



**AFCAP/ETH/075/A**

**Training Programme for Improved Performance of Surface Treatments in Ethiopia**

## **FINAL PROJECT REPORT**

**Ethiopian Roads Authority**

*November 2012*

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## **EXECUTIVE SUMMARY**

Due to problems with bidding, specifications and quality control, the practice of thin bituminous surfacings is declining in Ethiopia in favour of asphalt concrete. This is leading to an unnecessarily expensive surfacing being used on roads where a thin bituminous surfacing is sufficient to resist traffic abrasion. In order to solve this issue, a series of training courses have been developed and implemented with the intention of reviving skills in the design, construction and maintenance of thin bituminous surfacings. Three groups of practitioners have been involved in the training courses; operators and foremen, technicians and engineers. It is intended that these training courses will fit into the existing training and education system in Ethiopia.

Classroom training was included in the training in order to convey theoretical aspects of design, construction and maintenance. Worksheets were also carried out by participants during these sessions in order to reinforce their understanding, and group discussions allowed participants to share their experience and discuss problems on their current projects. Laboratory training on the technicians course allows demonstration of various tests for bitumen and aggregate. Practical demonstration of the construction of a double surface dressing is included in each course with the purpose of demonstrating the procedure and the necessary preparation to participants, and to highlight problems that can occur and how to solve them.

At the end of each course, evaluation questionnaires were filled by the participants so that they could provide their views on each of the modules, their views on facilities provided and on how the courses could be improved. The answers given by the participants showed that they felt they had gained from the courses, and many stated that they believed the courses should be longer and contain a higher proportion of practical work. The courses are viewed as a success overall, however there are aspects that can be improved, particularly the practical demonstrations as there were problems with materials, equipment and the preparation of the road base.

There is much scope for the training courses in thin bituminous surfacings to be integrated into the existing training systems in Ethiopia. The future intention is that the courses are adopted by the ATTC; this will require a 'train the trainers' session so that the staff at the centre are enabled to carry out the courses independently. It is also intended that the ATTC receives accreditation under the TVET system for the training courses. This will require full handover of the courses, including comprehensive training materials. It is recommended that effective practical training on project sites is implemented in the future, so that practitioners in Ethiopia may gain real experience of how surface dressings are successfully constructed.



## 1 INTRODUCTION

Thin bituminous surfacings are used throughout the world for surfacing newly built roads with light to medium traffic, and can also be used as a maintenance treatment for roads with heavy traffic. The chief purpose of thin bituminous surfacings is to give a waterproofing layer to the road surface and prevent the ingress of harmful moisture; they can be used to seal hairline cracks. The additional purpose of thin bituminous surfacings is to give a durable, skid-resistant and dust-free wearing surface to the road.

Thin bituminous surfacings are a highly effective method of sealing roads with light to medium levels of traffic, however the skill of surface dressing is declining in Ethiopia. Therefore, the objective of this project is to deliver training courses at the Alemgena Training and Testing Centre (ATTC), in order to enhance the skills of practitioners in surface dressing.

### 1.1 Project Deliverables

The deliverables produced under this project include:

- Development of a modular course on thin bituminous surfacings covering the principles, design, quality assurance and construction of thin bituminous surfacings.
- Production of training course materials including presentations, handouts, notes, practical examples and examinations as part of the three one week courses. These materials are also to be used by the ATTC during subsequent training events.
- Production of a Best Practice Manual for Ethiopia that gives guidance on the design, construction, testing, pricing and maintenance of thin bituminous surfacings, tailored to Ethiopian conditions.

### 1.2 Purpose of this Report

The purposes of this Report are to summarise the outcomes of the project and to report on the most significant aspects of the delivery of the training courses, including the training modules delivered in the classroom, on site and in the laboratory. The final purpose of this report is to give recommendations for future training.

### 1.3 Staffing

The Roughton International (RI) team consisted of the following staff:

- |  |                 |
|--|-----------------|
| ➤ Project Director                         | Simon Gillett   |
| ➤ Bituminous Road Surfacing Specialist II  | Harold Bofinger |
| ➤ Bituminous Road Surfacing Specialist III | Jon Hongve      |
| ➤ Support Engineer I                       | Dawit Ergicho   |
| ➤ Support Engineer II                      | Thomas Falconer |
| ➤ Head Office Bituminous Surfacing Expert  | Bernard Obika   |

Members of Ethiopia Roads Authority:

- |                                      |                 |
|--------------------------------------|-----------------|
| ➤ Deputy Director General (Planning) | Bekele Negussie |
| ➤ Project Manager                    | Alemayehu Ayele |

- Counterpart Engineer

Abeba Berhanu

#### 1.4 Mobilisation and Negotiated Programme

RI staff were mobilised to Addis Ababa on the following dates:

- Support Engineer I: 7 February 2012 Dawit Ergicho
- Support Engineer II: 7 February 2012 Thomas Falconer
- Team Leader/Bituminous Road Surfacing Specialist: 11 February 2012 Jon Hongve
- Bituminous Road Surfacing Specialist: 11 February 2012 Harold Bofinger
- Project Director: 11 February 2012 Simon Gillett

The programme was implemented with the following milestones:

- RI started work on the project on 1 July 2011.
- Familiarisation and Inception Report submitted on 26 August 2011.
- Training Reports submitted on 5 March 2012.
- Best Practice Manual (draft) submitted 9 March 2012. The Final version was completed in September 2012, after undergoing peer review.
- Accreditation Report (draft) submitted on 13 March 2012. The Final version was completed in September 2012, after undergoing review by Crown Agents and ERA and subsequent amendments.
- Final Project Report (draft) submitted on the 13 March 2012. The final version was completed in November 2012, after undergoing amendments required subsequent to the meetings held with ERA from 5 to 9 November regarding future training courses.

#### 1.5 Contact List

A list of contacts for the ERA staff involved with the project, the Consultant's staff and the various participants and stakeholders is shown in Appendix A.

