

EUROPEAN UNION - TACIS

Technical Assistance to the Southern Republics of the CIS and
Georgia - TRACECA

TRADE AND TRANSPORT SECTORS

Terms of Reference

for

**IMPLEMENTATION OF PAVEMENT MANAGEMENT
SYSTEMS**

Final Recipients:
TRACECA Region Ministries of Transport

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1. Background and Introduction

1.1 During May 1993 a conference was held in Brussels organised by the Commission and attended by authorities of the eight Republics of the south of the former USSR:

- Armenia,
- Azerbaijan,
- Georgia,
- Kazakstan,
- Kyrgyzstan,
- Tadjikistan,
- Turkmenistan,
- Uzbekistan.

They are the Beneficiary States of this programme.

The objectives of the conference were :

- to stimulate interest in developing major transport corridors between Asia and Europe, including the Central Asian - Trans Caucasian - Europe Transport Corridor
- to promote co-operation among the participating Republics in all matters pertaining to the development and improvement of trade within the Region
- to identify problems and deficiencies in the Region's trade and transport systems
- to define, in terms of contents and timing a Technical Assistance Programme to be financed by the European Union (EU).

TRACECA (Transport Corridor Europe Caucasus Central Asia) was thence created as a component of the TACIS interstate programme.

The "Brussels Declaration" issued at the conclusion of the conference recommended the European Union to include in the TACIS programme the implementation of a Pavement Management System (PMS) through technical assistance and the training of technical personnel.

1.4 During and immediately after the days of the Soviet Union road maintenance was performed by hierarchically managed organisations within the Ministries (of Roads, Construction,...). It was funded systematically according to fixed term plans, which were based essentially on engineering rather than economic criteria.

Since independence the TRACECA states have been passing through difficult economic times. Authorities responsible for road maintenance, with the sole exception of Uzbekistan complain of chronic underfunding. The situation has progressively worsened over the past three years, so that most expect their funding for the present year to be only of the order of 15% of budgeted needs. Deterioration of road surfacings is now too frequently manifest, though not yet generalised.

1.5 The roads network was constructed to high nominal standards (eg. a design speed of 150km/hr on so-called Category IA roads). Basic pavement design theory and pavement deterioration mechanisms are well understood by engineers within the Region. However the standard of road construction has been low. Levelling was approximate, and compaction control was spasmodic. Consequently roughness was excessively high even when roads were new.

Roughness and deflection measures have been carried out in the Region, using local equipment similar but not always identical to that used in the West. Institutes which were responsible for these activities are now relatively inactive, because of a lack of funding.

So-called road passports have been compiled in the past. Certain records have been computerised, and synoptic displays of the status of road condition have been developed locally, in Kazakhstan for example.

Freeze-thaw cycles are marked across much of the Region. Precipitation is generally low.

1.7 Flexible, as against rigid, pavement construction dominates. Local standards for materials selection, mix design, and control have not been extensively reviewed by Western consultants. It is however apparent that surfacings have been poorly laid. Excessive bituminous content is a generalised problem.

Modern Western performance criteria and technical specifications for premix overlays and surfacings are little known in the Region.

1.8 Organisations for the collection and processing of traffic data exist, operating to varying degrees of efficiency, across the Region. The equipment they employ appears to be in doubtful condition. In particular axle load data is missing from records.

Roads are not carrying high cumulative axle loadings comparable with Western traffic. This situation may change, especially on international routes, as road hauliers are eager to re-equip with Western type heavy goods vehicles. Overloading of vehicles may be expected whatever regulations are in force.

1.9 Road maintenance in the Region is typically financed by Road Funds. Specific taxes may be levied on the turn-over of general businesses, vehicle sales taxes, road transport firms turn-over, VAT on petroleum products, sales tax on fuel, rental income from property, transit taxes,... The potential revenues from these taxes is indeterminate, as is the linkage of cost with road use, in the perception of the user.

