for experiments

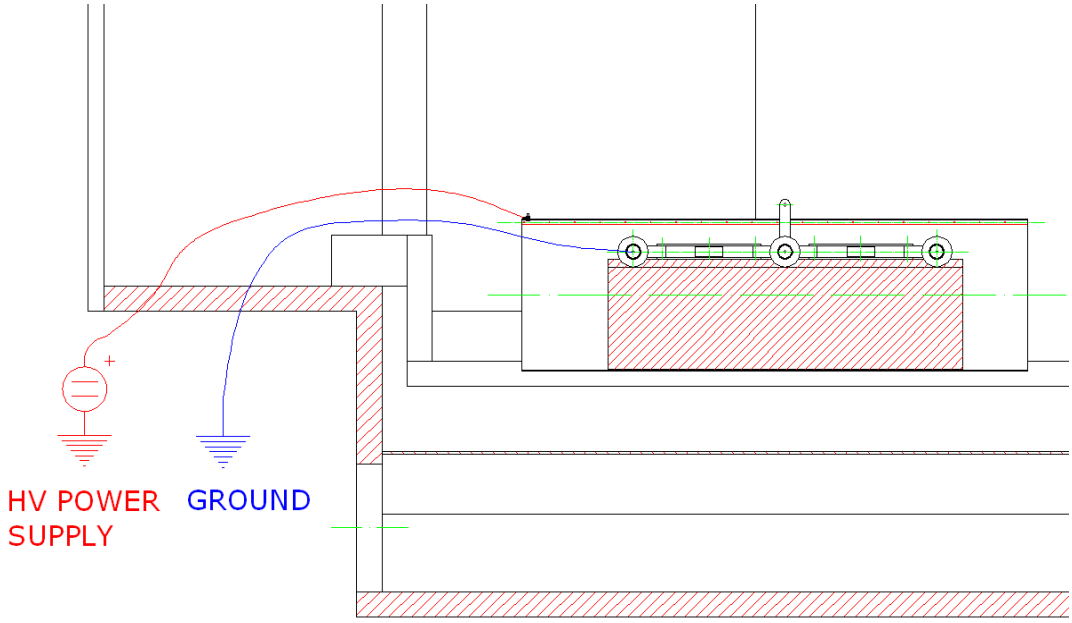


Fig. 4: ProTECC prototype installation draft

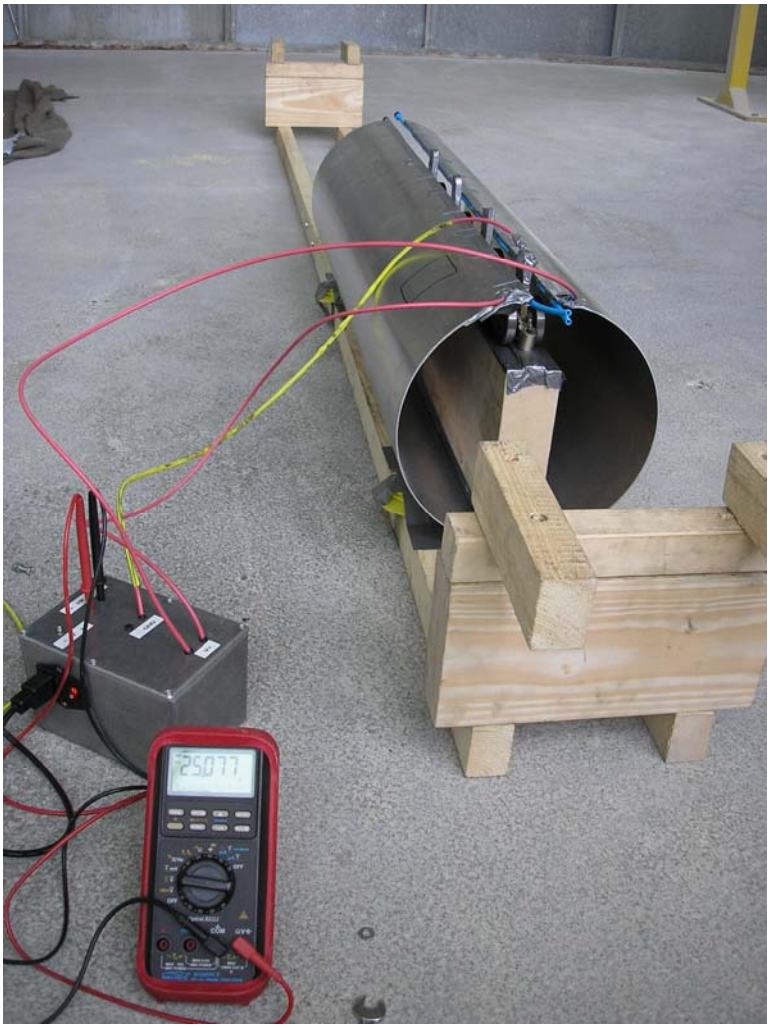


Fig. 5: ProTECC prototype ready for experiment

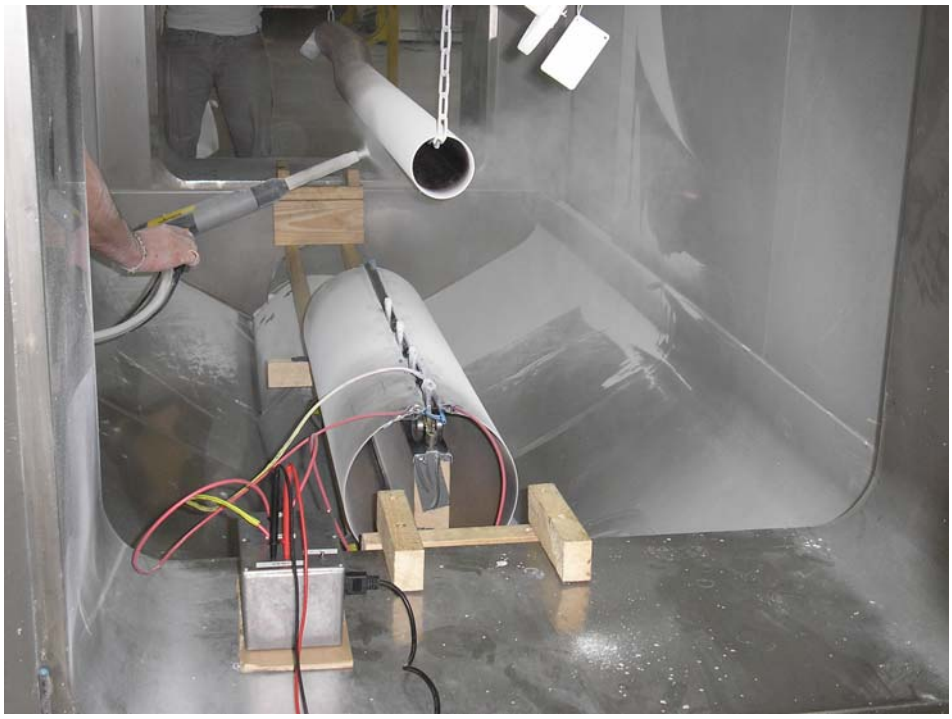