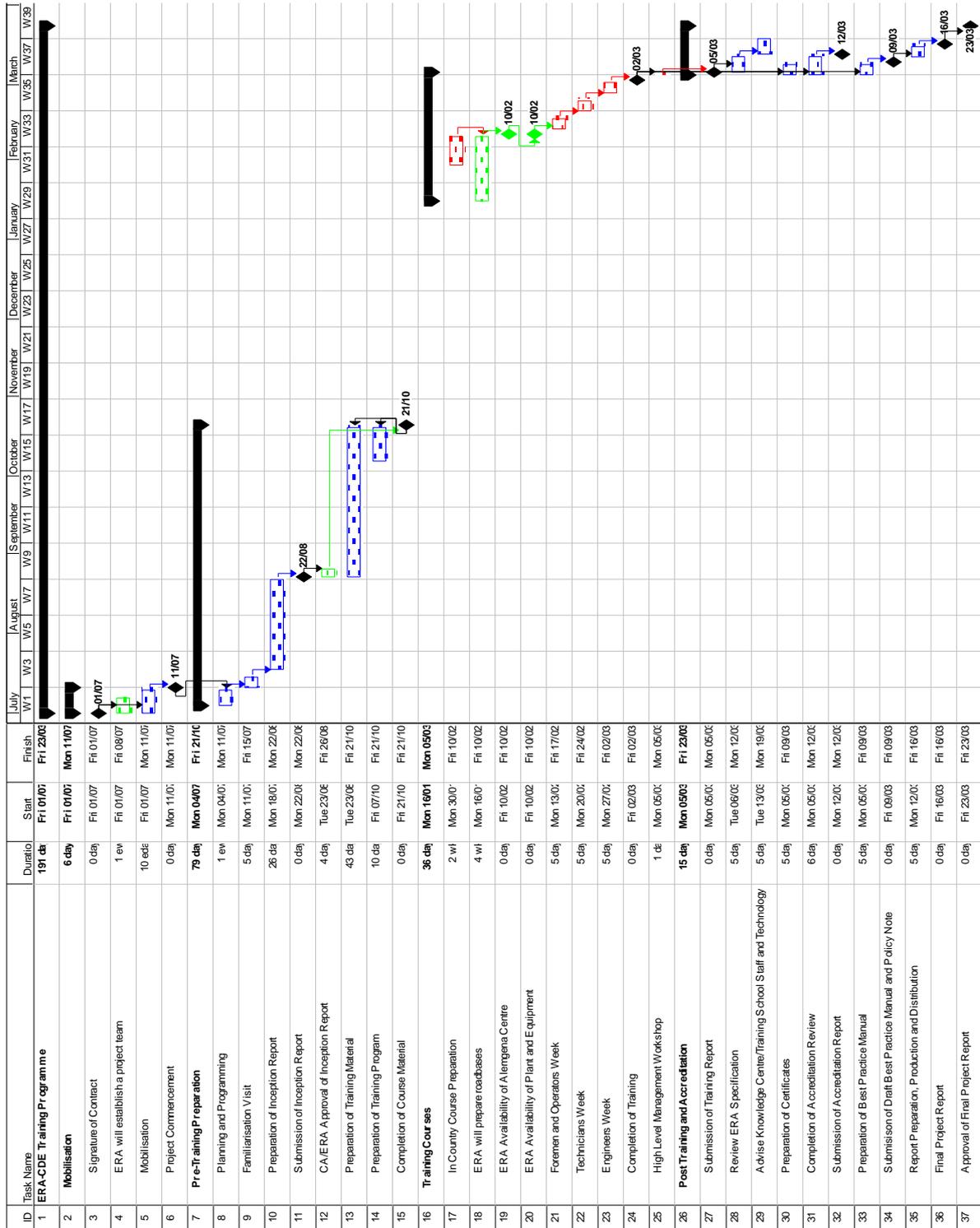
#### 1.6 Programming

The training commenced during the dry season on 13 February 2012, due to the impracticality of carrying out the site work during the rainy season.

The training programme is shown in Figure 1 with the three courses in the following order:

1. Foremen and Operators – 13 February to 17 February 2012
2. Technicians – 20 February to 24 February 2012
3. Engineers – 27 February to 2 March 2012

Figure 1 Programme





## **2 FAMILIARISATION VISIT**

The RI project team carried out a familiarisation visit to Addis Ababa from 11 to 15 July 2011, including a visit to the ATTC. It was agreed that the ATTC was to be the Local Training Partner and that the facilities of the Testing Centre would be used for the training courses. It was also agreed during this visit that trainers at the ATTC would work closely with the RI project team during the training, to enable them to adopt the training modules for future courses.

The following points were drawn from the visit and meetings:

1. The cost of transport, accommodation and subsistence for the participants during the training courses was the responsibility of the ERA.
2. The ATTC was found to be a well equipped and well staffed training centre and ideal for the project training. Laboratory and classroom facilities at ATTC were of good quality, as well as the plant available for practical demonstrations.
3. A 2 km stretch of the Alemgena – Butajira road, which is 72 km from the ATTC, was found to be suitable for the on-site training and was in need of maintenance work.
4. It was also confirmed that the Alemgena District Maintenance Unit yard adjacent to the training centre was ideal for carrying out practical demonstrations in tasks such as cleaning the nozzles, calibrating the distributor and general instruction on maintaining the plant.
5. The certificates issued to participants on satisfactorily completing the course would combine a Roughton format with the format of the exemplar certificate obtained whilst visiting the ATTC. The certificate would be in both Amharic and English, and would be signed by the ERA General Director and the Roughton International Project Director.



### **3 THE TRAINING MODULES**

#### **3.1 Course Design**

The detailed course design was based upon the ToR and discussions with ERA staff during the familiarisation visit. The training target groups were as follows:

- Foremen and Operators (from ERA approved contractors)
- Technicians (from ERA approved contractors, consultants and government staff)
- Engineers (from ERA approved contractors, consultants and government staff)

The benefit of this approach was that each course would be designed for the specific needs of each target group.

Three Training Specifications outlining the objectives, participant entry requirements, content, constraints and resources necessary for each course are shown in

Table 5, Table 6 and Table 7.

### 3.2 Module Details

Each training module differed in content and a different selection of modules formed each of the three training courses, as deemed appropriate for the participants in each course. For example, all groups attended the Safety and First Aid module and the Construction of Thin Bituminous Surfacing module, whereas only the Engineers attended the Design of Thin Bituminous Surfacing module, only the Technicians attended the Laboratory module and only the Foremen and Operators attended the Operation and Maintenance of Equipment module.

A list of the training modules is shown in

Table 1. More detail on the content of each Module is given in Appendix B.

An outline timetable for each weekly course was developed as shown in

Table 2,

Table 3 and Table 4. Adjustments were made to these programmes where necessary during the delivery of the training.

**Table 1 List of the Training Modules**

Module No.	Topic/Content	Engineers	Technicians	Foremen and Operators
1	Registration of Participants	✓	✓	✓
2	Introduction to Thin Bituminous Surfacing	✓	✓	✓
3	Safety and First Aid	✓	✓	✓
4	Design of Thin Bituminous Surfacing	✓		
5	Materials	✓	✓	✓
6	Equipment	✓	✓	✓
7	Construction of Thin Bituminous Surfacing	✓	✓	✓
8	Supervision and Quality Control	✓	✓	
9	Testing and Quality Control – laboratory work		✓	
10	Surface Dressing Demonstration – on-site training	✓	✓	✓
11	Operation and Maintenance of Equipment - in-yard training			✓
12	Fault avoidance and corrective procedures			✓
13	Evaluation and Closing	✓	✓	✓

**Table 2 Training Programme for Operators and Foremen**

Start Times	Monday 13.02.12	Tuesday 14.02.12	Wednesday In Yard 15.02.12	Thursday On Site 16.02.12	Friday 17.02.12
<b>09.00</b>	<b>Module 1</b>	<b>Module 5</b>	<b>Module 11</b>	<b>Module 10</b>	<b>Worksheet 2</b>
10.30	Break	Break	Break	Break	Break
<b>11.00</b>	<b>Module 2</b>	<b>Module 6</b>	<b>Module 11</b>	<b>Module 10</b>	<b>Worksheet 3</b>
12.30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
<b>13.30</b>	<b>Module 3</b>	<b>Module 7</b>	<b>Module 11</b>	<b>Module 10</b>	<b>Module 13</b>
15.00	Break	Break	Break	Break	Break
<b>15.30</b>	<b>Worksheet 1</b>	<b>Preparation for Site Visit</b>	<b>Module 12</b>	<b>Module 10</b>	<b>Closing</b>