In fact the collection and allocation of these taxes appears haphazard and inadequate to finance even the short run marginal costs of road use. The result is deterioration of the network, as well as distortions of demand and other unforeseen effects. Furthermore, these financial restraints are sapping the road maintenance organisations of the human and physical assets that they need to keep roads at reasonable service levels.

Under the circumstances assistance to improve technologies must be accompanied by actions to mobilise funding. Likewise, the eventual divestiture of maintenance plant and human resources into the private sector, can only eventually be successful if there is a reasonably stable workload to support it there.

1.10 Road safety is inadequate. Signage, junction design, lighting, and related aspects of traffic engineering are not well applied.

1.11 Bridges are commonly of reinforced and prestressed concrete construction, while steel trusses have been employed for longer spans. Split grade crossings are rare and the majority of bridges cross rivers with high seasonal flow variations.

The maintenance of bridges is being neglected, in similar circumstances to those relating to pavement maintenance. There appears to be little knowledge locally of the most recent Western techniques of Bridge Maintenance Systems (BMS) and rehabilitation techniques.

2. Objectives

The project aims to introduce Regional roads maintenance authorities to the latest Western pavement management techniques. It is to promote a reduction in road maintenance backlogs, which have arisen in certain states during the past three years. To do so, it must examine problems of financing maintenance activities. While the road maintenance problem is generalised, the focus of this project will be on international transit routes.

Specific objectives fall under two distinct but mutually complementary headings.

Technical

- Establish databases of:
 - road and bridge conditions, including roughness and pavement strength
 - traffic intensity, including axle-loadings
 - forecasts of future traffic (scenarios)
- Formulate, test and refine technical pavement maintenance strategies (using a computerised deterioration model). Establish Pavement Management Systems in each Regional state
- Implement a Bridge Maintenance System
- Familiarise local authorities with Western
 - road and bridge maintenance techniques and specifications
 - road safety standards
- Review roads design standards

Economic

Expand the resources available for road maintenance by:

- demonstrating the real costs of road utilisation, by users who at present pay little, and thus reinforce arguments for recurrent collections of revenue by charges (taxes) on users
- list and describe road maintenance projects and programmes susceptible to attract IFI interest, including presentation of their economic justification

Furthermore, by making extensive paid use of local Research Institutes, the appointed Consultant should re-invigorate their activities, and contribute to their long term survival.

Local persons are to be fully trained in the techniques employed throughout the project. Know-how transfer is a prime objective of the project.

3. Scope of Work

3.1 Implementation of the System

During the current Institutional transformations taking place in each TRACECA state, the titles of the entity responsible for the direction of roads maintenance vary. The counterparts for the implementation of the present system will be the following organisations, or their designees:

- Armenia, Ministry of Transport and Communications
- Azerbaijan, Azeravtoyol
- Georgia, Ministry of Transport
- Kazakstan, Kazakhstan Zholdary,
- Kyrgyzstan, Ministry of Transport
- Tadjikistan, Ministry of Transport
- Turkmenistan, Turkmenautoellari
- Uzbekistan, Uzavtoyul

Where necessary in the following text, they will be referred to generically as the Roads Directorates.

The Consultant must commence work with experienced local Research Institutes, which he must contract to provide the local technical services he considers necessary to achieve the projects objectives. The eventual organisational form of the PMS (and BMS) will be decided during the course of the project, by the Roads Directorates. The Consultant will make recommendations on this mid-way through the project, and thereafter assist in the final implementation.

The intention is for the individual States to develop the systems fully themselves, beyond the scope of this present project.

Computer hardware and software should be supplied to each individual state. The system implemented in each Recipient State should possess sufficient total capacity to at least manage all primary inter-urban type roads and bridges in that State. Systems supplied are to be common to all TRACECA states, facilitating eventual data sharing and development of common models.

The Roads Directorates or their designees will be the ultimate recipients of the necessary hardware, software, testing equipment, and know-how transfer which is the object of this project.

It is not a requirement that field testing equipment be supplied for each individual state. The eventual recipient of shared equipment may be decided during the course of the project, as Regional collaboration is one of the themes of TRACECA.