Fig. 6: Experiments inside the cabin with manual Tribo gun

Fig. 7: Experiments inside the cabin with automatic Tribo guns

Fig. 8: ProTECC Power supply / Control unit

Fig. 9: ProTECC prototype with pressed air supply

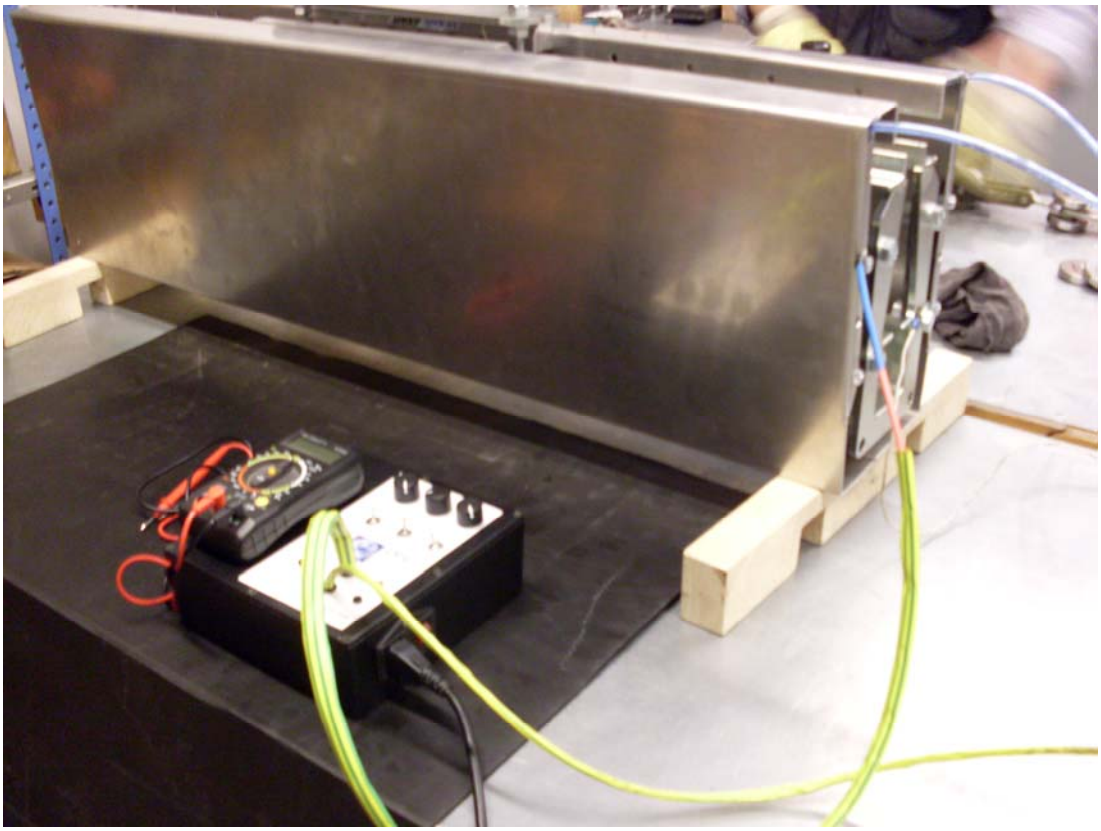


Fig. 10: ProTECC setup for functional tests

Fig. 11: ProTECC prototype integrated to powder cabin

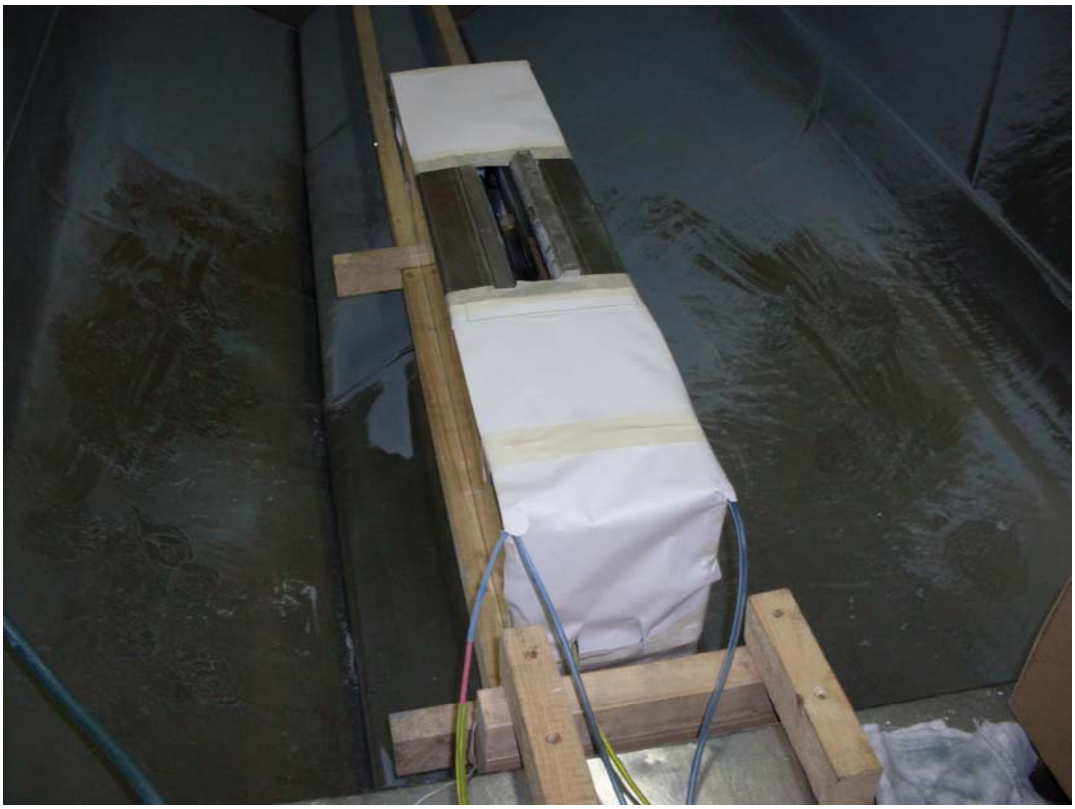


Fig.12: Added test No. 5