**Table 3 Training Programme for Technicians**

Start Times	Monday 20.02.12	Tuesday 21.02.12	Wednesday Laboratory 22.02.12	Thursday Site Visit 23.02.12	Friday 24.02.12
<b>09.00</b>	<b>Module 1</b>	<b>Module 5</b>	<b>Module 9</b>	<b>Module 10</b>	<b>Worksheet 2</b>
10.30	Break	Break	Break	Break	Break
<b>11.00</b>	<b>Module 2</b>	<b>Module 6</b>	<b>Module 9</b>	<b>Module 10</b>	<b>Worksheet 3</b>
12.30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
<b>13.30</b>	<b>Module 3</b>	<b>Module 7</b>	<b>Module 9</b>	<b>Module 10</b>	<b>Module 13</b>
15.00	Break	Break	Break	Break	Break
<b>15.30</b>	<b>Worksheet 1</b>	<b>Module 8</b>	<b>Module 9</b>	<b>Module 10</b>	<b>Closing</b>

**Table 4 Training Programme for Engineers**

Start Times	Monday 27.02.12	Tuesday 28.02.12	Wednesday 29.03.12	Thursday Site Visit 01.03.12	Friday 02.03.12
<b>09.00</b>	<b>Module 1</b>	<b>Module 4</b>	<b>Module 5</b>	<b>Module 10</b>	<b>Worksheet 2</b>
10.30	Break	Break	Break	Break	Break
<b>11.00</b>	<b>Module 2</b>	<b>Module 4</b>	<b>Module 6</b>	<b>Module 10</b>	<b>Worksheet 3</b>
12.30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
<b>13.30</b>	<b>Module 3</b>	<b>Module 4</b>	<b>Module 7</b>	<b>Module 10</b>	<b>Module 13</b>
15.00	Break	Break	Break	Break	Break
<b>15.30</b>	<b>Worksheet 1</b>	<b>Module 4</b>	<b>Module 8</b>	<b>Module 10</b>	<b>Closing</b>

**Table 5 Training Specification for Foremen and Operators**

Key Component	Operators and Foremen One Week Course in Thin Bituminous Surfacing
<b>Reference</b>	Foremen and Operators course
<b>Priority Level</b>	Skills Development
<b>Organisational Objectives</b>	Restore industry confidence and practitioner skills base for the provision of cost effective and durable thin bituminous surfacings on rural roads.
<b>Target Trainees</b>	ERA approved contractors
<b>Target Training Population</b>	<p>Recommended: One Foreman and two Operators from each company.</p> <p>Foremen, minimum entry requirements:</p> <ul style="list-style-type: none"> <li>➤ Must be employees of an approved ERA contractor</li> <li>➤ Permanent employees for at least one year</li> <li>➤ Two years experience in highway related work</li> </ul> <p>Operators, minimum entry requirements:</p> <ul style="list-style-type: none"> <li>➤ Must be employees of an approved ERA contractor</li> <li>➤ Permanent employees on long term contract for at least one year</li> <li>➤ Must have a licence to operate the relevant equipment</li> <li>➤ Two years experience in operating construction plant/ equipment</li> </ul>
<b>Overall Aim of the Training (from ToR)</b>	<p>Skills enhancement in quality assurance and workmanship issues.</p> <p>To focus on construction practices and quality control, fault avoidance and corrective procedures.</p>
<b>Proposed Training Methods</b>	<p>Lectures, group work and discussions.</p> <p>Practical work with materials, plant and equipment.</p> <p>Site visits and practical demonstrations.</p>
<b>Indicative Content and Module Reference</b>	<ol style="list-style-type: none"> <li>1. Registration</li> <li>2. Introduction to Thin Bituminous Surfacing</li> <li>3. Safety and First Aid</li> <li>5. Materials</li> <li>6. Equipment</li> <li>7. Construction of Thin Bituminous Surfacing</li> <li>10. Surface Dressing Demonstration – on-site training</li> <li>11. Operation and Maintenance of Equipment – in-yard training</li> <li>12. Fault Avoidance and Corrective Procedures</li> <li>13. Evaluation and Closing</li> </ol>
<b>Lead Resource Personnel</b>	RI Team, ATTC staff to provide experienced plant and equipment operator trainers that can also act as Interpreters.
<b>Method of Evaluation</b>	<p>Reaction Level – by questionnaires at closing of course.</p> <p>Immediate Level – evaluating case study work by participants and pre-post course comparison/evaluation of written work.</p> <p>Intermediate Level – via follow up visits by ERA to surface dressing contracts.</p>
<b>Time-Scale for Delivery and Constraints</b>	<p>Delivery proposed for February 2012.</p> <p>Subject to site preparation is completed for practical site visits, and plant and equipment operation. Availability of materials.</p>

**Table 6 Training Specification for Technicians**

Reference	Technicians one-week course in thin bituminous surfacings
<b>Priority Level</b>	Skills Development
<b>Organisational Objectives</b>	Capacity building through training, which will be a tool to restore industry confidence and practitioner skills base for provision of cost effective and durable thin bituminous surfacing on rural roads in Ethiopia.
<b>Target Trainees</b>	From ERA approved contractors, consultants and government staff
<b>Target Training Population</b>	Technicians, minimum entry requirements: <ul style="list-style-type: none"> <li>➤ Diploma in Civil Engineering, or equivalent.</li> <li>➤ Two years experience in highway related work.</li> <li>➤ Experience in materials laboratory and field testing.</li> <li>➤ Good understanding of written and spoken English.</li> </ul>
<b>Overall Aim of the Training (from ToR)</b>	Skills enhancement in quality assurance and workmanship issues. To focus on construction practices and quality control, fault avoidance and corrective procedures.
<b>Proposed Training Methods</b>	Lectures, group work and discussions. Case studies. Site visits and demonstrations. Laboratory work – materials testing.
<b>Indicative Content and Module Reference</b>	<ol style="list-style-type: none"> <li>1. Registration</li> <li>2. Introduction to Thin Bituminous Surfacing</li> <li>3. Safety and First Aid</li> <li>5. Materials</li> <li>6. Equipment</li> <li>7. Construction of Thin Bituminous Surfacing</li> <li>8. Supervision and Quality Control</li> <li>9. Testing and Quality Control – laboratory work</li> <li>10. Surface Dressing Demonstration – on-site training</li> <li>13. Evaluation and Closing</li> <li>14. Intermediate Equipment Technologies</li> </ol>
<b>Lead Resource Personnel</b>	RI Team with support from ATTC staff.
<b>Method of Evaluation</b>	<p>Reaction Level – by questionnaires at closing of course.</p> <p>Immediate Level – evaluating case study work by participants and pre-post course comparison/evaluation of written work.</p> <p>Intermediate Level – via follow up visits by ERA to surface dressing contracts.</p>
<b>Time-Scale for Delivery and Constraints</b>	<p>Delivery proposed for February 2012.</p> <p>Subject to completion of site preparation for practical site visits and the contractor availability for the demonstration work.</p> <p>Subject to laboratory equipment and materials being available.</p>