Equipment supplied is always to include five copies of manuals for operation and maintenance translated into Russian. Essential specialist tools, and spare parts for one years operation after termination of this project are also to be provided.

International road links of direct interest to this project are shown on the schematic included with this TOR. Consultants are to formulate a proposal to mount a pilot or demonstration activities on this network, in each TRACECA state. Modifications to conform with actual local priorities are to be made during the course of the project. Critical sections with highest traffic are to be identified during the course of the project, and subject to closer scrutiny (see Section 3.8)

Consultants are not expected to venture into areas of civil conflict.

Consultants must show in their proposal that they have established sufficient key liaisons with local Research Institutes to commence technical operations (not necessarily in every TRACECA State) immediately upon award of the contract.

3.2 Data Collection

3.2.1 Road Conditions

Existing road condition and geometrical databases, computerised or not, must be adapted to the proposed PMS functional model.

Field validation and measurement of data will also be necessary. At a minimum, roughness, deflection measures are to be taken, as well as visual parameters. Equipment for field measurement must be supplied by the Consultant. The Consultant should fully specify in his proposal the parameters to be considered, the equipment to be used, its origin, be it local existing or imported for the project, and arrangements made for local support.

Some field investigative work to discover the credibility of pavement history from records should be done.

The methodology for testing, including the extent and density of the testing campaign, are to be described in the Consultants proposal.

3.2.2 Traffic Intensity

Classified traffic counts have been systematically carried out in the past by the Roads Directorates. During the present economic difficulties, it is possible that the coverage has diminished, and the sufficient availability of suitably classified counts cannot be assured. Sufficient classified traffic counts must be taken by the Consultant to run the pilot demonstration, in all states.

Counts may be made both by manual and automatic methods. Sufficient axle weight measurements must be performed to categorise the characteristic traffic loading of the different road links. Equipment for traffic counting and axle weighing must be supplied by the Consultant. He should fully specify in his proposal, the equipment to be used, its origin, be it local existing or imported for the project, and arrangements made for local support.

Localised forecasts of future traffic are to be made, based on the counts, vehicle types, axle types, and suitable for input to the PMS.

A project expected to run in parallel to this one (see Section 3.9 Other Related Projects-Traffic Forecasting) will also carry out traffic counts. Duplication of effort is to be avoided, but the sufficient availability of results for this project from other sources is not assured. The Consultant will determine at Inception Report stage the opportunities for collaboration between this and other projects, the validity of existing data, and any possible redeployment of estimated project resources that collaboration may eventually allow.

3.3 Model

A road deterioration model is to be established to process road condition and traffic data. The model should be calibrated using local experience and historic traffic counts to the full extent possible.

If the HDM3 road deterioration module is proposed as a basis for a deterioration model then its adaptation to cold weather conditions must be described in the Consultant's proposal. Results from the current HDM4 development may eventually be used as available and considered appropriate.

Output from the model must identify where maintenance interventions are required, the technical options for action, and the timing of interventions. The model must be capable of demonstrating the effects of different intervention strategies. Estimates of total and discounted costs are to be produced by the model. These estimates must indicate the total vehicle operating costs and the cost of maintenance operations. The processes should be interactive, with the operator able to establish optimised priority rankings according to criteria he sets.

Vehicle Operating Cost (VOC) data and unit prices of work are to be developed within the project.

Road safety aspects should be taken into account, at least qualitatively, or manually.

3.4 Bridges

A bridge management system is to be implemented in each State, defining strategies based on the real condition of each bridge, determined by periodic inspections. It must formalise the decision making process for bridge maintenance.

Two levels of analysis are to be considered:

- at the bridge level, determine the optimal maintenance alternative for the bridge
- at the system level, support decision makers in developing system wide strategies for optimal use of the limited bridge maintenance budgets .

The system should incorporate the following characteristics:

- an integrated diagnostic and assessment procedure to investigate defects, with a standardised description of defects
- build on existing bridge databases as far as possible
- be installed using either established or purpose written software
- be based on proven software, though data entry may be via portable interactive devices during inspection, or later via a standard keyboard and PC. It would be an organisational advantage for the PMS and BMS systems to be as closely integrated as possible..
- provide information on repair techniques
- select network-wide optimal maintenance and repair procedures and priorities based on an optimisation model

The Consultant must develop and enter sufficient economic data to implement the system.