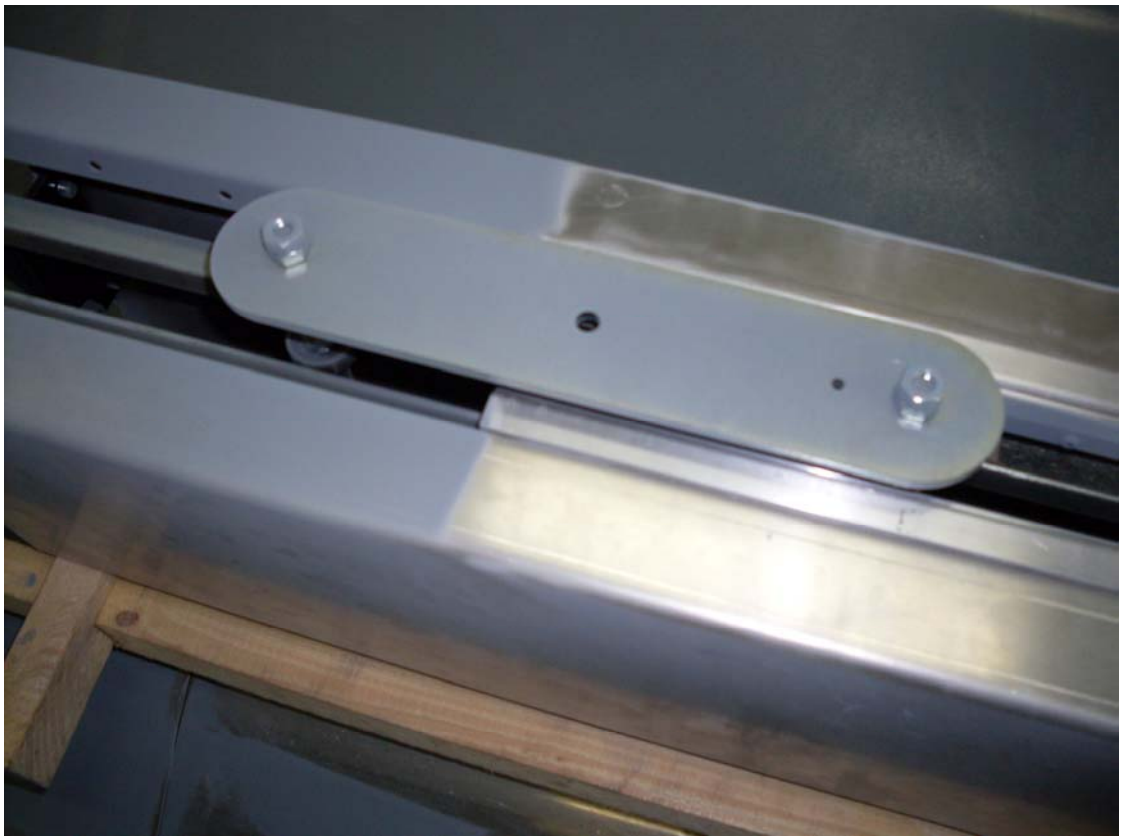


Fig. 13: Test result wind curtain

Fig. 14: Preparation of onsite tests at NWOs facilities

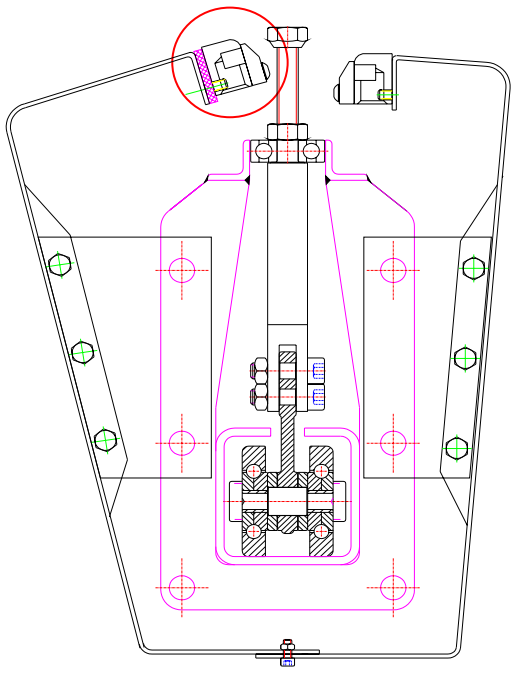


Fig. 15: Modified CAD comparing improvements to original