**Table 7 Training Specification for Engineers**

Reference	Engineers one-week course in thin bituminous surfacings
<b>Priority Level</b>	Skills Development
<b>Organisational Objectives</b>	Capacity building through training, which will be a tool to restore industry confidence and practitioner skills base for provision of cost effective and durable thin bituminous surfacing on rural roads in Ethiopia.
<b>Target Trainees</b>	From ERA approved contractors, consultants and government staff
<b>Target Training Population</b>	Engineers, minimum entry requirements: <ul style="list-style-type: none"> <li>➤ Degree in Civil Engineering, or equivalent</li> <li>➤ Two years experience in highway related work</li> <li>➤ Good understanding of written and spoken English</li> </ul>
<b>Overall Aim of the Training (from ToR)</b>	Skills enhancement in quality assurance and workmanship issues. To focus on construction practices and quality control, fault avoidance and corrective procedures.
<b>Proposed Training Methods</b>	Lectures, group work and discussions. Case studies. Site visits and demonstrations.
<b>Indicative Content and Module Reference</b>	<ol style="list-style-type: none"> <li>1. Registration</li> <li>2. Introduction to Thin Bituminous Surfacing</li> <li>3. Safety and First Aid</li> <li>4. Design of Thin Bituminous Surfacing</li> <li>5. Materials</li> <li>6. Equipment</li> <li>7. Construction of Thin Bituminous Surfacing</li> <li>8. Supervision and Quality Control</li> <li>10. Surface Dressing Demonstration – on-site training</li> <li>13. Evaluation and Closing</li> </ol>
<b>Lead Resource Personnel</b>	RI Team with support from ATTC staff.
<b>Method of Evaluation</b>	Reaction Level – by questionnaires at closing of course. Immediate Level – evaluating case study work by participants and pre-post course comparison/evaluation of written work. Intermediate Level – via follow up visits by ERA to surface dressing contracts.
<b>Time-Scale for Delivery and Constraints</b>	Delivery proposed for February 2012. Subject to completion of site preparation for practical site visits and the contractor availability for the demonstration work.



## 4 OPERATORS AND FOREMEN WEEK

Further details of the Operators and Foremen week are provided in the Operators and Foremen Training Report.

### 4.1 Participant Attendance

A total of 74 participants attended the Operators and Foremen week from across Ethiopia. The participants were mostly employees of the Ethiopian Road Construction Corporation (ERCC), ERA and private contractors, as detailed in the Operators and Foremen Training Report. There were difficulties for some participants to reach the ATTC as they were required to travel large distances, and there was insufficient accommodation space at the Training Centre.

All participants had some experience in road works, most with more than 7 years experience.

### 4.2 Training Programme

The initial training programme was adjusted to suit as shown in Table 8, due to the difficulties with the practical demonstrations.

**Table 8 Operators and Foremen Timetable**

Time	Monday 13.02.12	Tuesday 14.02.12	Wednesday 15.02.12	Thursday 16.02.12	Friday 17.02.12
09:00	<b>Module 1 Registration</b>	<b>Module 5 Materials</b>	<b>Worksheet 1</b>	<b>Module 12 Fault Avoidance</b>	<b>Module 11 Calibration and results</b>
10:30	Break	Break	Break	Break	Break
11:00	<b>Module 2 Introduction</b>	<b>Module 6 Materials</b>	<b>Group Discussion</b>	<b>Group Discussion</b>	<b>Module 13 Evaluation</b>
12:30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
13:30	<b>Module 3 Safety &amp; First Aid</b>	<b>Module 7 Equipment</b>	<b>Module 11 Distributor Service</b>	<b>Module 11 Calibration cont.</b>	<b>Module 10 Practical Site Demonstration</b>
15:00	Break	Break	Break	Break	Break
15:30	<b>Module 3 Safety &amp; First Aid cont.</b>	<b>Module 7 Equipment cont.</b>	<b>Module 11 Distributor Service</b>	<b>Module 11 Calibration cont.</b>	<b>Module 10 Practical Site Demonstration</b>

### 4.3 Classroom Training

The classroom training was opened by Ato Alemayehu Ayele of ERA on 13 of February 2012 and delivered by Harold Bofinger, Jon Hongve, Dawit Ergicho and Thomas Falconer, with logistical support from the ATTC trainers.

A variety of media was utilised including a whiteboard, PowerPoint presentations, projector, Sabita videos, Phoenix Engineering videos and discussion. Bound handout booklets of the presentations were given to all participants. In addition a small booklet outlining the course was

given to participants, as well as a CD containing soft copies of all handouts and additional training materials.

Approximately half of the training participants had a reasonable understanding of English, and much Amharic translation was provided to assist those who struggled with English. It was stated during the participant evaluation that future courses for operators and foremen should be entirely in Amharic. Despite the language difficulty, most participants engaged enthusiastically during group discussions. One training participant also assisted in translating points of discussion into Amharic.

#### 4.4 On Site Training

There were difficulties in the on-site training. The distributor to be used was brand new and the operators at ATTC were in the process of training to use it. The operating manual was used in order to determine how to carry out the main functions. An additional problem with the equipment was that there were no bitumen heaters available, meaning that the bitumen had to be heated in the tank. This is a more time-consuming method of heating.

There were also problems with segregation in the roadbase. Improvement to the condition of the roadbase was attempted by applying extra layers of MC 30, followed by additional fines. This work on the roadbase was demonstrated to the participants. Calibration procedures were demonstrated in the ATTC yard. Due to the time constraints it was not possible to demonstrate chip spreading to the participants. See Figure 2, Figure 3 and Figure 4 for photographs from the practical training.

**Figure 2** Carrying out a transverse distribution test at the ATTC



**Figure 3** Carrying out the longitudinal spray rate test



**Figure 4** Spraying MC 30 during the practical demonstration



## **4.5 Evaluation**

The evaluation procedure involved a questionnaire to be completed by the participants, in order to gauge their perspective on the successes and potential improvements to the training. Much positive feedback was received from the participants regarding the classroom training and the facilities provided at the ATTC; however a recurring comment from the participants was that more practical work should be included and that the practical demonstration should be better organised.

The evaluation session also included a review of the course contents and reminders of the most important aspects of thin bituminous surfacings. The participants were successful in carrying out Worksheet 1 with 35% achieving a score above 70%.

Certificates have been printed, signed by the Director General of ERA, and distributed to participants.

## 5 TECHNICIANS WEEK

Full details of the Technicians Week are provided in the Technicians Training Report.

### 5.1 Participant Attendance

A total of 48 participants attended the Technicians training course. In addition to a majority of technicians and material inspectors, there were also small numbers of engineers, inspectors and foremen included among participants, and a significant number of surveyors. Participants came from contractors, consultants, ERA and ERCC.