The Consultant's and counterpart local staff are to be trained to run the system. The Consultant is to recommend the staffing levels, other resources, and operational cycle, to permit local staff to continue full implementation of the system

A structural survey of main bridges on the project network is to be performed, and an assessment of maintenance needs including costs is to be presented.

The Consultant is to fully describe in his offer the system he proposes to install, and the extent of inspection and analysis which he plans to implement within this project.

3.5 Design Standards and Maintenance Techniques

3.5.1 Pavements

Current maintenance working practice is to be examined, particularly the use of bituminous bound products. Recommendations are to be made on the progressive introduction of new technology, evolving from the present equipment and working methods.

Existing specifications for bituminous bound materials are to be reviewed in detail. Recommendations for their revision are to be made, basing any proposed changes on Western codes. Draft specifications in the Russian language are to be prepared, by the Consultant's local personnel and under the Consultant's guidance.

Pavement design standards are to be reviewed in detail with local experts, and compared with Western best practice. Suggestions for revision, if considered necessary by the Consultant, are to be made. They should recommend the most suitable Western design guidelines for adoption, noting necessary adaptations.

3.5.2 Traffic Engineering - Safety Standards

Design guidelines and codes relating to road signage, and to geometric design of rural highways, including rural road intersections, are to be reviewed in detail with local experts and compared to current Western practice. Suggestions for revision are to be made. They should recommend the most suitable Western design guidelines for adoption, noting any adaptations, if considered necessary.

Work in this section should be closely coordinated with the road safety seminars, to promote a maximum of local input.

3.6 Study Tour and Seminars

A study tour to Western Europe is to be provided for twenty persons, to be nominated by the Consultant and approved by the Recipient States. The tour is to focus on routine maintenance practice, bitumen bound materials technology and road safety.

The Consultant is to arrange site visits and demonstrations, such as to

- working road and bridge maintenance units
- bituminous bound materials production plants
- in-situ surface recycling operations
- on-site expositions and explanations of road safety dispositions

About five full working days is to be foreseen, plus appropriate acclimatisation/briefing and debriefing periods. Participants should meet West European counterparts, and be able to question them on all aspects of the activities they are shown. Russian language interpreters are to be in attendance.

Short seminars are to be organised in each of the Recipient States to present overviews, explanations of state-of-the-art PMS, bituminous bound products technology, bridge maintenance techniques and concepts of road safety, to Roads Directorate senior staff. Seminar manuals are to be prepared in the Russian language.

Road safety presentations should cover the most recent and ongoing work in the West concerned with the prediction of accidents and implementation of safety measures (eg. conflict techniques of safety situation analysis, the economic analysis of safety measures, recent case studies and risk analysis findings). It may be assumed that the basic principles and established standards of road safety design are already known by the local authorities.

Bridge maintenance presentations should include the most recent Western practice for treatment of cracking, concrete removal, patch repairs, sprayed concrete, external reinforcement, supplementary prestress, corrosion countermeasures, surface treatments, coating of reinforcement, cathodic protection, desalination and realkalisation..

3.7 Cost and Financing of Road Usage

3.7.1 The present system of taxes is neither effective in financing road maintenance, nor in allocating the incremental cost of road usage within the economy. Furthermore, it could provoke

distortion of demand within the transport sector. The general problem has been reviewed in previous reports by Western consultants.

This study is to present a rigorous, authoritative analysis embracing:

- the cost of road usage
 - the elements comprising vehicle operating costs and their dependency on road condition
 - the dependency of condition on maintenance practice
 - the eventual reconstruction costs under scenarios such as do-nothing, minimum maintenance and optimised scenarios
 - the incremental deterioration of pavements under the effect of axle loads
- the advantages and disadvantages of the present collection systems, including for example
 - a comparison with marginal cost pricing
 - the impact of transit fees across the region
 - distortions to competition between modes
 - distortions to vehicle and fuel demand
- external costs of road transport
- foreign exchange components in overall cost of road transport, for the different states

Recommendations are to be made for workable, balanced, systems of levying taxes on road use, and the equitable allocation of funds to road maintenance. The cost inputs are to be considered separately for each State.