Many participants possessed considerable experience in roadworks with over 7 years experience, and many were familiar with the main standard tests for bitumen and aggregate. A number of participants also had experience in design work.

### 5.2 Training Programme

The initial training programme was adjusted to suit as shown in Table 9.

**Table 9 Technicians Timetable**

Time	Monday 20.02.12	Tuesday 21.02.12	Wednesday 22.02.12	Thursday 23.02.12	Friday 24.02.12
09:00	<b>Module 1 Registration</b>	<b>Module 5 Materials</b>	<b>Module 9 Bitumen Lab</b>	<b>Sabita Testing Video and Worksheet 2</b>	<b>Module 8 Supervision and Quality Control</b>
10:30	Break	Break	Break	Break	Break
11:00	<b>Module 2 Introduction</b>	<b>Module 6 Equipment</b>	<b>Module 9 Bitumen Lab</b>	<b>Module 10 Calibration</b>	<b>Worksheet 3</b>
12:30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
13:30	<b>Module 3 Safety &amp; First Aid</b>	<b>Module 7 Equipment</b>	<b>Module 9 Aggregate Lab</b>	<b>Module 10 Site Visit</b>	<b>Module 13 Evaluation</b>
15:00	Break	Break	Break	Break	Break
15:30	<b>Worksheet 1</b>	<b>Module 7 Equipment cont.</b>	<b>Module 9 Aggregate Lab</b>	<b>Module 10 Site Visit cont.</b>	<b>Closing</b>

### 5.3 Classroom Training

Classroom modules were delivered by Harold Bofinger, Jon Hongve, Dawit Ergicho and Thomas Falconer.

The participants generally had a good understanding of English, meaning that only a small amount of translation into Amharic was required. This was provided by Dawit Ergicho Fanta.

The bound handout book, small booklet and the CD containing training materials were distributed to all participants. The handouts proved to be particularly popular amongst the Technicians, who used them to take notes and as an aid in following the presentations as they were delivered.

#### 5.4 Laboratory Training

The training participants spent the morning of Wednesday 22 February 2012 in the bitumen laboratory, followed by the afternoon in the aggregate laboratory. The laboratory demonstration is pictured in Figure 5.

Bitumen test equipment demonstrated included:

- Penetration Test.
- Ductility Test.
- Softening Point Test.
- Flashpoint Test.

Aggregate tests carried out included:

- Grading.
- Aggregate Impact Value
- Aggregate Crushing Value.
- Los Angeles Abrasion Value.

**Figure 5 Laboratory Demonstration**



### 5.5 On Site Training

The on site demonstration was carried out on Thursday 23 February 2012, pictured in Figure 6. The demonstration included the longitudinal calibration test, checking the chip spreader, applying the first layer of bitumen and applying the first layer of chippings in the double surface dressing. The second layer of the double surface dressing was intended to be applied the following week with the Engineers. The segregation problems of the previous week appeared to have been rectified however there was some extensive cracking which showed the strength of the base to be inadequate. The cracks were sealed by spraying with the hand lance and further application of fines.

**Figure 6 Technicians on site training**



### 5.6 Evaluation

The Technicians evaluation session included the same participant questionnaire as in the first week, in order to gain participant opinions and perspectives, as well as the review and reiteration of important points raised during the training. The participant feedback was again very positive among the Technicians Group, although many would have liked the course to be longer with more practical work and more laboratory work.

The Technicians were successful in carrying out the worksheets with 40% scoring above 70% in Worksheet 1, 70% scoring above 70% in Worksheet 2 and 70% scoring above 70% in Worksheet 3.

Certificates have been printed, signed by the Director General of ERA and distributed to participants.



## 6 ENGINEERS WEEK

Full details of the Engineers week are given in the Engineers Training Report.

### 6.1 Participant Attendance

A total of 84 participants attended the Engineers week. In addition to a majority of junior engineers, site engineers, project engineers and material engineers, the participant group also included small numbers of researchers, inspectors, surveyors and ATTC trainers. The participants came from contractors, consultants, ERA and ERCC, as well as other government bodies.

### 6.2 Training Programme

The initial training programme was adjusted to suit as shown in Table 10. The programme was changed to four days in duration due to the Adowa National Holiday on Friday 2 March.

**Table 10 Engineers Timetable**

Time	Monday 27.02.12	Tuesday 28.02.12	Wednesday 29.02.12	Thursday 01.03.12	Friday 02.03.12
09:00	<b>Module 1 Registration and Module 2 Introduction</b>	<b>Module 4 Design cont.</b>	<b>Module 5 Materials</b>	<b>Module 10 Site Visit</b>	<b>National Holiday</b>
10:30	Break	Break	Break	Break	Break
11:00	<b>Module 3 Safety &amp; First Aid</b>	<b>Module 4 Design cont.</b>	<b>Module 6 Equipment</b>	<b>Module 10 Site Visit Cont.</b>	<b>National Holiday</b>
12:30	Lunch break	Lunch break	Lunch break	Lunch break	Lunch break
13:30	<b>Worksheet 1</b>	<b>Module 4 Design cont.</b>	<b>Module 7 Construction</b>	<b>Module 10 Site Visit cont.</b>	<b>National Holiday</b>
15:00	Break	Break	Break	Break	Break
15:30	<b>Module 4 Design</b>	<b>Module 4 Design cont.</b>	<b>Module 8 and Sabita Testing Video</b>	<b>Module 13 and Closing</b>	<b>National Holiday</b>

### 6.3 Classroom Training

No translation was necessary during the classroom training as the participants had an excellent understanding of English. Due to the large number of participants, assistance was required from the ATTC in logistical tasks such as providing pens and organising transport to the site demonstration.

The bound handout book, small booklet and the CD containing training materials were distributed to all participants. The handouts proved to be a particularly popular medium amongst the

Engineers, who used them to take notes and as an aid in following the presentations as they were delivered.

#### 6.4 On Site Training

There were problems with the distributor during the Engineers practical training; the pump had broken down in the morning and therefore it was not possible to get enough bitumen into the tank. Although the operators and the RI team attempted to rectify the problem throughout the day, it was not possible to find the exact cause of the problem within the time constraint.

The problems with the roadbase as well as the problems with the surface dressing applied the previous week were explained to the participants, picture in Figure 7.

On reaching the site on 1 March 2012, there were some loose chippings remaining from the surface dressing carried out previously with the Technicians on the 23 February 2012. The importance of removing these chippings by brooming and air blowing was demonstrated, as pictured in Figure 8 and Figure 9.