A full analysis of tolling of roads and bridges is beyond the scope of this study. However any obvious candidate projects may be cited and used as an example.

The order of magnitude of time and safety costs and savings are to be estimated and presented, but separately from direct costs. The effects of congestion may be included qualitatively.

Full collaboration with the Ministries of Economy and Finance in the preparation of this analysis and recommendations, will be essential for the output to have any impact.

Serious price distortions (eg. through subsidies) have been encountered. Shadow pricing is to be applied as appropriate, but applications should then be clearly explained.

The cost and financing analysis described in this section is to be issued as a separate report dealing with this single issue. It should be clear and concise, to address a readership of Officials in the TRACECA states, foreign consultants (eg to Ministries of Economy and Finance), as well as other decision makers, who may be presumed unfamiliar with transport economics. It should be strictly objective, and applicable as a reference document for negotiations between Ministries of Transport and Ministries of Economy and Finance in the Region. It should emphasise the local consequences and obligations of road maintenance policies, rather than seeking to justify IFI intervention.

3.8 Immediate Investment Opportunities

The PMS (and BMS) and the economic analysis are to be applied to compile an inventory of the most urgent regional road maintenance actions based on the highest economic returns.

It should catalogue and justify, State by State, maintenance sub-projects most susceptible to attract IFI funding.

This section in particular is to be coordinated with the work of other Consultants working on national projects.

3.9 Other Related Projects

Several related reports prepared by Western consultants precede this project. They include:

| | | |
|---|--|------------|
| Road Development Study | Republic of Kazakhstan | EBRD |
| Roads & Road Transport Study | Russia, Ukraine, Kazakhstan & Bielorussia | EBRD |
| Central Asia Outline Transport Strategy | Kazakhstan, Kyrgyzstan, Turkmenistan, Uzbekistan | EBRD/TACIS |
| Azerbaijan Road Project | Azerbaijan | TACIS |
| Armenia Highway Study | Republic of Armenia | TACIS |
| Road Improvement Project | Republic of Turkmenistan | EBRD/TACIS |

The last two mentioned contain detailed recommendations on financing of road improvements particularly relevant to the *Economic* objectives of this project. The contents of these reports may be validated and used by the Consultant for this project, in so far as Armenia and Turkmenistan is concerned, to formulate his recommendations.

At the time of writing the following projects within a similar domain of interest are expected to commence shortly:

| | | |
|----------------------------------|------------------------|-----------|
| Road Rehabilitation Project | Republic of Kazakhstan | ADB |
| Bishkek-Osh Feasibility Study | Republic of Kyrgyzstan | ADB/EBRD |
| Highway Project | Republic of Armenia | WB |
| Meghri-Batoumi Road Study | Republic of Armenia | TACIS/PCP |
| Transport Legal Reform | TRACECA | |
| Improvement of Roadside Services | TRACECA | |

Other related projects are or may be expected to commence within the timeframe of this present one. TRACECA may sponsor a project concerned specifically with institutional reform of highway maintenance.

The Consultants appointed to carry out this project are to co-ordinate their work closely with all other related activities within the TRACECA region. The preceding information must not be considered limitative.

3.10 Local Participation

National consultants and local Institutes should be deeply involved in every aspect of the project. All TRACECA countries have Institutes specialising in various aspects of roads planning and engineering. It is a firm requirement that Organisation and Methodologies include local experts and Institutes to:

- make full use of local experience, antecedent projects and data bases
- promote the emergence of a financially viable local consulting sector
- ensure the effective transfer of know-how to the Beneficiary states
- ensure the enduring effect of project output

Consultants should base their activities, including the writing of reports, largely in the TRACECA region, carrying out the project in close collaboration with local technical organisations, and employing both senior and junior professional staff, from several TRACECA states.

The Consultant's Methodology should fully explain his training and know-how transfer programme within the project. This should allow local organisations to maintain, update and modify the PMS installed. Consultants must make amply clear in their proposal the arrangements they have made to work with local entities.

The databases, models, functions, and licences for software are to remain with regional organisations. At the end of the project, the local organisations must be able to continue developing the systems autonomously.

The Consultants schedule should allow for continuous field work/data collection by local personnel, throughout the project, such that an ongoing operation may be programmed (see Sections 3.1, 3.4 and 4.5).

The close involvement of local Research Institutes in the review of design guidelines is essential, to promote local acceptance of the results (see Section 3.5). Co-authorship of the reviews would be desirable.

3.11 Foreign Expertise

The Consultant is free to compose his expatriate Team for this project, mobilising long and short term participants, as he sees fit. The following domains of expertise should be clearly visible in the proposed staff list:

- project management
- transport economics, particularly road transport and including fiscal aspects
- roads maintenance planning, including cold weather experience
- bituminous bound materials technology

- roads engineering/road safety analysis
- bridge maintenance planning and technology

3.12 Logistics

The Consultant shall be responsible for arranging necessary living accommodation, transportation, telecommunications, equipment (IT and other), surveys, investigations, document reproduction, printing, secretarial services, interpretation, translation, office space and all other input required for the purposes of the work.

4. Time Table and Reporting

4.1 The project is to be completed within a period of twelve months.

Task durations and staff assignments are to be clearly shown on planning schedules in the proposal. Milestones for output and key dates for data acquisition are to be indicated.

4.2 It would be preferable for the study tour to be scheduled as early as possible within the project.

4.3 It is important that reports should not be considered the principal project output of the project, and should not distract from the achievement of all of the defined project Objectives. Reports may be considered as management tools.

4.4 All reports are to be delivered in the numbers, languages and locations as follows:

| | Bound | | Loose-leaf | | Diskette (Eng.+Rus) |
|---------------------------|---------|---------|------------|---------|------------------------|
| | English | Russian | English | Russian | |
| TACIS Brussels | 5 | 1 | 1 | 1 | 2 |
| TRACECA CU (per state) | 1 | 5 | 1 | 1 | 0 |

The word processing programme to be used will be agreed with TACIS (and DOS compatible).

4.5 All reports are to be prefaced by an Executive Summary, and be in accordance with standard TACIS Guidelines.

Project inception report

An Inception Report will be issued within two months of the commencement of the project. It will summarise initial findings and propose any modifications to the methodology and work plan. In particular it will adapt the work plan to the needs of each individual TRACECA state taking into account the parallel activities of other Technical Assistance programmes, avoiding duplication of effort, and addressing unfilled needs.

Project progress report I

This report will be issued at the end of month 6. In addition to the normal progress reviews, and suggested adaptations of the project, it will contain recommendations on the full implementation of the PMS. These should include:

- the institutional arrangements for Recipient State authorities to adopt the system, including the transfer of equipment, hardware and software
- a detailed work programme for continuing field investigations and monitoring to develop the PMS, beyond the duration of the present project
- the staffing level and equipment necessary to maintain such an ongoing programme
- a cost estimate of this ongoing operation, for consideration of the level of financial support that could be provided to local entities to continue development of the PMS.

Progress report II

This report will transmit two separate self-contained Deliverables:

- the economic analysis and financial recommendations described in Section 3.7.
- the review of design standards described in Section 3.5

It will be issued at the end of month 8.

Final Report

The Draft Final Report will be submitted at the end of month 12.

It will contain a full review of project implementation, and recommendations for the development of the database and model.

A separate self-contained Deliverable will describe the Investment Opportunities of Section 3.8.

Any comments on the Draft Final Report will be issued by TACIS Brussels within six weeks of its receipt. The Final Report incorporating any modifications will be issued one month thereafter (2,5 months after issue of the Draft Final)

The Consultant is to describe in his proposal the instruction or operational Manuals for local staff which he intends to produce.