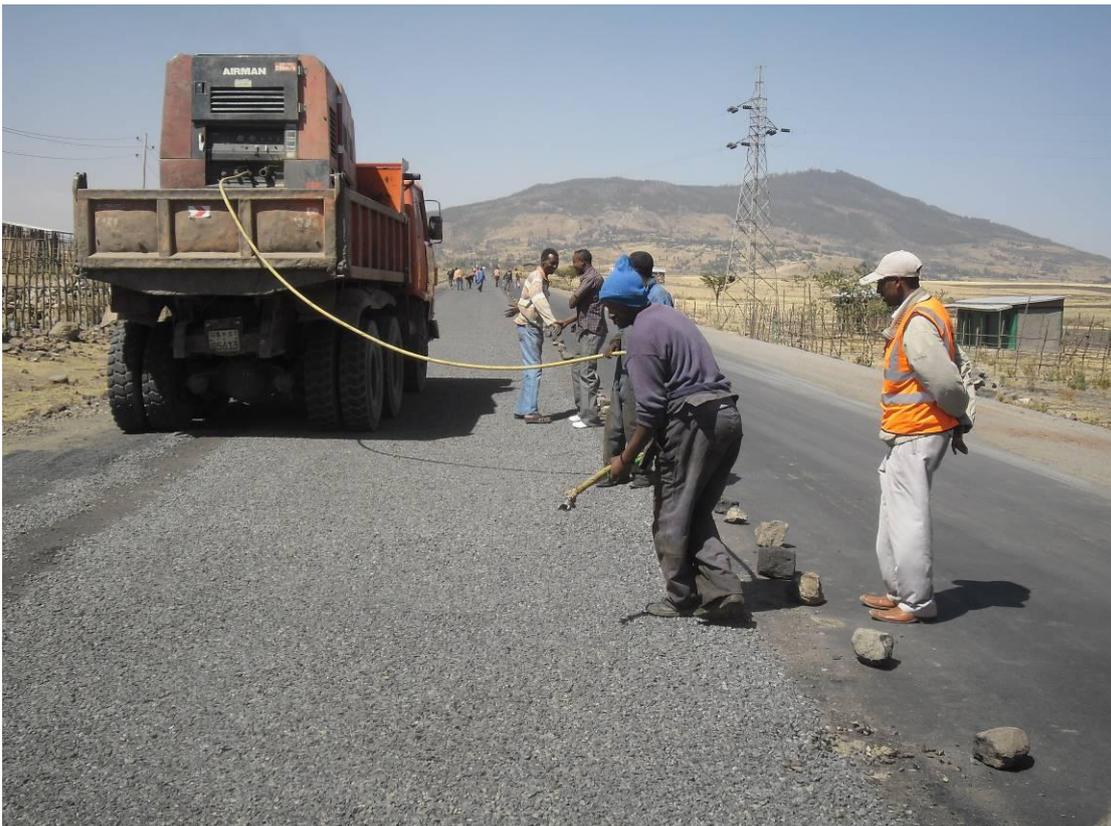
**Figure 7 Demonstration of the site problems**



**Figure 8 Manual brooming during the practical demonstration**



**Figure 9 Air blowing during the practical demonstration**



## **6.5 Evaluation**

The participants gave positive feedback on the quality of the training. The main area that participants felt needed improvement was the practical demonstration, due to the problems experienced in this part of the training. Many participants suggested that practical laboratory training should be included in their course, along with more on site training.

As with the Technicians, the participants carried out a short review of the course and filled in the evaluation forms. The trainees were successful in carrying out Worksheet 1 with 70% of participants achieving above 90%.

Certificates have been printed, signed by the Director General of ERA, and distributed to participants.

## **7 BEST PRACTICE MANUAL**

### **7.1 Introduction**

A Best Practice Manual for Ethiopia was produced as part of this project. It provides guidance in the design, construction and maintenance of thin bituminous surfacings. The guidance provided includes interpretation of standards for thin bituminous surfacing design, guidance on the selection of the most appropriate type of thin bituminous surfacing for particular site conditions, as well as guidance on construction and maintenance methods.

### **7.2 Outline**

The following outlines the contents of the Best Practice Manual:

1. Introduction to the practice of thin bituminous surfacings and the various types, including surface dressing, slurry seals, cape seals, Otta seals and sand seals.
2. Selection of an appropriate type of thin bituminous surfacing according to specific conditions on site, such as traffic levels, structural and surface condition, the road geometry, environment and capability of contractors and consultants.
3. Field investigations, including the MEXE cone penetrometer, traffic surveys, assessment of existing road condition, the depot tray test and the Bakkie test.
4. Design of thin bituminous surfacings, including material properties, surface dressings, Otta seals, slurry seals cape seals and sand seals.
5. Pricing, including information on the different cost aspects that should be considered.
6. Construction of thin bituminous surfacings, including preparation of the road surface, materials, equipment, construction of surface dressings, Otta seals, sand seals, slurry seals, cape seals, cold mix asphalt, fog sprays and site safety.
7. Quality control and the specifications that materials used in surface dressing must meet. An appendix gives information on laboratory tests, including bitumen tests for penetration, ductility, softening point, viscosity and flashpoint, and aggregate tests for grading, flakiness, ACV, AIV and soundness. Guidance on quality control measures within construction procedures is also given.
8. Maintenance, including general repairs and the repair of structural defects, surface dressing as a maintenance tool and other thin bituminous surfacings as maintenance tools. This section also includes guidance on base preparation and repair.

### **7.3 Review and Amendment**

The Best Practice Manual has undergone extensive review and amendment subsequent to the draft submission of the Best Practice Manual in March 2012. A review of the Best Practice Manual was carried out by Eng. Gerrie van Zyl in April 2012, which included recommendations for improvements to the Manual. Therefore amendments were made, including additions of further detail to some sections as well as re-organisation of some sections. This review period also involved some discussion and final agreement between Eng. van Zyl and the RI team on technical details within the Manual. The Manual is to undergo further review by ERA.



## **8 ERA STANDARD TECHNICAL SPECIFICATION - 2002 SERIES 6000: BITUMINOUS SURFACINGS AND ROAD BASES**

### **8.1 Overview**

The ERA standard technical specification – 2002 Series 6000 is the standard specification in Ethiopia for the design and execution of thin bituminous surfacings in Ethiopia. Series 6000 is part of the overall pavement design specification of ERA. Chapters included in this part of the specification include:

- Division 6100 – Bituminous Prime Coat.
- Division 6200 – Tack Coat.
- Division 6300A: Surface Treatments: Materials and General Requirements.
- Division 6300B: Single Surface Treatments.
- Division 6300C: Double Surface Treatments.
- Division 6300D: Triple Surface Treatment.
- Division 6300E: Single Surface Treatment with Slurry (Cape Seal).
- Division 6300F: Sand Seals.
- Division 6400: Bituminous Roadbases.
- Division 6700: Surfacing of Bridge Decks.
- Division 6800: Treatment of Certain Defects in Existing Bituminous Surfacing.
- Division 6900: Bituminous Road Mix Surfacing.

The divisions detail the requirements for materials, equipment, personnel and traffic safety, construction, surface preparation, application rates, bitumen heating requirements, measurement and payment appropriate to each Division.

### **8.2 Review**

The RI project team have concluded that there are no significant problems with the specification and that it is adequate for the execution of satisfactory surface treatment work. It must be ensured that the specification is adhered to by engineers and other responsible personnel in the industry; if the specification is adhered to and a good standard of workmanship is maintained on site, there should not be major problems with surface treatment work that is carried out.

A review of the ERA Technical Specification – 2002 is being carried out by ERA. The format of specification preferred by ERA is that of a ‘method’ specification that provides comprehensive guidance throughout all processes required in surface treatment works, rather than an ‘end’ specification that specifies only the required end results of processes.

## 9 DESIGN MANUAL

The ERA Pavement Design Manual contains a chapter providing guidance on the design of surface treatments. This contains information on single surface dressings, double surface dressings, triple surface dressings, racked-in surface dressings, pad coats and sandwich surface dressings. The specific requirements for aggregates regarding grading, Average Least Dimension (ALD), Polished Stone Value (PSV), Aggregate Crushing Value (ACV), Aggregate Abrasion Value and the flakiness index are specified. Specific guidance is given on the requirements of bitumen in terms of the general requirements, viscosity according to grade and road surface temperature, and adhesion to the aggregate.

Design guidance is provided on the appropriate choice of surfacing type and the appropriate choice of bitumen and aggregate according to the site conditions, such as road surface hardness, current and anticipated traffic loads, surface texture, climate and availability of materials. Methodology is also provided for calculating basic bitumen and aggregate application rates, as well as adjustment factors according to specific site conditions.

Some guidance is also provided on the use of slurry seals, cape seals, Otta seals, sand seals, synthetic aggregate and resin treatments, fog sprays and enrichment sprays.

### 9.1 Recommendations

The ERA specification for surface treatments is satisfactory for carrying out surface treatments to a good standard. It must be ensured that the specification is adhered to in all projects being carried out, in the design stage as well as in the construction stage.

Although the Otta seal is not in common use in Ethiopia, it is recommended that comprehensive guidance on their use is brought into the Ethiopian specifications, in anticipation of the potential future use of Otta seals in the country. If brought into common practice the Otta seal could be a very useful surfacing solution particularly in rural parts, where adequate single sized aggregate may be difficult to obtain.

## **10 FUTURE TRAINING COURSES**

### **10.1 Transfer of the Courses to the ATTC**

The intention of AFCAP and ERA is that the training courses on thin bituminous surfacings are fully transferred to the staff at the ATTC, so that they are able to deliver the training courses independently in the future. The intention is also that the training courses will be integrated into existing training programmes at the ATTC and receive official accreditation under the Technical and Vocational Education and Training (TVET) system. See the Accreditation Report produced as part of this project for details of the accreditation process.

Meetings were held with ERA from the 5 to the 9 of November 2012 in order to discuss the implementation of a 'Train the Trainers' course at the ATTC. This is intended to consist of 1 week spent with the ATTC staff (provisionally set for January 2013), in order to go through the course material with them and explain the different aspects of the courses. During this time all queries that the ATTC staff have on the logistical and detailed technical aspects of the courses will be explained and clarified. The answering of queries will be delivered in a group discussion, so that all ATTC staff attending the 'Train the Trainers' course may benefit. The maximum number of ATTC staff attending the 'Train the Trainers' course is expected be around 15; the course will not be effective if the number of attendees significantly exceeds this.

ERA also requested that the 'Train the Trainers' week is followed by an additional week for delivering the presentations on thin bituminous surfacings at Addis Ababa University. The attendees to these lectures will be students from the University, professional engineers with an interest in thin bituminous surfacings and ERA staff. Subsequent to the 'Train the Trainers' week, the ATTC staff can also participate during the week at the University so that they can gain some experience in delivering the presentations.

### **10.2 Further Practical Training**

In order to construct successful surface dressings it is critical that the construction is carried out correctly, using suitable materials that meet the specification and using the correct construction methods. In order to gain practical skills in the construction aspects of surface dressing, practitioners and trainees in Ethiopia should spend significant time gaining experience on project sites. It is therefore recommended that long-term practical training on project sites, in conjunction with the full transfer of the classroom training to the ATTC, is carried out. This is believed to be the most effective approach to implementing gradual improvement in the quality of surface dressing in Ethiopia.

During the meetings held between the 5 and 9 November 2012, the possibilities of long-term practical training were discussed. This would involve training on project sites for periods of around 3 months, for small groups of trainees. Due to the significant costs involved it will not be possible to carry out this practical training under the current AFCAP programme. However over a 2 to 3 year period a number of project sites in Ethiopia or in nearby African countries could be designated for trainees to gain this practical experience. The most practical way to implement this training would be to designate projects in Ethiopia that include surface dressing works, and to ensure that the work contracts include:

- a) A full description of what the training involves and what it must achieve. This should set out the achievement criteria that the trainees must meet on completing the training in order to receive certification.
- b) An expert in surface dressing to be on the project site with the specific role of training groups of around 3 during the surface dressing works. A specific section of the surface dressing works could be designated for each group of trainees.
- c) An allowance for the trainees' accommodation, per diem and transport.

## 11 CONCLUSIONS

There have been successes in the implementation of the training as well as aspects that can be improved for future courses. Full recommendations appropriate to each training group are detailed in each of the three training reports.

### 11.1 Participant Information Packs

It is suggested that all participants are provided with information packs in advance of future training courses that detail the following:

- Training commencement dates and travel arrangements.
- Accommodation and catering arrangements.
- Training timetables and information on modules.
- A notepad and pen for use during training, and a folder in which to store handouts.

### 11.2 Classroom Delivery

Items that should be provided for future training course include:

- A DVD player.
- Flipcharts and marker pens.
- Tables on which participants can work during the training.

It is recommended that future training courses are carried out over longer periods and with fewer participants at one time, so that group discussions, practical examples and workshops can be more effectively included in the training.

### 11.3 Practical Training

It is recommended that the bitumen distributor is checked in advance of the training courses by experienced personnel, and that operators are provided with specialised training courses. It must be ensured that the spray nozzles are cleaned and that there is no blockage in the delivery tubes, and that the speedometer and temperature gauge are functioning properly.

Adequate time must be allowed to deal with problems in the base preparation. For this reason, any base preparation required in future training courses should be commenced 1 or 2 months in advance of the training course so that it is completed in time. The work should be closely supervised in order to ensure that the correct materials and equipment are used, and progress checks should be carried out weekly.

It is advisable in future training courses to carry out practical surface dressing demonstrations on a section of road that does not require structural repairs, as this can cause problems in the tight schedule of training programmes.

During the training programme in February 2012 it was necessary to borrow a bitumen distributor from the ERA Emergency Unit, an own force account that usually serves projects in the Blue Nile Gorge area. This was because the distributor seen in July 2011 was no longer functional, neither was the distributor owned by the adjacent ERCC contractor. Due to the tight schedules of training programmes the ATTC should own at least two bitumen distributors with trained operators, so that a spare machine is available in the case of problems with the other.

#### **11.4 ERA High Level Management Workshop**

It is recommended that on future training programmes a workshop is carried out for high level management in ERA in order to boost awareness of the benefits of thin bituminous surfacings. This would consist of a summary of the training programmes carried out, the Best Practice Manual, use of thin bituminous surfacings, Otta seals, the use of geo-synthetics, cost considerations for surfacing options, plans for future training programmes, etc.

#### **11.5 Future Courses**

It is recommended that training be provided to staff of the Alemgena Technical Training to enable them to integrate surface treatment training into their normal curricula for training of road sector personnel. Courses offered under this curriculum are accredited under the TVET system.

ERA should also look for opportunities to provide engineers and technicians, foremen and operators with practical training in the construction of surface treatments. This could be achieved by developing structured training activities on existing construction sites. The cost of the training could be provided through the works contract.

**Appendix A Contact List**

The following is a list of contacts for participants in the project:

Name	Org.	Job Title	Telephone	Email Address
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**Appendix B Details of the Training Modules**

Module	TOPIC/CONTENT	Engineers	Technicians	Foremen and Operators
1	<b>Registration of Participants</b>	✓	✓	✓
	Registration details			
	Participant questionnaires and introductions			
	Course outline and explanation of the evaluation process			
2	<b>Introduction to Thin Bituminous Surfacing</b>	✓	✓	✓
	Definitions			
	Principles of thin bituminous surfacings			
	Types and appropriate uses of thin bituminous surfacings, surface dressings, Otta seals, slurry seals, sand seals, fog sprays and grout			
	Economic and safety benefits			
	Limitations of thin bituminous surfacings			
	Frequently Asked Questions (FAQs)			
3	<b>Safety and First Aid</b>	✓	✓	✓
	Construction safety			
	Safety and health in the workplace			
	Protective clothing, footwear			
	Basic First Aid. Provision of first aid materials and water			
	Fire precautions			
	Types of fire extinguishers, solvents, naked flames			
4	<b>Design of Thin Bituminous Surfacing</b>	✓		
	Introduction			
	Pavement serviceability; design life and maintenance inputs			
	Survey and data collection			
	Repair of defects and other preliminary works			
	Selection of thin bituminous surfacing type, Otta seals, slurry seals, sand seals, fog sprays and grout			
	The theory of thin bituminous surfacing design			
	TRL Overseas Road Note 3			
	Traffic; measurement and significance			
	Measurement of road surface hardness			

Module	TOPIC/CONTENT	Engineers	Technicians	Foremen and Operators
	Selection and classification of chippings			
	Determination of bitumen rate-of-spray			
	Selection of binder type and grade			
	Material quantities; estimating			
	Pre-coated chippings; additives, modifiers			
	Slurry seals: (TRH 3) Selection of binder type. Selection of appropriate size of quarry fines, designing the mix, possible problems.			
	Cape seals: Selection of binder types. Selection of size of chippings. Selection of quarry fines.			
	Otta seals			
	Fog sprays: Rejuvenation of older surfaces			
	Grouting: Sealing cracks			
	<b>Materials</b>	✓	✓	✓
	Introduction			
	Specifications – bitumen, chippings			
5	Slurry Sealing: Specifications – emulsion and quarry fines. Selection of mix proportions.			
	Cape Seal: Specifications - Bituminous products, aggregate and quarry fines.			
	Otta seal: Grading of aggregate, types of binder			
	Fog Spray: Dilution of emulsion			
	<b>Equipment</b>	✓	✓	✓
	Constant Volume Distributors			
	Constant Pressure Distributors			
	Distributors; spraybars; ancillary equipment			
6	Distributors; calibration; systems and operation; cleaning			
	Chipping Spreaders; types and operation			
	Bitumen Decanter			
	Pneumatic Tyre Roller (PTR)			
	Power Broom and ancillary equipment			
	<b>Construction of Thin Bituminous Surfacing</b>	✓	✓	✓
7	Introduction			

Module	TOPIC/CONTENT	Engineers	Technicians	Foremen and Operators
	Planning surface dressing work			
	Preparation of equipment, chipping stockpiles and bitumen			
	Repairs to existing surface			
	Priming new road bases			
	The surface dressing operation			
	Spreading and rolling chippings			
	Traffic control and signing			
	Slurry seals: Preparation of existing surface. Preparation of mixer, battens, squeegees, wheelbarrows. Storage of quarry fines, water, cement and bitumen at mixing site. Slurry sealing operation. Traffic control and opening to traffic.			
	Cape seals: Preparation of existing surface. Construction of single surface dressing. Construction of single or double layer of slurry.			
	Otta seals			
<b>8</b>	<b>Supervision and Quality Control</b>	✓	✓	
	Introduction			
	Materials Acceptance Tests			
	Aggregates; Grading; Flakiness Index; Average Least Dimension			
	Aggregate Abrasion Value; Los Angeles Test			
	The Polished Stone Value - PSV			
	Adhesion of Aggregate to Bitumen			
	Bitumen – Penetration and softening point tests			
	Rate of spray/spread of bitumen/chippings			
	Depot Spray Test (ERA Specification 6110)			
Quality Control; supplementary tests and calibrations				
<b>9</b>	<b>Testing and Quality Control – laboratory work</b>		✓	
	Laboratory work – safety and general considerations			
	Aggregates tests			
	Bitumen tests			
<b>10</b>	<b>Surface Dressing Demonstration – on-site training</b>	✓	✓	✓
	Use and calibration of equipment			
	Distributor; loading, circulation, spraying, cleaning, unload			
	Selection and maintenance of equipment			

Module	TOPIC/CONTENT	Engineers	Technicians	Foremen and Operators
	Operation of all plant and equipment for surface dressing production			
	Operation of plant and equipment specifically for Otta seals, slurry seals, sand seals, fog sprays and grout			
	Laying of cut-off strips			
	Instruction in the occasional need for hand spreading of chippings			
	Static calibration and use of the dip stick			
	Preparation of equipment and materials			
	Planning of the works			
	Traffic control			
	Operation of the bitumen distributor			
	Operation of the chip spreaders			
	Back-up manual operations			
	Rolling of finished surface			
	Field tests			
	Measurement and records			
	Cleaning of equipment after use			
	After care			
	<b>Operation and Maintenance of Equipment – in-yard training</b>	✓	✓	✓
	Duties of the Foreman and Operators			
	Decanter and transfer of bitumen			
	Bitumen Distributor			
	Chipping spreaders			
	Tipper trucks			
<b>11</b>	Pneumatic Tyre Roller (PTR)			
	Sequence of operations for surface dressings and other thin bituminous surfacing types.			
	Daily maintenance by the Operator			
	Cleaning of plant and equipment			
	Cleaning of concrete mixers, squeegees, hessian drags after slurry operations			
<b>12</b>	<b>Fault Avoidance and Corrective Procedures</b>			✓

Module	TOPIC/CONTENT	Engineers	Technicians	Foremen and Operators
	Checking spray rates, aggregate distribution, bitumen storage temperatures, rotation of drums of emulsion			
	Treatments for non-uniform spraying, bleeding, insufficient chippings, whip-off of chippings			
	Correcting errors in Otta seals, slurry seals, sand seals, fog sprays and grout			
<b>13</b>	<b>Evaluation and Closing</b>	✓	✓	✓
	Self assessment			
	Group assessment			
	Course assessment			
	Examination			
	Issue of certificates			